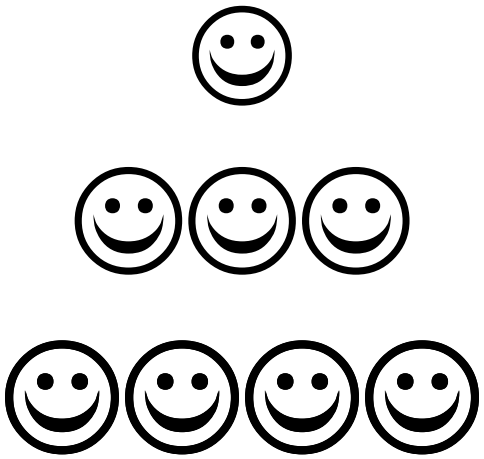
Toqwa'tu'kl Kjijitaqnn / Integrative Science

ThoughtTraps **1**

MSIT 101/103

SENSE OF PLACE, EMERGENCE, AND PARTICIPATION



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TEAM UCCB MSIT 2001

(written by Cheryl Bartlett)

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* some inserts and articles will be handed out in class

UCCB Academic Calendar Description for MSIT 101/103

Course title: Sense of Place, Emergence, and Participation

Mi'kmaq world view: This course will provide an opportunity for students to appreciate Creation and attain skills to restore the traditional thought of co-existence, recognizing that balance and harmony are embodied in First Nations' traditions, and that First Nations' perspectives on the environment reflect consciousness and therefore create attitudes. Discussion will involve the Spiritual Ecology of Indigenous education and two of its six foundations, namely the Mythical and Environmental.

Western science: The need in humans for a deep and intimate association with the natural environment (particularly its living biota) can serve as Common Ground between Western science and Indigenous world views, as it is the evolution-based need recognized in the biophilia hypothesis of Western science. It will be explored by considering details and patterns in diversity, change, relationship, and balance in Nature in conjunction with human consciousness, i.e. how "things" in the external environment are detected, analyzed, and retained in the internal environment of the human senses and brain to develop understandings and knowledge.

Program's ThoughtTraps **symbols**

☺ humans, or human consciousness ... positive involvement or interesting aspect

☹ humans, or human consciousness ... negative involvement or unfortunate aspect

◙ function of a structure

✄ is something missing in this explanation?

☞ pay attention to, or a conclusion, or a summary point, or related to

✍ new understandings starting to accumulate in Western science

♧ spirituality

✪ example

✺ important point ... note it

? question ... ask yourself

❒ your textbook, or another source ... read it!

❖ drawing ... look at one

⊎ metaphor ... one is provided OR you create one

❡ story ... one to add context to, or enhance, your understanding

⊕ map ... create one

⧖ be creative!

CONSCIOUSNESS

QUESTION: What is consciousness?

Answer: There is no widely accepted scientific definition for the concept of ***consciousness*** ... but it is generally understood as an awareness of "I", or "a sense of self", or "the reality of being and knowing" ... extending, within Aboriginal world views, to include "tribal consciousness". Thus, questions that reflect upon different levels of awareness are often part of any discussion about the concept — a list of such questions is provided below.

A list of questions about levels of consciousness

- Is it awareness of the external environment only?
- Is it awareness of the external environment, and also of one's internal environment?
- Is it awareness of the external and internal environments, and also of the presence of self?
- Is it awareness of the external and internal environments, of self, and also of their boundaries?
- Is it awareness of the external environment, of self, of boundaries, and also of one's ability to participate with and influence these ... i.e. awareness that one has the potential to be creative, awareness of the presence of Self?
- Is it awareness of all the above, and also of the interconnectedness of the Universe and thus, of the "now you see it, now you don't" nature of boundaries ... i.e. awareness of the potential of Self to have a spiritual dimension?

☞ **self** ... is broadly acceptable to Western scientists

☞ **Self** ... is problematic for those Western scientists who perceive the concepts of spirit, spiritual, and spirituality as equivalent to a supernatural or divine being or beings

☞ **Self** ... does not conflict with the understandings or way of knowing of modern science, when the concepts of spirit, spiritual, and spirituality relate to our human potential and ability to perceive relationship and unity with, and in, the Universe, and to participate in life in an appropriately positive and creative manner ... i.e. the potential and the ability to sense **creative relationship** with our fellow humans, fellow species, Earth, and Universe. Of course, issues of quality and value immediately become part of any consideration of "appropriately positive and creative" ... and subjectivity has thus entered the discussion, something from which Western science has, since its emergence in the 1600's, tried to free itself.

☞ **MSIT 101/103,** entitled "Sense of Place, Emergence, & Participation", recognizes our human potential to sense creative relationship with the world. It will look at the nature of **consciousness** and **creative relationship**, in particular the **crossing of the boundaries** between the external and internal environments.

Consciousness within world views

Question: Where does the "I" ... or, "sense of self " fit in a world view?
Answer: Western and Aboriginal world views are outlined in the ThoughtTraps ∞∞ for "Scientific Pursuit of Knowledge". Some of these points are repeated below — note the position accorded to "I" in each.

Aboriginal World Views

☺ I participate, therefore we are.

Metaphysics: Nature, or the Universe, is both physical and spiritual.
Ontology: The physical is made of matter and energy, infused with Spirit. The spiritual is sacred. Change and renewal are the most fundamental processes in Nature.
Epistemology: **Experience** is a major epistemic value (indicator of what is real). **Thus, both objectivity and subjectivity are valued — indeed, they are embraced.**

Aboriginal world views are considered to be a holistic "way of knowing"... which means they involve or consider the insights from all different dimensions of what makes a human a human (physical, mental, emotional, and spiritual), plus what makes a human a responsible and caring participant within a community and within Nature (ethics). In other words, there is a place for both objectivity (consensus or group knowledge about the *physical characteristics* of things and processes) and subjectivity (one's or the tribe's *experience*, or knowledge about the *personal and cultural meanings* of things and processes) ... and both are valued.

Western World View

☺ I think, therefore I am.

Metaphysics: Nature, or the Universe, consists of only a physical dimension.
Ontology: Nature, being entirely physical (or material), consists of "fields" of matter and energy dancing in spacetime. "Spirit" is a construct of human consciousness, as is any "sacred" aspect of Nature. There is a small but growing acknowledgment of the creative ability within Nature (as a "self-organizing principle", not a force).
Epistemology: **Measurement** is a major epistemic value (indicator of what is real). **Thus, objectivity is prized, and subjectivity (and along with it, experience) is devalued.**

The Western world view (sometimes also called the Eurocentric world view) is considered to have differentiated "ways of knowing" ... which means that scientific, aesthetic, and religious understandings are to be considered as separate from one another. The scientific "way of knowing" emphasizes objectivity, i.e. attempts to focus only on *physical characteristics* of things and processes, especially characteristics that can be measured. It is assumed that, ideally, the human "knower" can be an "observer" who can detach or separate himself or herself from the things and processes being observed in Nature (although physics research has shown that this assumption is wrong at the quantum level).

Approaches to explore ideas about consciousness

Consciousness studies ... what approach to use?

A common approach in the pursuit of knowledge ... is the breaking up of the whole into parts, which can then be more easily discussed. We will use this approach to discuss consciousness, but will strive to continually acknowledge that "consciousness is more than the sum of its parts".

a **WHOLE** is made up of **PARTS**

Therefore,
if WHOLE = consciousness
then consciousness has ... PARTS

☺ Different cultures and different scholars have schematized the "whole - parts" approach to consciousness in different ways ... be aware of this, so that it does not bewilder you when encountering different schemes.

☺ MSIT will look at concepts of consciousness and their "whole-part" approaches in:

- Aboriginal views: relationships
  - foundations of education
- emerging Western views that overlap Aboriginal views
  - the Biophilia Hypothesis
  - Ecopsychology
  - Creation Spirituality
- Western academia
  - philosophy: easy and hard problems
  - science: brain and building blocks
  - developmental psychology: multiple intelligences
- Integral Psychology

1) Aboriginal views

☺ **consciousness as deriving from relationships among the people, their land, and their language**

It is possible to explore consciousness by acknowledging the wealth of ***relationships*** that create consciousness ... and that are embodied in the language and stories of the people.

- consciousness ... created by the relationships among individuals, families, communities, the natural environment, and the Creator

To appreciate Creation in this way, one must attain skills that recognize the importance of balance and harmony towards attitudes of co-existence. Education can foster these skills.

☞ MSIT discussion of such an Aboriginal educational approach will draw upon the research of **Gregory Cajete**, a Tewa Indian from Santa Clara Pueblo, who is also an educator and scientist at the University of New Mexico. Understandings specific to the Mi'kmaq and other tribes, as available in writings and as brought forward by students within UCCB's Toqwa'tu'kl Kjijitaqnn / Integrative Science program, will also be discussed.

2) Emerging Western views that overlap with Aboriginal views

☺ **consciousness as epistemology reflecting mindful ecology**

☞ MSIT discussion will briefly consider emerging views in the Western world that overlap in significant ways with Aboriginal world views, especially in recognizing that a "healthy consciousness" requires interaction with a "healthy natural environment". These views include:

- the Biophilia Hypothesis
- Ecopsychology
- Creation Spirituality

3) Western academia views

■ ***Western philosophy***

☺ **consciousness studies as having "easy" and "hard" problems**

It is possible to explore consciousness by focusing on the types of problems involved in the discussion, with the problems falling into two main categories ... thus:

- the study of consciousness ... as "easy" and "hard" problems

☞ MSIT discussion of this approach draws mainly upon the work of **David Chalmers**, a philosopher at the University of California.

■ ***Western science***

☺ **consciousness as based in the brain**

It is possible to explore consciousness by focusing on the biological mechanisms involved ...with the enabling assumption that these are located or "seated" in the brain ... thus:

- consciousness ⇒ mind ⇒ brain

This "reductionist approach" characterizes much of Western science. "Mind" is taken to include the *mental, emotional,* and *spiritual* ... all within the context of the *physical*, which is the *moment to moment electro-chemical functioning of the neuronal structures of the brain*.

✳ Most scientists prefer to talk about "mind-brain" rather than "consciousness".

☞ MSIT discussion of the scientific approach ... draws upon understandings in **Cognitive Science** and **Neuroscience** about the brain and the "building blocks" of consciousness.

■ ***Western developmental psychology***

☺ **consciousness as multiple intelligences**

It is possible to explore consciousness by focusing on the developmental potential of individual humans, using research from developmental psychology ... thus:

- consciousness ... humans have multiple intelligences that differ among individuals

☞ MSIT discussion of this approach draws upon "multiple intelligences theory" of **Howard Gardner**, a psychologist at Harvard University whose research points towards 8-9 human intelligences, not just "old-fashioned word and number smarts".

4) Integral Psychology

☺ **consciousness as multidimensional ... "integral psychology"**

It is possible to explore consciousness from diverse perspectives and cultures by focusing on the developmental potential of humans, individually and collectively, with the enabling assumption that humans potentially are multidimensional beings ... thus:

- consciousness of Self ... whole = physical + mental + emotional + spiritual

☞ MSIT discussion of this approach draws upon understandings from "Integral Psychology" as developed by **Ken Wilber,** an American scholar who works outside academia ... and who has developed a detailed "four quadrants" scheme based on comparison of all the world's wisdom traditions, as well as Western science.

ABORIGINAL VIEWS: RELATIONSHIPS FOR A "SENSE OF PLACE, EMERGENCE, AND PARTICIPATION"

☞ First Nations' perspectives on the environment reflect consciousness and therefore create attitudes (from academic calendar description for MSɬT 101/103).

Consciousness, or the finding of Self (i.e., an individual's *Sense of Place, Emergence, and Participation*), requires the cultivation of a direct awareness of one's natural environment ... and the involvement of all of one's senses, responsibilities to Self and community, and sensitivities to spiritual essences.

☺ Education can nurture this consciousness.

Elements within education ... elements within knowledge
The word "element" refers to "things that must come first in order to create more complex things later".

✪ For example, you must attend *element*ary school before advancing to junior high, senior high, and university.

This concept, of things "basic and central" is found in the knowledge systems of both Aboriginal people and Western science, and in their educational systems.

- Western science, with an ontology of matter and energy, has traditionally centred much of its understandings around the different types of building blocks of inanimate matter — i.e. awareness of the diverse atoms in the Universe and their properties. This basic and central concept is generally depicted as the *Periodic Table of the Elements*, and studied in Chemistry (which is, therefore, sometimes called the "central science"). "Building blocks" is a common theme in Western science ... note that the concept refers to objects, i.e. nouns.

- Aboriginal world views, with an ontology of matter and energy and spirit, are traditionally centred around the diverse relationships and responsibilities required to create consciousness and community — i.e. awareness of life and Nature. This central concept has been depicted in different ways by different Aboriginal peoples, but all seek to show the "interconnectedness" of the various parts within the overall awareness. Gregory Cajete has researched and written extensively on the interconnectedness or "ecology" of the educational approach that can nurture this awareness, and his ideas are outlined below. "Ecology" can be considered the web of relationships that sustain life ... note that "relationships" focus on interactions, i.e. verbs.

Foundations of Indigenous Education (*sensu* Gregory Cajete)

Gregory Cajete is a Tewa Indian from the Santa Clara Pueblo in New Mexico, a scientist, and an Assistant Professor in the College of Education at the University of New Mexico. He has researched and written extensively on Indigenous educational approaches, and written three keys books.

- His 1994 book *Look to the Mountain; an Ecology of Indigenous Education* discusses seven elemental or foundational processes that characterize Indigenous education. It is the source of the information outlined herein.

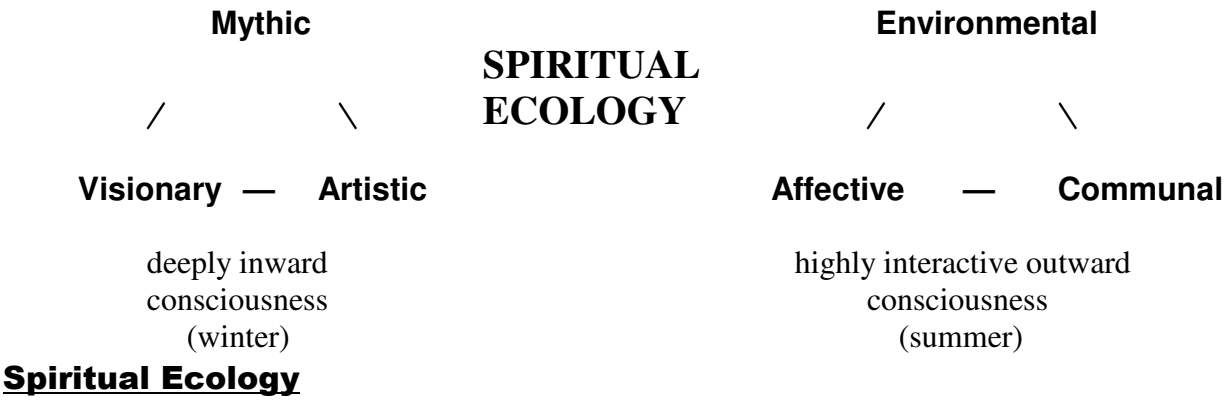
- His 1999 book *Igniting the Sparkle; an Indigenous Science Education Model* describes an educational model to examine Western and Indigenous "ways of knowing" in science. It was used to help design the new curricula for the MSIT science courses.

- His 2000 book *Native Science; Natural Laws of Interdependence* discusses the philosophy of and knowledge within Native science. It is a required textbook for the Toqwa'tu'kl Kjijitaqnn / Integrative Science program.

Cajete's seven foundations of Indigenous education are:

- Spiritual Ecology ..... discussed in MSIT 101/103
- Environmental Foundation ..... discussed in MSIT 101/103
- Mythical Foundation ..... discussed in MSIT 101/103
- Visionary Foundation ..... discussed in MSIT 201/203
- Artistic Foundation ..... discussed in MSIT 201/203
- Affective Foundation ..... discussed in MSIT 201/203
- Communal Foundation ..... discussed in MSIT 201/203

Figure p. 38, The ebb and flow of tribal education, Cajete (1994), *Look to the Mountain; an Ecology of Indigenous Education:*



information directly from: Cajete (1994), *Look to the Mountain; an Ecology of Indigenous Education*, Chapter 3 "For Life's Sake"

Note: at the end of the chapter on Spiritual Ecology, Cajete states the following:

> This chapter has outlined a perspective of Indigenous education inherent in Native American spirituality. Native American traditionalists would contend that all learning is related to the spirit. Native American progressives would agree that they may be so, but it is also essential that Indian people be trained to compete and exist in a modern world. Many people are uncomfortable with spirituality in any aspect of modern education because of the instances of misunderstanding and misapplication of spirituality in modern society. As with everything in human affairs, it becomes a matter of perspective and consciousness.
>
> My intent has been to present a point of view based on my own visioning and tempered by my experience as an American Indian, image maker, and professional educator. There are many paths to the Center. There are infinite ways to talk about and image that Center, "that place the Indians talk about." We walk infinite paths and talk in infinite ways about getting to the Center every day of our lives. This has been going on in every generation of every culture of mankind since the first words were spoken and the first images constructed. It is a very, very long human quest!

The Spiritual Ecology Foundation is both a foundational process and a field.

- As a foundational process ... it involves the recognition that one's own spirituality evolves from exploring and experiencing the living energy moving in each of us, through us, and around us ... thus, the necessity for life-long learning and a personal pathway ... towards the ultimate goal of being fully knowledgeable about one's innate spirituality.

- As a field ... it integrates one's innate spirituality with the other six foundations ... and with the spiritual traditions of the family, the community, and the tribe

Spiritual Ecology ... as a field

The diverse native peoples of North America had many *shared structures and tools for learning about spirit*, for example: the roles of shamanism, the making of sacred art, the use of the sweat lodge, the reflection of the cosmos in a tribe's central ceremonial structures, vision questing, and ceremonies, rituals, and dances tied to Nature's cycles.

In addition, there were many *shared metaphors and concepts about spirit* that found unique forms of expression among different tribes, as for example the understanding that breath represents spirit in all living things, with language (and its oral stories, songs, prayers, and chants) being its most tangible form of expression and having immense power to move people (i.e. orient them) by expressing human thoughts and feelings. Breath could also be consciously formed and activated through various rituals, dances, sport, work, play, and art.

Learning about the nature of the spirit in relationship to community and the environment was considered central to learning the full meaning of life. *Five general characteristics are shared*

by such spiritual traditions:

1. lack of an espoused doctrine of religion ... reflecting a focus on life processes rather than a restriction to intellectual structures

2. recognition that spoken words and language have a quality of spirit ... and a life energy that can influence other energy and life forms towards certain ends ... thus when language is used in a spiritual, evocative, or affective context it is sacred and is to be used responsibly

3. recognition that the creative act of making something with spiritual intent has its own quality and spiritual power ... that needs to be understood and respected ... thus art was sacred

4. recognition that life and spirt move in never-ending cycles of creation and dissolution ... therefore, ceremonial forms, life activities, and the transformations of spirit are cyclical ... they follow the visible and invisible patterns in Nature ... thus ritual cycles are used to structure and express the sacred in the communal context of traditional life

5. recognition that Nature is the true ground of spiritual reality ... natural forms and forces are expressions of spirit whose qualities interpenetrate the life and process of human spirituality ... thus, Nature is sacred and its Spiritual Ecology is reflected throughout, leading to the concept of sacred knowledge.

And, with respect to sacred knowledge, there are *shared basic understandings*:

- a universal energy infuses everything in Nature and expresses itself through a multitude of manifestations

- all things and all thoughts are related through spirit

- people must constantly be aware of their weakness and strive to become wise in the ways that they live their lives. Through story, humor, and ritual, people "remember to remember" who they are, where they come from, and the spirit they share with all of creation.

Spiritual Ecology ... as a foundational process

Spiritual ecology has four basic concepts that inform the expression of the spiritual dimension in Indigenous education.

1. seeking life and becoming complete

This concept is captured in many of the metaphoric phrases that imply a journey of learning to know life in all its manifestations — especially those of the spirit — and through this journey a state of wholeness ... phrases such as "seeking life, for life's sake, to find life, to complete, to become complete, of good heart, of good thought, with harmony" exist in all native languages and are often used to begin and end communal events, in ritual, in stories, in conversation, as greetings, and in teaching.

> Cajete states (p. 46): As a guiding concept "seeking life and becoming complete" pervades the expressions of Native American spirituality to such an extent that it is seldom discussed or questioned. Historically, this was the world view that guided thought and behaviour. The extent to which this guiding concept was internalized compares with the pervasive internalization of capitalism and the consumer mindset of modern Americans. Capitalism and consumerism are so ingrained in the American "real world" that they are seldom questioned as foundations of the mindset of most modern people. For many moderns, this orientation has become a theology of money, treated as sacred and strived for religiously. For American Indians and other Indigenous people, Spirit and Nature were the real world, the ground of existence upon which they formed a theology of Nature that has evolved and matured over the last forty thousand years.

2. thinking the highest thought

This concept means thinking of one's self, one's community, and one's environment richly, i.e.. in the highest, most respectful, and compassionate way ... which influences the actions of both individuals and the community ... and thus the community becomes a center for teaching and a context for learning how to live ecologically. Living ecologically is also about living in harmonious relationship to a "place" ... the sacred place embodied by the community itself and as told in its guiding story.

Learning to think the highest thought is a step-by-step process ... each step is a "way of thinking":

1st: One has to come to terms with where one lives physically ... one's home, one's village, and then the land — the Earth upon which one lives ... its hills, valleys, forests, rivers, lakes, and seas ... the place where you live ... **awareness of one's physical environment**.

2nd: One has to come to terms with other people, plants, animals, and natural elements and phenomena ... by consciously coming to understand the nature of one's relationships to other people, other life, and the natural world. It is a way of thinking that allows one to experience and understand the differences and similarities between the life in one's self, other living things, and other entities of the natural world.

3rd: One has to come to terms with reflective contemplation, speaking, and acting ... which

involves applying the capacity to think things through completely, to make wise choices, to speak responsibly for purpose and effect, and to act decisively to produce something that is useful and has spirit. This also has to do with the expression of respect, ethics, morals, and proper behaviour. It brings forth the best and most desirable aspect of humanness as a proper response to learning and dealing with the natural world.

4th: One has to come to terms with the kind of knowing that comes from long experience with all aspects of human life ... it requires a learning that comes only from maturity ... and leads to a knowing that includes, but also moves beyond knowing just through the physical senses towards wisdom. Wisdom is a complex state of knowing founded on accumulated experience ... it is the realm of the Elders.

5th: One has to come to terms with thinking that starts with wisdom and evolves beyond it to understanding and knowing the spirit directly with all one's senses. It is a multisensory consciousness, a way of knowing associated with the mystic or spiritual leaders, or the most elderly (although this is not always the case, for this way of thinking can develop earlier in life from visionary experiences). This is also the level of thinking most closely associated with myth and dream.

3. orientation

This concept is about more than an external orientation to the physical context and placement of family, community, society, and culture. It is about learning an internal orientation to self and to spirit ... it is about a mindset, ways of thinking and knowing, origins of communication, and a sense of direction. It is about how the human spirit understands itself ... and Indigenous people have many different tribal expressions of this shared concept.

4. pathway

This concept is about the understanding that learning involves a transformation that unfolds through time and space — learning can be said to be like the process of journeying which requires a pathway. In traveling a pathway, we make stops, encounter and overcome obstacles, recognize and interpret signs, seek answers, and follow the tracks of those entities that have something to teach us. We create ourselves anew. In this metaphor, "path" denotes a structure, and "way" denotes a process ... and Indigenous peoples have many different tribal expressions of this shared concept.

Environmental Foundation

information directly from: Cajete (1994), *Look to the Mountain; an Ecology of Indigenous Education*, Chapter 4 "Singing Waters"

Environmental education provides the foundation that enables human beings to resonate individual and communal "inscapes" with the natural environment ... and revolves around issues that are essentially ethical, religious, and sacred.

- This is in direct opposition to most modern education wherein extreme profaneness and materialism are emphasized ... which leads to conditioning that engenders a radical destructiveness at the individual, spiritual, communal, and environmental levels of being.

- Indigenous environmental understandings, in contrast, are centered around the fact that "we are all related, and that includes the natural environment".

Harmonizing with "place" is a matter of spiritual, psychological, and cultural survival for Indigenous people.

- Harmonizing involves the integration of mind, body, and spirit through a dynamic and complex set of activities. Living in a harmonious and sustainable relationship with the land was a sacred responsibility ... tempered with the realization that neglect of the responsibility would bring dire results and retribution from the Earth. The perpetuation of this sacred and survival-oriented responsibility from one generation to the next was accomplished through myth, ritual, art, traditional education, and honouring the "**psychology of place**".

Indigenous people perceive multiple realities in Nature — that experienced by the five senses was only one of many possibilities.

- In such a "multiverse," knowledge could be received directly from animals, plants, and other living and non-living entities. They perceived that animals and plants have ritual ways of behaviour that interact with one another. All life and Nature have a "personhood," a sense of purpose and inherent meaning expressed in many ways and at all times.

- The real test of living was to establish a harmonious relationship with Nature, i.e. the land and the place where Indigenous people lived — to understand it, to see it as a source of one's life and livelihood, and the source of one's essential well-being.

Nature was the essence of the Great Mystery, which guides and breathes life into all things. The land was full of spirit, full of life energy. Everything — a rock, a tree, a plant, a mountain, an animal, a bird, an insect — had its unique expression of life and way of Spirit ... and this understanding was coded into the process of education.

Basic concepts within the Environmental Foundation include:

- natural world as a sacred pathway of knowledge and learning.

  Certain geographical features personify ties between natural processes. Generally, such features are looked upon as sacred places. These natural features may be specific formations, springs, lakes, rivers, mountains, or other natural places. Therefore, much attention is given to ways of knowing and learning about important natural phenomena.

- relationships and their multidimensional significance

  1) co-creative relationships

  2) web relationships

  3) right relationships

  4) symbolic representations of relationships
     - projections, pathways, cycles
     - Earth, Moon, Sun, Stars
     - seasons

Mythical Foundation

information directly from: Cajete (1994), *Look to the Mountain; an Ecology of Indigenous Education*, Chapter 5 "Living our Myths"

Cajete (p. 134) states:

> The evolution of human consciousness has generally been marked by transformations of the guiding myths that a society holds. In a sense, mythic stories trace the journey of a people through different stages of their consciousness as well as through the times and places in which they have lived.

He begins the chapter on the Mythical Foundation with the following thoughts:

> When appropriately accessed, tribal myths contain tremendous potential for illuminating the education of both the individual and the community. Every body of Tribal myth contains a variety of stories that are culturally important to a tribe and reflect their uniqueness. Tribal myths are filled with metaphors, symbols, images, and creative linguistic and visual forms that are emotionally affective for members of a tribe. They represent accounts of the world as experienced and interpreted through the history of the people of a tribe. As a whole, they are reflections of the role of people and entities that affect a tribe's world. They are a body of explanation that forms the Story of the People as they have perceived themselves through generations of relationship to their lands and to each other.
>
> Each tribe created vehicles for accessing the psychological energy contained in their body of myth. Through the telling, performance, and artistic expression of myth, Tribal teachers actively brought their bodies of myth alive and made its lessons relevant to their audience's time and place. While keeping true to the core meanings of their myths, Tribal teachers continually improvised, reorganized, and recreated the particular expressions of a myth to fit their audience, the situation, and their own personal expression. In reality, every myth is renewed with each time and in each place it is told. Myths life through each teller and through each audience that hears and actively engages them. Myths and their enactment in every form were the way a tribe remembered to remember their shared experiences as a people.

Cajete follows the above with these points:

- Humans are story-telling animals. Story is a primary structure through which humans think, relate, and communicate. We make stories, tell stories, and live stories because it is such an integral part of being human. Myths, legends, and folk tales have been cornerstones of teaching in every culture.

- Myths explain what is means to live in community with one another. They explain human dependence on the natural world and essential relationships that must be maintained therein. They explore the life-and-death matters of human existence and relate such matters to basic origins, causes, or relationships. They reflect on the concerns that are basic and crucial to human's understanding of themselves. Creation, survival, relationship, healing, wholeness, and death are the consistent themes of myth in every culture, place, and time.

- The function of myth is as diverse and complex as human life and culture. The myths that we live by glue our communities together through shared metaphors of identify and purpose.

Myths help to balance individual psychologies and connect them to the greater whole of the tribe, natural environment, and global community. Myths resound the spiritual essence of religion and ritual in life-related terms. Myths mirror the paradoxes of life and reflect the truth behind every paradox.

- Myths live or die through people. Myths, as human creations, are messages — as well as a way of conscious reflection — that live through the people who share them.

- Living through myth means using the primal images that myth presents in a creative process of learning and teaching that connects our past, present, and future. Living through myth also means learning to live a life of relationships to ourselves, other people, and the world based appreciation, understanding, and guidance from our inner spirit and our wealth of ancestral and cultural traditions.

- Mythic images are ... pictures that involve us both physiologically, in our bodily reactions to them, and spiritually, in our higher thoughts about them. When a person is aware of living mythically, he or she is experiencing life intensively and reflectively.

Mi'kmaq Understandings

The Significance of the Number Seven (7)

- The Creation Story is as told by Steven Augustine, Big Cove, New Brunswick. The Mi'kmaq language is in his style.
- At the end of the story where the 7 districts are listed, now that is in the Bernie Francis style Mi'kmaq language.
- contributed to the Toqwa'tu'kl Kjijitaqnn / Integrative Science program by Linda Gould, Fall 2000.

What are the sevens (7's) in Mi'kmaq spirituality?

1) 7 stages of creation
2) 7 directions
3) 7 districts
4) 7 Mi'kmaq medicines
5) 7 virtues

Mi'kmaq Creation Story

This story has been passed down from generation to generation since time immemorial and it explains how Mi'kmaq people came into existence in North American. The story tells about the relationship between the Great Spirit Creator and Human Beings and the Environment. It also explains a philosophical view of life, which is indigenous to North America. This way of thinking is evident in the Native Languages and Cultures and in the spiritual practices.

The fact that the Mi'kmaq people's language, culture and spiritualism have survived for centuries is based on the creation story. Respect for their elders has given them wisdom about life and the world around them. The strength of their youth has given them the will to survive. The love and trust of their motherhood has given them a special understanding of everyday life.

Among the Mi'kmaq people, the number seven is very meaningful. There are seven districts for distinct areas that encompass an area of land stretching from the Gaspe coast of Quebec and include New Brunswick, Prince Edward Island and Nova Scotia. The most powerful spirit medicine is made from seven barks and roots. Seven men, representatives from each distinct area or Grand Council District sit inside a sweat-lodge smoke the pipe and burn the sweet grass. Inside the sweat lodge, the Mi'kmaq will pour water over seven, fourteen and then twenty-one heated rocks to produce hot steam. A cleansing or purification takes place. A symbolic rebirth takes place and the men give thanks to the Spirit Creator, the Sun and the Earth. They also give thanks to the first family, Kluskap, Nogami, Netaoansom, and Neganagonimgoosisgo.

Here's the story.

ONE
KISU'LK

Kisu'lk is the Great Spirit Creator who is the one who made everything. The word Kisu'lk in Mi'kmaq means "you have been created". It also means "the one credited for your existence".

The word does not imply gender. Kisu'lk is not a He or She; it is not important whether the Great Spirit is a He or She.

The Mi'kmaq people do not explain how the Great Spirit came into existence only that Kisu'lk is responsible for everything being where it is today. Kisu'lk made everything.

TWO
NISKAM

Niskam is the sun, which travels in a circle and owes its existence to Gisoolg. Niskam is the giver of life. It is also a giver of light and heat.

The Mi'kmaq people believe that Niskam is responsible for the creation of the people on earth. Nisgam is Gisoolg's helper. The power of Niskam is held with much respect between the Mi'kmaq and other aboriginal peoples. Niskam owes its existence to Kisu'lk the Great Spirit Creator.

THREE
OOTSITGAMOO

Ootsitgamoo is the earth or area of land upon which the Mi'kmaq people walk and share its abundant resources with the animals and plants. In the Mi'kmaq language Oetsgitpogooin means "the person or individual who stand upon this surface", or "the one who is given life upon this surface of land". Ootsitgamoo refers to the Mi'kmaq world, which encompasses all the area where the Mi'kmaq people can travel or have traveled upon.

Ootsitgamoo was created by Kisu'lk and was placed in the center of the circular path of Niskam, the sun. Nisgam was given the responsibility of watching over the Mi'kmaq world or Ootsitgamoo. Niskam shines bright light upon Ootsitgamoo as it passes around the world and this brought the days and nights.

FOUR
KLUSKAP

After the Mi'kmaq world was created and after the animals, birds and plants were placed on the surface, Kisu'lk caused a bolt of lightening to hit the surface of Ootsitgamoo. This bolt of lightening caused the formation of an image of a human body shaped out of sand. It was Kluskap who was first shaped out of the basic element of the Mi'kmaq world, sand.

Kisu'lk unleashed another bolt of lightening which gave life to Kluskap but yet he could not

move. He was stuck to the ground only to watch the worlds go by and Niskam traveled across the sky everyday. Kluskap watched the animals; the birds and plants grow and pass around him. He asked Niskam to give him freedom to move about the Mi'kmaq world.

While Kluskap was still unable to move, he was lying on his back. His head was facing the direction of the rising sun, east, Oetjgoabaniag or Oetjibanoog. In Mi'kmaq these words mean "where the sun comes up" and "where the summer weather comes from" respectively. His feet were in the direction of the setting sun or Oetgatsenoog. Other Mi'kmaq words for the west are Oeloesenoog, "where the sun settles into a hallow" or Etgesnoog " where the cold winds come from". Kluskap's right hand was pointed in the direction of the north or Oatnoog. His left hand was in the direction of the south or Opgoetasnoog. So it was the third big blast of lightening that caused Kluskap to become free and to be able to stand on the surface of the earth.

After Kluskap stood up on his feet, he turned around in a full circle seven times. He then looked toward the sky and gave thanks to Kisu'lk for giving him life. He looked to the earth or the ground and gave thanks to Ootsigamoo for offering its sand for Kluskap's creation. He looked within himself and gave thanks to Niskam for giving him his soul and spirit.

Kluskap then gave thanks to the four directions east, north, west and south. In all he gave his heartfelt thanks to the seven directions.

Kluskap then traveled to the direction of the setting sun until he came to the ocean. He then went south until the land narrowed and he came to the ocean. He then went south until the land narrowed and he could see two oceans on either side. He again traveled back to where he started from and continued towards the north to the land of ice and snow. Later he came back to the east where he decided to stay. It is where he came into existence. He again watched the animals, the birds and the plants. He watched the water and the sky. Kisu'lk taught him to watch and learn about the world. Kluskap watched but he could not disturb the world around him. He finally asked Kisu'lk and Niskam, what was the purpose of his existence. He was told that he would meet someone soon.

FIVE
NOGAMI

One day when Kluskap was traveling in the east he came upon a very old woman. Kluskap asked the old woman how she arrived to the Mi'kmaq world. The old woman introduced herself as Nogami. She said to Kluskap, I am your grandmother". Nogami said that she owes her existence to the rock, the dew and Niskam, the sun. She went on to explain that on one chilly morning a rock became covered with dew because it was sitting in a low valley. By midday when the sun was most powerful, the rock got warm and then hot. With the power of Niskam, the sun, Kisu'lk's helper, the rock was given a body of an old woman. This old woman was Nogami, Kluskapk's grandmother.

Nogami told Kluskap that she came to the Mi'kmaq world as an old woman, already very wise and knowledgeable. She further explained that Kluskap would gain spiritual strength by listening to and having great respect for his grandmother. Kluskap was so glad for his

grandmother's arrival to the Mi'kmaq world he called upon Abistanooj, a marten swimming in the river, to come ashore. Abistanooj did what Kluuskap had asked Him to do. Abistanooj came to the shore where Kluskap and Nogami were standing. Kluskap asked Abistanooj to give up his life so that he and his grandmother could live. Abistanooj agreed. Nogami then took Abistanooj and quickly snapped his neck. She placed him on the ground. Kluskap for the first time asked kisu'lk to use his power to give life back to Abistanooj because he did not want to be in disfavor with the animals.

Because of marten's sacrifice, Kluskap referred to all the animals as his brothers and sisters from that point on. Nogami added that the animals will always be in the world to provide food, clothing, tools, and shelter. Abistanooj went back to the river and in his place lay another marten. Kluskap and Abistanooj will become friends and brothers forever.

Nogami cleaned the animal to get it ready for eating. She gathered the still hot sparks from the lightening which hit the ground when Kluskap was given life. She placed dry wood over the coals to make a fire. This fire became the Great Spirit Fire and later was known as the Great Council Fire.

The first feast of meat was cooked over the Great Fire, or Ekjibuctou. Kluskap relied on his grandmother for her survival, her knowledge and her wisdom. Since Nogami was old and wise, Kluskap learned to respect her for her knowledge. They learned to respect each other for their continued interdependence and continued existence.

SIX
NETAOANSOM

One day when Kluskap and Nogami were walking along in the woods, they came upon a young man. This young man looked very strong because he was tall and physically big. He had grey coloured eyes. Kluskap asked the young man his name and how he arrived to the Mi'kmaq world. The young man introduced himself. He told Kluskap that his name is Netaoansom and that he is Kluskap's sister's son, in other words, his nephew. He told Kluskap that he is physically strong and that they could all live comfortably. Netaoansom could run after moose, deer and caribou and bring them down with his bare hands. He was very strong. Netaoansom said that the east wind blew hard it caused the waters of the ocean to become rough and foamy. This foam got blown to the shore on the sandy beach and finally rested on the tall grass. This tall grass was sweetgrass. Its fragrance was sweet. The sweetgrass held onto the foam until Niskam, the sun, was high in the midday sky. Niskam gave Netaoansom spiritual and physical strength in a human body. Kisu'lk told Kluskap that if he relied on the strength and power of his nephew he would gain strength and understanding of the world around him.

Kluskap was so glad for his nephew's arrival to the Mi'kmaq world, he called upon the salmon of the rivers and seas to come to shore and give up their lives. The reason for this is that Kluskap, Netoansom and Nogami did not want to kill all the animals for their survival. In celebration of his nephew's arrival, they all had a feast of fish. They all gave thanks for their existence. They continued to rely on their brothers and sisters of the woods and waters. They relied on each other for their survival.

SEVEN
NEGANOGONIMGOSSEESGO

While Kluskap was sitting near a fire, Nogami was making clothing out of animal hides and Netaoansom was in the woods getting food. A woman came to the fire and sat beside Kluskap. She put her arms around Kluskap and asked "Are you my son?" Kluskap was surprised. He stood up and asked the woman who she was and where she came from. She explained that she was Kluskap's mother. Her name is Neganogonimgooseesgo. Kluskap waited until his grandmother and nephew returned to the fire then he asked his mother to explain how she arrived to the Mi'kmaq world.

Neganogonimgooseesgo said that she was a leaf on a tree which fell to the ground. Morning dew formed on the leaf and glistened while the sun, Niskam, began its journey towards the midday sky. It was at midday when Niskam gave life and a human form to Kluskap's mother. The spirit and strength of Niskam entered into Kluskap's mother.

Kluskap's mother said that she brings all the colours of the world to her children. She also brings strength and understanding. Strength tdo withstand earth's natural forces and understanding of the Mi'kmaq worldk; its animals and her children, the Mi'kmaq. She told them that they will need understanding and co-operation so they all can live in peace with one another.

Kluskap was so happy that his mother came into the world and since she came from leaf, he called upon his nephew to gather nuts, fruits of the plants while Nogami prepared a feast. Kluskap gave thanks to Kisu'lk, Niskam, Ootsitgamoo, Nogami, Netaoansom and Neganogonimgooseesgo. They all had a feast in honour of Kluskap's mother's arrival to the world of Mi'kmaq.

The story goes on to say that Kluskap, the man created from the sand of the earth, continued to live with his family for a very long time. He gained spiritual strength by having respect for each member of the family. He listened to his grandmother'wisdom. He relied on his nephew's strength and spiritual power. His mother's love and understanding gave him dignity and respect. Kluskap's brothers and sisters of the wood and waters gave him the will and the food to survive. Kluskap now learned that mutual respect of his family and the world around him was a key ingredient for basic survival. Kluskap's task was to pass this knowledge to his fellow Mi'kmaq people so that they too could survive in the Mi'kmaq world. This is why Kluskap became a central figure in Mi'kmaq story telling.

One day when Kluskap was talking to Nogami he told her that soon they would leave his mother and nephew. He told her that they should prepare for that occasion. Nogami began to get all the necessary things ready for a long journey to the North. When everyone was sitting around the Great Fire one evening, Kluskap told his mother and nephew that he and Nogami are going to leave the Mi'kmaq world. He said that they will travel in the direction of the North only to return if the Mi'kmaq people were in danger. Kluskap told his mother and nephew to look after the Great Fire and never to let it go out.

After the passing of seven winters, "elwigneg daasiboongeg", seven sparks will fly from the fire and when they land on the ground seven people will come to life. Seven more sparks will land

on the ground and seven more people will come into existence. From these sparks will form seven women and seven men. They will form seven families. These seven families will disperse into seven different directions from the area of the Great Fire. Kluskap said that once the seven families get to their place of destination, they will further divide into seven groups.

Each group will have their own area for their subsistence so they would not disturb the other groups. He instructed his mother that the smaller groups would share the earth's abundance of resources of which included animals, plants and fellow humans.

Kluskap told his mother that after the passing of seven winters, each of the seven groups would return to the place of the Great Fire. At the place of the fire all the people will dance, sing and drum in celebration of their continued existence in the Mi'kmaq world. Kluskap continued by saying that the Great Fire signified the power of the Great Spirit Creator, Kisu'lk. It also signified the power and strength of the light and heat of Niskam, the sun. The Great Fire held the strength of Ootsitgamoo the earth. Finally the fire represented the bolt of lightening which hit the earth from which Kluskap was created. The fire is very sacred to the Mi'kmaq. It is the most powerful spirit on earth.

Kluskap told his mother and nephew that it is important for the Mi'kmaq to give honour, respect and thanks to the seven spiritual elements. The fire signifies the first four stages of creation, Kisu'lk, Niskam, Ootsitgamoo and Kluskap. Fire plays a significant role in the last three stages as it represents the power of the sun, Niskam.

In honour of Nogamits arrival to the Mi'kmaq world, Kluskap instructed his mother that seven, fourteen and twenty-one rocks would have to be heated over the Great Fire. These heated rocks will be placed inside a wigwam covered with hides of moose and caribou or with mud. The door must face the direction of the rising sun. There should be room for seven men to sit comfortably around a pit dug in the center where up to twenty-one rocks could be placed. Seven alders, seven wild willows and seven beech saplings will be used to make the frame of the lodge. This lodge should be covered with the hides of moose, caribou, deer or mud.

Seven men representing the seven original families will enter into the lodge. They will give thanks and honour to the seven directions, the seven stages of creation and continue to live in good health. The men will pour water over the rocks causing steam to rise in the lodge to become very hot. The men will begin to sweat up to point that it will become almost unbearable. Only those who believe in the spiritual strength will be able to withstand the heat. Then they will all come out of the lodge full of steam and shining like newborn babies. This is the way they will clean their spirits and should honour Nogami's arrival.

In preparation of the sweat, the seven men will not eat any food for seven days. They will only drink the water of golden roots and bee nectar. Before entering the sweat the seven men will burn the sweetgrass. They will honour the seven directions and the seven stages of creation but mostly for Netaoansom's arrival to the Mi'kmaq world. The sweet grass must be lit from the Great Fire.

Kluskap's mother came into the world from the leaf of a tree, so in honour of her arrival tobacco

made from bark and leaves will be smoked. The tobacco will be smoked in pipe made from a branch of a tree and a bowl made from stone.

The pipe will be lit from sweetgrass which was lit from the Great Fire. The tobacco made from bark, leaves and sweetgrass represents Kluskap's grandmother, Nephew and mother. The tobacco called "spebaggan" will be smoked and the smoke will be blown in seven directions.

After honouring Nogami's arrival the Mi'kmaq shall have a feast or meal. In honour of Netawansom they will eat fish. The fruits and roots of the trees and plants will be eaten to honour Kluskap's mother.

Kluskap's final instruction to his mother told her how to collect and prepare medicine from the barks and roots of seven different kinds of plant. The seven plants together make what is called "ektjimpisun". It will cure mostly every kind of illness in the Mi'kmaq world. The ingredients of this medicine are: "wikpe"(alum willow), "waqwonuminokse"(wild black-cherry), "kastuk"(ground hemlock), and "kowotmonokse"(red spruce).

The Mi'kmaq people are divided into seven distinct areas which are as follows:

1) Wunama'kik (Cape Breton Island, Nova Scotia)
2) Piwktuk (Pictou, Nova Scotia) and Epekwitk (Prince Edward Island)
3) Eskikewa'kik (Eastern Shore, Nova Scotia)
4) Sipekne'knatik (South Shore, Nova Scotia)
5) Kespukwitk (Annapolis Valley, Nova Scotia)
6) Siknikt (Cumberland County, Nova Scotia, and southern New Brunswick)
7) Kespek (Northern New Brunswick, and parts of Gaspe, Quebec)

EMERGING WESTERN VIEWS THAT OVERLAP WITH ABORIGINAL VIEWS

Some new intellectual and social movements in the Western world have considerable Common Ground with Aboriginal knowledge ... an overlap that has led some Aboriginal people to raise concerns both about appropriation of traditional knowledge by non-natives and contamination of traditional knowledge with "new age" thinking.

For the purposes of the Toqwa'tu'kl Kjijitaqnn / Integrative Science program ... the overall desire is to facilitate mutual understandings via recognition of Common Ground and acknowledgment of differences.

- With respect to Aboriginal or Indigenous views, Gregory Cajete's research is instrumental as it thoroughly articulates shared concepts in traditional Indigenous efforts towards holistic education. Some of Cajete's work was outlined earlier in these MSIT 101/103 ThoughtTraps and more in the MSIT 201/203 ThoughtTraps.

- With respect to Western views, among the many emerging ideas or movements, three are outlined below ... chosen on the basis of their on-going efforts towards conceptual coherence, scholarship, and public openness.

  ➜ two ... wherein the central understanding is that a "healthy human consciousness or spirit" requires interaction with "a healthy natural environment" (epistemology reflects ecology)

  - **Biophilia** ..... the above idea put forward as a testable idea (hypothesis) in Western science

  - **Ecopsychology** ..... the above idea put into action — as an effort to revision what human psychology is, or should have been in the first place, such that it takes the ecological context of human life into account (something current theories in psychology tend to ignore)

  ➜ one ... wherein the central effort is to integrate the wisdom of Western spirituality and global Indigenous cultures with the emerging scientific understanding of the universe and the awakening artistic passion for creativity

  - **Creation Spirituality** ..... the above idea put into action

Biophilia

Biophilia is the idea, put forward as a scientific hypothesis, that humans are dependent on nature for, not only for simple material and physical sustenance, but also aesthetic, intellectual, cognitive, and spiritual meaning and satisfaction. The dependency is held to be part of human's evolutionary heritage ... not just a disguised attempt to promote or romanticize "tree-hugging".

The biophilia hypothesis, with its emphasis on the importance of human contact with nature and especially living biota ... connects directly with issues surrounding ***biodiversity*** ... which is very much an accepted, and increasingly important, area in Western science.

Biodiversity is also an area for which the United Nations recognizes that Indigenous peoples have extensive knowledge ... often labeled ***Traditional Ecological Knowledge (TEK)***, or ***Indigenous Knowledge (IK)***.

For this reason, biodiversity and issues surrounding it ... especially ecosystems and organisms ... are topics of the various optional MSIT courses for the Toqwa'tu'kl Kjijitaqnn / Integrative Science program:

- MSIT 211 Ecosystems of Cape Breton
- MSIT 221 Water, soils, minerals, and climate
- MSIT 231 Animals of the land
- MSIT 241 Animals of the rivers, lakes, and sea
- MSIT 251 Applied botany
- MSIT 351 Plants 2

As a scientific hypothesis:

- Biophilia is attributed to Edward O. Wilson, Professor of Science at Harvard University, who in 1984 wrote a book entitled *Biophilia; the Human Bond with Other Species*. The idea of a close, essential, and multidimensional kinship between humans and nature certainly did not, however, originate with Wilson.

- Wilson intended that biophilia be "testable" within the context of the hypothetical-deductive method of Western science.

  ... Therefore, predictions arising from the overall idea are to be clearly stated ... evidence then gathered, analyzed, and interpreted ... towards a conclusion that either supports or refutes their validity.

A second influential book appeared in 1993 entitled *The Biophilia Hypothesis*, which is a compilation of essays edited by S.R. Kellert and E.O. Wilson.

In the introduction to this 1993 book, Kellert provides the following thoughts:

- Assertions made about the human inclination, indeed "craving" to affiliate with the natural environment, particularly its living biota, include that it is:
    - inherent (i.e. biologically ... i.e. evolutionary based)
    - part of the evolutionary heritage of the human species
    - associated with human competitive advantage and genetic fitness
    - likely to increase the possibility for achieving individual meaning and personal fulfilment
    - the self-interested basis for a human ethic of care and conservation of nature, most especially the diversity of life
- The idea is treated as a scientific hypothesis to:
    - underscore the need for systematic inquiry (both empirical and theoretical)
    - emphasize the scientific convention that a proposition does not "exist" until proven otherwise
    - avoid the inevitable suggestion that the exploration is nothing more than a disguised attempt to promote a romantic idealization of nature

With respect to the book *The Biophilia Hypothesis* ... Chapter 1, by Wilson, entitled *Biophilia and the conservation ethic*, and Chapter 2, by Kellert, entitled *The biological basis for human values of nature* ... are both fully available on the internet at:

wysiwyg://115/http://dhushara.tripod.com/book/diversit/restor/bph1.htm

■ **information from: *World Wide Words - Biophilia***

http://www.quinion.com/words/turnsofphrase/tp-bio2.htm
⇨ accessed 10 August 2001

The term **biophilia** was popularized by Edward O. Wilson, Professor of Science at Harvard University, in 1984 as the title of his book *Biophilia; the Human Bond with Other Species*. To him it seemed obvious that we human beings have an innate sensitivity to and need for other living things, because we have coexisted in the closest relationship with the natural world for so many millennia. He defined biophilia as "the connections that human beings subconsciously seek with the rest of life", and argued that they are determined by a biological need. Indeed, those who advocate an emotional, even a spiritual dimension to our relationship with nature, point to studies that show patients recover quicker if they are exposed to greenery, even pictures of greenery, rather than a purely artificial environment.

■ **information from:** ***News in Science - Mother Nature is a great nurturer***

http://www.abc.net.au/sience/news/print/print_ 268480.htm
⇨ press release for 30 March 2001 (accessed 13 August 2001)

Exposure to the natural environment has a positive effect on your health and could actually help prevent and treat illness, argues a US researcher. According to Environmental News Network, Emory University's Dr. Howard Frumkin makes the case in a review of the literature to be published in next month's issue of the American Journal of Preventive Medicine.

"Our standard clinical paradigm involves medications more than non-medical approaches, treatment more than prevention. But many people are intuitively drawn to this idea. They feel restored and healthier in a beautiful landscape, for example," says Dr. Frumkin who is professor and chairman of the department of environmental and occupational health in the School of Public Health. "And on the other side, many environmentalists work to preserve nature for a range of very good environmental reasons, but forget that one of the major benefits may be human health."

Frumkin cites the work of Pulitzer Prize-winning author and scientist Edward O. Wilson, whose "biophilia" hypothesis asserts that humans are attracted to living organisms and that this contact with the natural world may benefit health. He suggests that evolution may have "hard-wired" humans with a preference for specific natural settings.

Frumkin presents evidence of health benefits from four interactions with the natural environment
- contact with animals and plants
- viewing landscapes, and
- contact with wilderness.

Frumkin points to research that concludes pet owners have fewer health problems than non-pet owners. Examples include lower blood pressure, improved survival after heart attacks, and enhanced ability to cope with stress. Contact with plants, from gardening to looking at trees, could also contribute to healing physical and mental ailments, Frumkin notes. Another example given is that of office employees who report that having plants in the workplace makes them feel calmer. In another study, prisoners in cells facing a courtyard had a 24% higher frequency of visits to the prison's clinic than those in cells overlooking the landscape. Likewise, post-operative patients with a view of trees had shorter hospital stays and needed less pain medication than patients with a view of a brick wall.

Although solid evidence is unavailable, Frumkin says, this may be the basis for traditional "healing gardens" in hospitals and of horticultural therapy used in hospitals, nursing homes, psychiatric clinics, and hospices.

"We need to identify which kinds of nature contact are most helpful, for which patients, and for which medical conditions," Frumkin said. "One day, we may return to building hospitals with healing gardens. Or we may find we can help prevent or treat illness by prescribing gardening, pet ownership, or vacations in beautiful places.

Frumkin points out that many of these principles are understood by architects and planners, who use them in designing buildings, parks, and other places.

"We physicians have a lot to learn from professionals in other disciplines." Frumkin said.

■ **information from: *Technophilia; holding the extremes in tension*, Delores Brien**

http://www.cgjungpage.org/psychtech/technophilia.html
⇨ accessed 13 August 2001

This article explores "***technophilia***" ... i.e. the love of technology ... via first considering its opposite, namely biophilia.

Ecopsychology

Many ideas within ***Ecopsychology*** overlap extensively with concepts in Aboriginal knowledge (cf. the comment about "unmapped territory" below). John Davis states that the term has not, however, been used by Indigenous wisdom ... probably because there, ecology and psychology have always been parts of a larger understanding.

Theodore Roszak, a Professor of History at the California State University, Hayward, was among the first to use and write about the term "ecopsychology" for the public. His 1992 book *The Voice of the Earth* and 1995 book *Ecopsychology; Restoring the Earth, Healing the Mind* (co-edited with M.E. Gomes and A.D. Kanner) are considered pioneering works. The field continues to develop, as outlined below.

☹/☺ Edward O. Wilson (proponent of the "biophilia hypothesis") commented, in reviewing Roszak et al.'s 1995 book "It is a remarkable fact that, despite its significance for human welfare, the relation of the mind to the natural world has been largely ignored by science. The contributors to this volume scout the unmapped territory far ahead; I hope that many others will soon follow."

☺ Ralph Metzner (http://www.metzner-greenearth.org/gpintro.html) in the introduction to his 1999 book *Green Psychology*, states that he and others prefer the name ***Green Psychology*** rather than Ecopsychology, because they do not mean to advocate the creation of yet another sub-discipline of academic psychology ... rather they wish to see a fundamental revisioning of what psychology is, or should have been in the first place, a revision that would take the ecological context of human life into account. He says that "the absence of any consideration given to the ecological basis of human life in textbooks and theories of psychology is startling: it's as if we lived in a vacuum, or a space capsule."

☺ A development related to Ecopsychology is ***Deep Ecology*** ... a social movement (in the United States) of people waking up to the root causes of society's destructive treatment of nature and peoples ... and seeking to transform this destructive way of life.

■ **information from: *Overview of Ecopsychology*, John Davis**, Chair of the Transpersonal Psychology Department at Naropa University,teacher at the *School of Lost Borders*, and formerly with the Dept of Psychology at The Metropolitan State College of Denver

http://clem.mscd.edu/~davisj/ep/ecopsy.html

⇨ accessed: 18 Dec 2000 (Note: This site was last updated 17 February 1999. Although there are numerous hyperlinks to it, it is now no longer available; a print copy of some parts is available from Team UCCB MSIT upon request.)

Ecopsychology is developing rapidly as a field of study, and it has no single definition yet. The term is used in different ways ... and its insights are not unique or original to Ecopsychology. Our ancestors who lived closed to the Earth as well as Indigenous people around the world today had or have very similar understandings.

• The deep and enduring questions — who we are, why we suffer, how we heal — are inseparable from our relationships with the physical world. Similarly, the over-riding environmental questions — the sources of, consequences of, and solution to environmental disaster — are deeply rooted in the psyche, our images of self and nature, and our behaviours.

• Ecopsychology integrates ecology and psychology. Among its contributions are bringing psychological principles and practices to environmental education and action, bringing the contributions of ecological thinking and the values of the natural world to psychotherapy and personal growth, and fostering lifestyles that are both ecologically and psychologically healthy.

• **Ecopsychology is rooted in three insights:**

1. There is a deeply bonded and reciprocal relationship between humans and nature ... two metaphors capture this relationship:
   - nature as home and family (siblings, Mother), and
   - nature as Self, with self-identifications broadened to include the "greater- than-human" world

2. The illusion of a separation of humans and nature leads to suffering both for the environment (as ecological devastation) and for humans (as grief, despair, and alienation).

3. Realizing the connection between humans and nature is healing for both. This reconnection includes the healing potential of contact with nature and other areas.

As an extension, Davis proposes combining Ecopsychology and ***Transpersonal Psychology***. He states: At their deepest, psyche and nature emerge as expressions of the same whole and reveal these questions and insights as essentially spiritual. I propose that Ecopsychology be extended to a view that both includes and transcends the nature-as-family and nature-as-self metaphors, recognizing a fundamentally non-dual, seamless unity in which both nature and psyche flow as expressions of the same absolute source. This is not simply a reciprocity between humans and nature, nor merely a broadening of the self to include the natural world, though it includes both. Rather, it calls for development beyond the self (self-transcendence) to an identification with the spirit or mystery which gives rise to all manifestations — humans, nature, and otherwise.

■ **information from: *The Place and the Story; Bioregionalism and Ecopsychology*, Ralph Metzner**, psychotherapist and professor at the California Institute of Integral Studies

http://www.metzner-greenearth.org/ecopsych.html
⇨ accessed 18 December 2000

Ecopsychology and ***Bioregionalism*** are two fields of the emerging new ecological world view. Both are concerned with revisioning our understanding of human identity in relationship to place, to ecosystem and to nature. Traditional people had a much closer relationship to place. We need to learn to understand ourselves in relationship to a place, and to the story of that place.

• Ecopsychology may be defined as the expansion and revisioning of psychology to take the ecological context of human life into account. It is not a variation of ***Environmental Psychology***, which deals mostly with the impact of institutional environments on psychological

states. It offers a critique of all existing schools of psychology — including the psychodynamic, object relations, cognitive, behaviorist, humanistic, and transpersonal — for focusing their research solely on the intrapsychic, interpersonal, and social dimensions of human life, and ignoring the ecological foundation. The most basic facts of our existence on this Earth — that we live in these particular kinds of ecosystems, in biotic communities with these kinds of species of animals and plants, in these particular geographical and climatological surroundings — appears to be irrelevant to our psychology. Yet our own personal experience as well as common sense contradict this self-imposed limitation.

> In that regard, Ecopsychology parallels similar revisionings taking place in other knowledge disciplines: philosophy is being challenged by environmental ethics and deep ecology, economics by green or ecological economics, religion and theology by the concept of creation spirituality and other ecotheological formulations, and new ecological perspectives are emerging in sociology and history. All of these foundational revisions may be seen as part fo an emerging ecological or systems world view, a world views that can also be called ecological post-modernism.
>
> Underlying these fundamental revisionings of our systems of knowledge is a major paradigm shift in the natural sciences, a shift from physics to ecology and evolution as the foundational or model science. Ecology has been called the "subversive science" because it deals with systemic interrelationships, and is therefore in essence transdisciplinary and subversive of academic specialization. Ecological concepts are ideally suited for helping the knowledge disciplines transcend their specialized blinders, and consider the wider contexts of ecosystems and Gaia.

■ **information from: *Shavano.org***
http://www.shavano.org/html/ecopsych1/html
⇨ accessed 10 August 2001

What is Ecopsychology?

• At the dawn of the twenty-first century there is a growing recognition of the essential interconnectedness and sacredness of all life. This awareness, coupled with the magnitude of the global ecological crisis, has given rise to new ways of viewing the relationship between humans and nature. Within this context, Ecopsychology has emerged as an educational and social movement that seeks to understand and heal our relationship with the natural world. It explores the psychological and emotional processes that either bond us to the Earth or alienate us from it.

• A central assumption of Ecopsychology is that our inner worlds and outer worlds are intimately connected. Most ecopsychologists believe that the environmental crisis and the cultural and political processes that have created it have a deep and lasting impact on the human psyche and soul. In turn, our states of mind are then expressed in the way we relate, or not, to the natural world. These inner and outer worlds mirror and support one another and therefore, a healthy ecosystem is inseparable from a healthy psyche.

• Ultimately, Ecopsychology is concerned with the transformation of hearts and minds essential to reawakening our sacred connection with other living beings and our planetary home.

Some of the foundational principles of Ecopsychology, as listed by Shavan,org include the following: (http://www.shavano.org/html/principles.html)

1. The Earth is a living system. Human beings are fundamentally interconnected with the Earth and with all life. Neither the Earth's problems or humanities can be resolved without taking full account of this interconnection.

2. Ecopsychology seeks to heal the alienation between the person and planet, and to establish a healthy relationship between the two. The needs of the person are the same as the needs of the planet. The rights of the person are the same as the rights of the planet.

3. Rather than viewing the ecological dilemma as a crisis "out there", in our physical environment, Ecopsychology recognizes that human consciousness is intricately involved in creating and healing the ecological crisis. We are in a crisis of "soul" and "spirit". There is a "screaming" link between pervasive personal dysfunction and the ecological crisis.

4. Ecopsychology calls for a new cosmology that embraces scientific models and understandings, spiritual teachings, ancient wisdom, and the land-based and non-Western knowledge of Indigenous peoples.

5. Ecopsychology calls for a profound revisioning of mental health and human consciousness. Today's dominant models of human consciousness and therapy are pathogenic and define the human being as an isolated, separate entity living in a purposeless, mechanical universe. A new vision of sanity and a new reality principle is needed by the psychology professions.

6. The drive to live in harmony with the natural world and its rhythms is deeply embedded within us.

Creation Spirituality

■ **information from:** ***About Creation Spirituality***
http://www.creationspirituality.com/about-cs.shtml
⇨ accessed 10 August 2001

Creation Spirituality is emerging effort in the United States that seeks to integrate the wisdom of Western spirituality and global Indigenous cultures with the emerging post-modern scientific understanding of the universe and the awakening artistic passion for creativity which reveals the inter-relatedness of all beings. It honours all of creation as an original blessing.

Its leading proponent is Matthew Fox, a spiritual theologian who was ordained as a priest in 1967. Because of his work as a liberation theologian and progressive visionary, he was silenced by the Vatican and dismissed from the Dominican Order. He is the founder and president of the University Creation Spirituality in California.

Creation Spirituality is based on the primacy of Nature as "The Book of Scripture", and is a way of life that emphasizes the positive and creative dimensions of humans and their harmonious participation with and in Nature (not "dominion over Nature").

☹ Do not confuse "Creation Spirituality" and "creation science".
- ✘ "Creation science is not the same as "Creation Spirituality".
- ✘ "Creation science" does not seek to integrate its understandings with Western science.
- ✘ "Creation science" is not compatible with Western science or Native knowledge.

Creation Spirituality has the following ten principles:

1. The Universe is basically a blessing, that is, something we experience as good.

2. We can and do relate to the universe as a whole since we are a microcosm of that macrocosm and that this relationship "intoxicates" us. (Aquinas)

3. Everyone is a mystic (i.e. born full of wonder and capable of recovering it at any age — of not taking the awe and wonder of existence for granted).

4. Everyone is a prophet, i.e. a "mystic in action" (Hocking) who is called to "interfere" (Heschel) with what interrupts authentic life.

5. That humans have to dig and work at finding their deep self, their true self, their spirit — thus, the role of spiritual praxis and meditation and community confrontation which can itself be a yoga. If we do not undergo such a praxis we live superficially out of fear or greed or addiction or someone else's expectations of us. That salvation is best understood as "preserving the good". (Aquinas)

6. That the journey the marks the digging can be names as a four-fold journey:
   - Via Positiva ..... befriending awe, delight, and wonder
   - Via Negativa ..... befriending darkness, silence, suffering, loss and letting go
   - Via Creativa ..... celebrating the birthing and creative artist and artisan in us all
   - Via Transformativa ..... compassion that transforms and heals and brings justice into the world

7. Everyone is an artist is some way and art as meditation is a primary form of prayer for releasing our images and empowering us and the community. Art finds its fulfillment in ritual, the community's art.

8. We are all sons and daughters of God; therefore, we have divine blood in our veins, the divine breath in our lungs, and the basic work of God is compassion.

9. Divinity is as much Mother as Father, as much Child as Parent, as much Godhead (mystery) as God (history), as much beyond all beings as in all beings.

10. That we experience that the Divine is in all things and all things are in the Divine (Panentheism) and that this mystical intuition supplants theism (and its child, atheism) as an appropriate way to name our relation to the Divine and experience the Sacred.

WESTERN PHILOSOPHY: "EASY" AND "HARD" PROBLEMS OF CONSCIOUSNESS

"Easy" versus "hard"

❒ Read the newspaper article *Watching the brain, seeing the soul* (National Post, 20 January 2001).

In our list of questions that could be asked as one ponders "what is consciousness?"(repeated below) are:

- some that Western science can comfortably deal with ..... marked ✔
- some that Western science is less comfortably able to deal with ..... marked ✓
- some that Western science does not (yet) ask ..... marked ✗

the list (again)

✔ • Is it awareness of the external environment only?

✔ • Is it awareness of the external environment, and also of one's internal environment?

✓ • Is it awareness of the external and internal environments, and also of the presence of self?

✓ • Is it awareness of the external and internal environments, of self, and also of their boundaries?

✗ • Is it awareness of the external environment, of self, of boundaries, and also of one's ability to participate with and influence these ... i.e. awareness that one has the potential to be creative, awareness of the presence of Self?

✗ • Is it awareness of all the above, and also of the interconnectedness of the Universe and thus, of the "now you see it, now you don't" nature of boundaries ... i.e. awareness of the potential of Self to have a spiritual dimension?

These questions can be considered as "easy" or "hard" problems in consciousness studies:

- **easy** ..... those marked ✔ [and ... maybe some aspects of those marked ✓]
- **hard** ..... those marked ✗

the easy problems: can be summarized as ... basic information processing ... towards survival in a physical environment

☞ with consideration of the brain as <u>just</u> an information processor
- video: Inside Information

☞ most research falls within a ***reductionist paradigm*** ... which holds that:

- humans are driven by instincts and primordial emotions, and thus consciousness is determined by instinctual and emotional desire with an overall goal towards survival

the hard problem: can be summarized as ... reflections on self, and transformations of self/Self ... towards higher levels of individual development, maturity, and wisdom

☞ with consideration of the brain <u>as more than just</u> an information processor ... because consciousness can also be creative and contribute to causality in Nature
- consciousness: multidimensional stages or levels of, as reflected in different world views and ontologies, especially those that include meaning and spiritualism
- integral psychology
- Aboriginal world views ... with natural laws of interdependence

☞ research uses approaches within the reductionist paradigm **<u>plus</u>** approaches within an ***autocreative paradigm*** ... which also incorporates emergentism, subjectivism, and holism. When combined, these acknowledge that:

- yes ... humans are driven by instincts and primordial emotions, and thus some aspects of consciousness are determined by instinctual and emotional desire for survival

- but ... humans are also capable of higher levels of consciousness ... especially creative relationships involving self, community, and Nature ... and thus some aspects of consciousness determine consciousness, i.e. play a <u>causal role</u>.

WESTERN SCIENCE: BRAIN BASIS FOR CONSCIOUSNESS

QUESTION: Why has consciousness been a "problem child" in Western science until recently?

Some background

☹ For decades, in the 20th century, the study of consciousness, unconsciousness, mind, and cognition were taboo, and even the objects of derision, for scientists and most psychologists in academia (Grigsby and Stevens 2000).

☺ Even today most cognitive scientists and neuroscientists prefer to talk about "mind-brain" rather than "consciousness".

☺ Francis Crick, in an interview in the mid 1990's with Jeffrey Mishlove (host of the Intuition Network's "Thinking Allowed" television program), agreed that most scientists "are kind of afraid" to talk about consciousness (www.intuition.org/txt/crick1.htm).

- Crick is the British biologist who, in 1953, co-discovered the 3-D structure of DNA (see section on Biology in MSIT 201/203). He now conducts research in neuroscience at the Salk Institute in San Diego, California, and wrote a book in 1994 entitled *The Astonishing Hypothesis* in an effort to stimulate new thinking, in society as a whole, towards the scientific study of consciousness.

☺ Along this same line, Alwyn Scott wrote a book in 1995 entitled *Staircase to the Mind; the controversial new science of consciousness.*

Question: So ... why has consciousness been a "problem child" that Western Science has preferred to ignore or overlook ... until very recently?

Answer: well ... because of:

- the lack of adequate technologies (or tools), and

- various historical factors ... Western philosophy has long considered consciousness to be:
  1) a metaphysical topic or issue ... i.e. one that could not be examined by experiment ... and thus, *not an appropriate topic* for scientific investigation which emphasizes the use of experiment (see epistemology)

  2) a subjective experience ... and thus, *not an appropriate topic* for the empirical sciences which deal with "objective things"
     - → "objective things" exist outside of, or external to, the inner world of the mind
     - → "objective things" can be talked about in terms of "it" (3rd person) language
     - → "objective things" can be measured, modeled, and manipulated

     If subjective experience could not be studied directly ... then the acceptable focus would have to be something else ... and so the much narrower area of "stimulus and response" studies emerged ... as the areas of behavioural psychology and animal behaviour ... with their emphasis on observational methods for the study of the relationship between behaviour and environment.

☺ Now, however, "consciousness studies" are becoming one of the hottest research frontiers in Western science ... so:

Question: What happened, or is currently happening, to cause this change?

Answer:

1) a new world view emerged ... in one science discipline and then its influence spread. This new view was the realization, in quantum physics in the early to mid 1900's, that the act of making an observation had the effect of disturbing the object being observed ... i.e., that there could be no true gap between mental and material (subject and object). This realization strongly influenced some psychologists, and the new discipline of "cognitive psychology" began to emerge in the early 1960's, with "consciousness" becoming as an acceptable word in the mid to late 1970's. Then, as some of its topic areas began to overlap with similar emerging interests in neuroscience and other disciplines, the even newer discipline of **cognitive science** emerged.

2) new technologies became available ... mainly brain imaging methodologies and high-speed computers. These have permitted new investigative approaches within the constraints (limits) of the standard, objective, empirical approach favoured by science.

☺ the 1990's ... i.e. the decade we just left ... was officially declared, at its outset, the "**Decade of the Brain**" ... and over its ten years saw extensive research, with remarkable new understandings as to how the brain functions

☞ the subjective dimensions of consciousness are considered to be "anchored" or "grounded" or "seated" in structures and processes in the brain that can now be studied

using technologies that permit the standard objective approach of the empirical sciences ... i.e. ones that correlate subjectivity with objectivity: the *specifics of consciousness* with the *measuring of specific brain activity*.

☺ "The search for **neural correlates of consciousness (NCCs)** is arguably the cornerstone in the recent resurgence of the science of consciousness." (from Chalmers' web article: What is a neural correlate of consciousness? ... Chalmers being the philosopher who advocates the "easy" vs. "hard" conceptualization for problems in consciousness studies)

☺ Using the idea of an **integrated mind-brain paradigm** (via NCCs), human consciousness can be studied as if it were material, orderly, and intelligible ... i.e. it has the ontological characteristics that Western science holds to be true of Nature (see ontology).

☺ The idea behind integrated mind-brain paradigm is referred to as the **psychoneural identity hypothesis** (Beatty 2001).

Question: Why is consciousness still problematic for Western science?
Answer: Part of the reason is because if it is causal ... where does its causation begin and where does it end?

QUESTION: What is "cognitive science"?

Answer: a new interdisciplinary approach to the study of "things that think", including natural entities such as the brain of humans and other animals (which are products of natural selection and evolution), and man-made entities such as computers with artificial intelligence (which are products of human design and technology).

→ **Howard (2000):** Cognitive science includes parts of several disciplines: biology, chemistry, neuroscience, psychology, information science, philosophy, linguistics, and anthropology ... thus, it is interdisciplinary.

→ **Matlin (1998):** Cognitive science emphasizes internal representations of the external world ... i.e. the *mechanisms* of mind [rather than behaviour, i.e. an external manifestation of mind ... which is more the object of study of psychology *per se*].

→ **Cummins and Cummins (2000):** Cognitive science is no longer the science of just cognition or "thinking" ... it is the science of the mind-brain.

Cognitive science emerged as an important new interdisciplinary field of study in the 1960's [although its beginnings are often dated back to 1948 (Howard 2000)] ... with the enabling assumption (foundational or basic idea) that "thinking" could be studied independently of other mental and physical phenomena (i.e. that it was an *autonomous domain*) ... that could be studied through *observation* and *experiment* (i.e. the conventional and broadly accepted tools of Western science) ... as opposed to only reflection and conceptual analysis (i.e. the tools of philosophy). Cummins and Cummins (2000) state that now, some 40 years later, there are basically three "big pictures" of the mind, that serve as the *enabling assumptions for different approaches towards observation, experiment, and theory in cognitive science* ... these are:

- the mind as a computer
- the mind as neural network
- the mind as brain

→ **Wilber (2000):** Cognitive science brings scientific empiricism to the problem of consciousness, but often ends up simply reducing consciousness to its objective dimensions ... i.e. its neuronal mechanisms and biocomputer-like functions ... thus devastating the *lifeworld* of consciousness itself [note ... characteristics of life include development and growth, i.e. transformation through time].

Core principles of Cognitive Science

Howard (2000) studied the vast new literature on the *mind-brain approach*, and determined that several big patterns could be detected in Cognitive Science ... which he called "core principles". His list of these, and an brief explanation of each, are provided below.

1) nativism

The principle of nativism holds that we inherit our behaviour and that our environment can either nurture it to develop naturally or distort it by withholding nurturance (e.g. food, shelter, warmth, touch, affection, attention).

2) unity

The principle of unity holds that the body and the mind are one and the same, and that a change in one will result in a change in the other.

3) connectivity

The principle of connectivity holds that the establishment of new connections between prior learnings is the essence of growth and development and that the condition of the connection points, like the condition of the gap in a spark plug, determines how we function.

4) interconnectivity

The principle of interconnectivity holds that each identifiable element in our vast storehouse of experiences and learnings is connected to each of the other elements, some more strongly or closely and others more loosely or distantly (thus, to remember a name, we silently say the alphabet until the name pops out).

5) control

The principle of control holds that the health of the human (and animal) organism is a function of the degree to which the individual feels in control of his or her situation, with less perceived control resulting in poorer health and performance and greater perceived control resulting in better health and performance.

QUESTION: What is "neuroscience"?

Answer:

➜ Neuroscience seeks to understand how the mind-brain works.
➜ Neuroscience is not nearly as interdisciplinary in its approach to the pursuit of new knowledge about the mind-brain as is Cognitive Science.
➜ Most of the current research in neuroscience is focused at the molecular and cellular levels (see below).
➜ Neuroscience tends to not to use the word "consciousness".

Bear et al. (1996) explain that neuroscience, to reduce the complexity of the mind-brain problem, breaks it (the whole) into smaller pieces (parts) for systematic experimental analysis. I.e., it takes a strong reductionist approach that characterizes much of Western science. The units of study are at different **levels of analysis**, which, in ascending order of complexity (along with their **big questions**), are:

- **molecular**
  ... big question: What are the mechanisms by which different molecules play roles crucial for brain function?

- **cellular**
  ... big question: What are the mechanisms by which different neurons play roles crucial to for brain function?

- **systems**
  ... big question: What are the different mechanisms by which different neural circuits analyze sensory information, form perceptions of the environment, make decision, and execute movement.

- **behavioural**
  ... big question: How do neural systems work together to produce integrated behaviours? For example: How can we explain memory? How do mind-altering drugs work? Where do dreams come from? What governs mood?

- **cognitive**
  ... big question: What are the neural mechanisms responsible for the higher levels of human mental activity, such as self-awareness, mental imagery, and language.

Some overview concepts on consciousness

Consciousness: brain basis

Question: What is the significance of the nervous system ... the brain ... in the modern scientific study of consciousness?

Answer: Most scientists who are willing to study consciousness believe that it is "anchored" or "grounded" or "located" or "seated" in *structures* and *processes* associated with specific brain activity: consciousness → mind → brain.

> Thus, investigations focus on the brain ... i.e., the system with billions of neurons interacting together → to form the basis of consciousness ☺ ☺☺ ☺☺☺ ☺☺☺☺ ☺☺☺☺☺.
>
> In the 1990's Francis Crick, a prominent neuroscientist at the University of California, referred to this "brain basis for consciousness" as an "astonishing hypothesis" ... because many people in the general public simply are not aware of it or do not agree with it, and even many scientists do not grasp its full implications (interview with Jeffrey Mishlove ... www.intuition.org/txt/crick1.htm).
>
> However ... this hypothesis now dominates the scientific study of consciousness ... study which is considered one of the hottest frontier areas of Western science.

The **neural correlates of consciousness (NCCs)** is the basic approach that neuroscience is using to study consciousness.

☞ "neural" ..... is an adjective meaning *'of the neurons and their activities'*

☞ "correlates" ..... is a noun meaning *'things associated with'* or *'correlated with'*

☞ and "correlated with" ..... is from *'correlation'* ... which is a measure of the strength of the relationship or association between two variables (things that are changing); thus, one can speak, for example, of one thing being "strongly *correlated with*" or "weakly *correlated with*" something else

☺ Using an **integrated mind-brain paradigm** (via NCCs), human consciousness can be studied as if it were material, orderly, and intelligible ... i.e. has the ontological characteristics that Western science holds to be true of Nature (see ontology in MSIT ThoughtTraps©). It then also becomes acceptable and possible for neuroscientists to create dynamic "maps of the human brain in conscious action" ... as discussed in **Mapping the Mind**.

Consciousness: what has to be studied

■ within the reductionist paradigm

Cognitive and Neuroscience generally agree that study of the "mind-brain" should include a reductionist approach to investigating the:

1. workings of the individual cells of the nervous system (neurons)
2. ebb and flow of neurotransmitters (molecules)
3. interactions of various brain parts (anatomical regions, functional systems, neuronal networks)
4. relationships between locations of specific brain activity and specific experiences or behaviours ... i.e. "mapping the mind" such that brain activity can be discussed as "creating" or "correlating with" experience or behaviour (modules of mind, building blocks of consciousness)

☞ study: organizational hierarchy, including details within the four points above

■ within an autocreative paradigm

Hobson (1999) advocates that studies of consciousness need to acknowledge and use insights from various approaches, including:

- reductionism
- emergentism
- subjectivism, and
- holism

Collectively ... these could be referred to as an "autocreative paradigm". In that emergentism, subjectivism, and holism are new areas for Western science, this collective approach is rather problematic and neither the label (which is not Hobson's) nor the ideas are currently in wide use.

Hobson suggests that to understand consciousness in a systematic way we need to use these multiple approaches to enumerate, define, and clarify three aspects about consciousness ... its:

1. global (or unitary) aspect,
2. componential (or modular) aspect, and
3. graded (or dynamic) aspect.

☞ study:

- organizational hierarchy (as per the reductionist paradigm)
- unity / plurality
- building blocks
  - as objective neuronal entities within the hierarchy of the reductionist paradigm ... but also including the emergent and holistic features that characterize consciousness as a process (recognizing herein, close ties to Cajete's work on *the ecology of Indigenous education*)
  - as subjective content (personal, cultural, historical) ... but also including the emergent and holistic features that characterize consciousness as a process (recognizing herein, close ties to Cajete's work on *the ecology of Indigenous education*)
- states

Consciousness: organizational hierarchy

Alwyn Scott (1995), a mathematician at the University of Arizona who studies non-linear dynamics and consciousness, has put forward a "**staircase to the mind**", or hierarchy, for the overall organizational structure of consciousness (he clearly indicates that the idea does not, however, originate with him). The staircase below is modified somewhat from Scott's.

culture
consciousness (mind)
brain → ➟ ➠ ➡ functions, and building blocks of consciousness
networks of neurons (assemblies)
circuits of neurons
cellular structures and processes ... neurons, nerve impulses, synapses
molecules
genes

The point of referring to this hierarchy as a "stairway" is that to understand one level, the levels below it must be explored. Thus, to understand the consciousness, we must explore the brain; to understand the brain, we must explore the networks of neurons, etc.

☺ Compare this "stairway" to the list of the "levels of analysis" that Neuroscience recognizes in its approach to the mind-brain problem (from earlier in these ThoughtTraps©).

cognitive
behavioural
systems
cellular
molecular

☺ Compare the "stairway" to the depiction of the brain's overall holarchical function (from later in these ThoughtTraps© , as per Greenfield 1999).

function
systems
regions
networks
circuits
neurons (brain cells) + synapses (molecular connections between brain cells)
genes

Consciousness: unity (or plurality?, or both?)

information from Hobson (1999)

In the global sense, we recognize that all conscious states are surprisingly unitary and single-minded. Although our minds may jump from one subject to another, and while the several biochemical molecules of consciousness contribute components to our integrated awareness in parallel, consciousness can at any given instant concern itself with only a single idea, a single percept, or a single emotion.

⇨ Consciousness, in spite of the multitude of simultaneous events occurring in the brain, is a "unity" ... not a "great buzzing of confusion" ... not "utter chaos" (unity is the "binding problem" in philosophy).

But the fact remains that the "widely accepted" unity of consciousness has been little studied from a scientific point of view.

⇨ Thus, we should ask:
- Is it true that we think of one, and only one, thing at a time?
- Is it true that we are always one, and only one, person at a time?
- Is it true that we always are in one, and only one, state of mind?

⇨ And, we should not jump to a "yes" answer to these questions. For example, insights from dreaming suggest fragmented, not unified, features. The study of dreams, therefore, may be a fertile area that science is only beginning to explore in its efforts to study consciousness.

It is obviously useful for the mind to have some built-in tendency to be continuous. But should it always be? Would such mental inertia prove occasionally or even often disadvantageously restrictive? Should consciousness not be subject to some internal turbulence whose adaptive function it is constantly to change our minds, the better to cope with the constantly changing demands and opportunities presented by constant change in the external and internal world?

Might we not propose that cerebral motion has its own mechanisms of inertia and its own dynamic mechanisms for changing speed and direction? The laws of cerebral inertia guarantee mental continuity and enough constancy for us to present a semblance of a self, while the laws of cerebral dynamics allow us to shift our attention and to change our mode of analysis.

⇨ Such a plurality or discontinuity or dissociative (vs. unity or associative) hypothesis mirrors the paradigm shift in the physical sciences from the Newtonian mechanics that prompted Freud to assume a more or less constant inertia of desire to the Lorentian chaos that views all complex systems as unpredictable in the face of deterministic but unanalyzable noise.

☺ Hobson is keenly interested in consciousness within an "autocreative paradigm" as outlined earlier (see "easy" and "hard" problems of consciousness), and in his 1999 book *Consciousness* (the source of the information presented here) he attempts to explains his ideas about how chaotic noise may be useful to consciousness, since it confers the constancy of change, and with it ... variety, originality, and creativity.

☺ Cajete (1994, 1999, 2000) indicates that consciousness in Aboriginal world views embraces multi-dimensionality and plurality. He also, as well as Briggs and Peat (1999), points to considerable compatibility between Aboriginal world views and the new paradigm of Western science wherein complex systems theory has a central place.

⇨ MSIT 301/303 explores the Common Ground offered by complex systems science.

⇨ The unity / plurality aspect of consciousness, as advocated by Hobson, is beyond the scope of further exploration in MSIT 101/103. However, the area obviously has the potential to become an exciting new area in Cognitive Science, and Aboriginal knowledge undoubtedly already has rich understandings.

Consciousness: building blocks

Different **building blocks** of consciousness are sometimes recognized (Hobson 1999):

		experienced by *all mammals and human infants*	*more mature humans*
• input sources			
- sensation	reception of input data	+	+
- perception	representation of input data	+	+
- attention	selection of input data	+	+
- emotion	feelings about representations of input data	+	+
- instinct	innate propensities to act on input data	+	+
• elaborative processing			
- memory	retrieval of stored representations	-	+
- thought	reflection upon representations	-	+
- language	symbolization of representations	-	+
- intention	representation of goals	-	+
- orientation	representation of time, place, persons	-	+
- learning	automatic recording of experience	+	+
• output actions			
- volition	decisions to act	-	+
- movement	motor acts and behaviours	+	+

☺ The above scheme could also be represented as:
input sources ⇨ elaborative processing ⇨ output actions

Consciousness: states

Four states of consciousness are recognized, although most research attention is directed towards the first.

1. waking
2. sleeping
3. dreaming
4. altered

Consciousness: video

Inside information; the brain and how it works

... with some questions and concepts

1. algorithm and metaphor

- define each ... and what is the difference between them?
- of the two, which one (according to neuroscience) is thought to be the way the brain "processes information"?
- How does your answer to the question immediately above relate to (or compare with) saying that the brain works on the basis of "pattern recognition"?
- of the two, which one is a useful tool to intentionally use when learning new things ... and why is it useful?
- of the two, which one might sometimes be referred to as "an admission of ignorance" ... and why?
- of the two, which one is most similar to "reductionist science" ... and why?

2. input of sensory information to the brain

- from a simple perspective ... what are the "traditional five" human senses?
- in what "language" (or code) does sensory information travel to the brain? Note: *Translation* of the sensory stimulus into this language is referred to as *transduction*. *Transmission* is then by way of "action potentials" that travel along what?
- The definition of "code" used by neuroscience is: a system for expressing information in symbols.
- in the "3 box model of memory"... what does the first box represent? How does this box relate to the concept of sensory information?
- true or false? Information from the different senses is collected and processed in different parts (compartments or modules) of the brain.

3. consideration of the brain, by neuroscience, as an "information processor"

- what definition of "information" is used by neuroscience, as well as by workers in the field of information technology?
- life itself, could be considered as information written in what language?
- the brain uses the equivalent of only 20 watts of energy, even though it has over 10 billion neurons (which would be like millions of personal computers)
- the distribution of information processing does what to information?
- the hoarding of information does what to information?

4. pattern recognition ... or "connecting the information dots"

- The brain "weaves" relevant information into pattern that is meaningful, although not necessarily abiding (permanent). Thus, we can change our ideas as new information becomes available. In fact, the brain is continuously computing reality although we are largely unaware of the end result.
- true or false? Evolution has resulted in a brain that emphasizes pattern recognition for biological survival, rather than for logical computations (like mathematics).
- with respect to pattern recognition, the brain is full of imperfections, i.e. it is patchwork rather than being optimally designed or perfect ... why?

- true or false? We tend to see patterns that are not really there, especially if we are over confident about our knowledge of the *system*.
- true or false? The brain tries to tell the best story possible with the available information ... and often makes assumptions about the missing information.
- To the best of its abilities so far, neuroscience considers the *activity of neurons* in the brain as the brain's code for expressing information, for sketching reality. This means we construct reality ... because we connect the dots in a certain way.
- To *perceive*, is to make choices between different interpretations.

5. thinking about our brains as computers

- true or false? The human brain is much, much better than any present day computer when it comes to gathering sensory information in real time.
- true or false? Computers are as good as humans when making judgement decisions on the basis of combining the best information available.
- true or false? Our brains are very good at recognizing relevant information (i.e. processing information) by winnowing out the garbage.
- true or false? Our brains are not nearly as good at creating "story" by combining information as they are at recognizing the relevant information in the first place.
- How does the statement immediately above relate to the "3 box model of memory"?
- true or false? Thinking about our brains as a computer has shown us that the things we thought most difficult (e.g. playing chess, proving mathematical theorems) are much, much easier than the things we take for granted (e.g. walking across a busy street).
- We <u>can</u> change our ideas as new information becomes available ... because the brain is continuously computing reality although we are largely unaware of the end result of most of these computations.

6. information concerning self

- the brain naturally tends to edit experiences about self ... to throw out the bad impressions we may have about ourself ... to enable us to "put the best face forward" (i.e. we are good at self deception). Why?

7. the human visual sense

- There is <u>no</u> "little person" (homonculus) in the brain that creates the "picture" that we are aware of, or conscious of. Thus, the "big questions" in cognitive science are "how does the brain do it", and "what is consciousness"?
- true or false? Vision is a collage of information.
- Information from the different senses is collected and processed in different compartments of the brain, and there is a surprising degree of autonomy of each part. Give an example of this understanding, with reference to vision.
- What is the "glue" that holds information from different compartments together in our brain ... to give us a coherent story or picture or understanding?

8. different types of computers as scientific models of the brain ... two basic types of computers: serial processors and parallel processors.

- What is the difference between a serial processor and a parallel processor?
- Which one is thought to be the better model of the brain, according to neuroscience?
- Which one would best reflect reductionist thinking? Why?
- Which one would best reflect holistic thinking? Why?
- Which one could be referred to as a "connectionist model"? Why?
- What is the "glue" that "connects"?

9. neural networks for memory ... in the parallel processor,

- Connections can be strengthened to modify the performance of the network. How does the story of "since chimpanzees like onions, I suspect gorillas do too" illustrate this understanding, this ability to strengthen connections?
- What does this suggest about metaphor as a learning tool?

10. Richard Dawkins' musings: our brain → through natural evolution → gave rise in humans to language and culture capabilities → through cultural evolution → has given rise to technological capabilities → through technological evolution → will it give rise to a silicon civilization (artificial intelligence) [note: present day life on Earth is <u>carbon</u> based]

☺ Recent research in neuroscience suggests it is not the pieces (individual neurons) that carry the secret of thought and consciousness in the brain, rather it is the way the ***whole system*** works together. This is a much more ***holistic view of what the question is*** (i.e. how does the system work), and is very different from how Western science has successfully explored many aspects about Nature so far. The way that has worked so well heretofore could be said to be a search for the one problem at the bottom of the issue which, when solved, allows understandings to flow from it ... i.e. it is reductionist. In contrast, it appears that the big question in neuroscience is how does the ***system*** organize, how does the ***system*** carry out computation?

As defined by Cognitive Science ...

INFORMATION is "something than makes a difference".

This is a key definition ... so ponder it.

Example: If someone invites me over to their place for morning coffee, and says "I want the coffee to be fresh, so I won't put it on until you arrive. When do you think you will get here?" And my response is "I'll get there when you put the coffee on".

☺ ? ☹ ... Is there any "information" in my response?

QUESTION: What are some of the details in the brain basis for consciousness?

Science and the "easy" problems

Science has discovered lots about the anatomy and physiology of the brain, and increasingly more and more about the electro-chemical events at the neuronal level ... towards answers for the "easy" problems of information processing by the brain.

☺ Consciousness of our **environment** always involves a continuous transformation of information from one mode into another ... i.e. information processing.

Remember: INFORMATION is "something than makes a difference".

Acquisition of environmental information by humans ... using:

☺ **an algorithm for "easy" problems of consciousness**

☞ in brief:
- **environmental information** → sensory input data → sensory processing in **brain**

☞ in more detail:
- **environmental information** → detected → transduced → transmitted → processed

☞ in more detail yet:
- **environmental information** ... i.e. events in the external environment
  - → presents itself in different energy forms
    - → some forms can be detected by human sensory receptors, as energetic stimuli
      - → stimuli are converted (transduced) by the receptors
        - → into an electro-chemical language (the universal language of the nervous system)
          - → and transmitted along nerves (as nerve impulses)
            - → to the spinal cord and brain (central nervous system, CNS)
              - → and processed in, and exchanged among different parts of, the brain to become the building blocks of **consciousness** ☺

➜ **INFORMATION has "made a difference"** ... it has "stimulated" a sensory receptor ... setting in action a series of events that trigger a nerve impulse. A nerve impulse is information "coded" in electro-chemical language ... information that previously was in an energy form in the environment.

General comments on the human nervous system

the human nervous system ... divided into:
- central nervous system
- peripheral nervous system

❖ Marieb 1998 ... Fig.11.2: levels of organization in the nervous system

• ***central nervous system*** (CNS) ... ◙ *body's control centre*
- brain
  - ◙ conscious activities ... see "building blocks of consciousness"
  - ◙ unconscious activities ... hormonal system, cardiovascular system, etc.
- spinal cord
  - ◙ simple reflexes (involuntary, automatic responses to stimuli)
  - ◙ pathway for sensory and motor signals traveling between brain and PNS

• ***peripheral nervous system*** (PNS) ... ◙ *body's communication network* ... with two functional subdivisions
- sensory division (somatosensory and visceral sensory) ... sensory nerves and sense organs
  - ◙ sense organs respond to environmental stimuli originating outside or inside the body, by converting the energy of stimuli into sensory input (electrical language of nerve impulses)
  - ◙ sensory nerves carry sensory input from sense organs (receptors) to the CNS
- motor division ... motor nerves
  - ◙ motor nerves carry command signals from the CNS to muscles and glands
    - autonomic nervous system (involuntary actions)
      - sympathetic nervous system (emergency situations)
      - parasympathetic nervous system (non-emergency situations)

      ❖ Beatty 2001: Fig. 2.24
    - somatic nervous system (voluntary actions)

Brain study techniques

☞ information below from Beatty (2001)

The brain may be studied in various ways ... but one of the reasons that consciousness studies have recently become an acceptable topic in Western science is the development of new methodologies using advanced brain imaging techniques. With these, it is possible to study the "higher mental functions" associated with consciousness (e.g. thought, language) that could not be easily studied using earlier technologies.

Remember ... the significance for Cognitive Science of the:
- neural correlates of consciousness (NCCs)
- psychoneural identity hypothesis
- integrated mind-brain paradigm

Three recent **brain-imaging techniques**, especially, make possible the study of both brain anatomy and patterns of brain activation in living, healthy human beings:
- computerized tomography (CT)
- positron-emission tomography (PET)
- magnetic resonance imaging (MRI)

Other techniques, some old and some new, are used to record the **brain's electromagnetic activity**, including:
- electroencephalogram, EEG
- magnetoencephalography ... SQUID
- microelectrode recording
- patch clamps

Still other, and even older, techniques exploit the results of **brain injury** (lesion analysis) to analyze brain function.

Computerized tomography (CT)

⇒ tells us what the brain looks like, i.e. brain structure

CT is an enhancement of the familiar X-ray procedure. Instead of producing the usual shadow imaging of a conventional X-ray, in CT an image of a horizontal slice of tissue is reconstructed. It is as if a slice of brain were surgically removed and placed on a table for inspection. To form this image, a large number of narrow X-ray beams are passed through the head across a single plane at a wide variety of angles. The amount of radiation absorbed along each lined is measured. From the measurements associated with each of the many beams passing through the slice, a computer program can determine the density of tissues at each point within the slice. The resulting image in the CT scan.

Positron-emission tomography (PET)

⇒ tells us what the brain is doing, i.e. brain function

ET involves the injection of a tracer substance labeled with a positron-emitting radionuclide. One common tracer is radioactively labeled oxygen, which is differentially absorbed by active neurons. Thus, metabolically more active portions of the brain will accumulate more radioactivity than will less active regions. By determining where the tracer is accumulating in the brain, patterns of differential brain activation can be mapped.

Tracer-distribution is measured by sensing the radioactive decay of the positron-emitting label. At some point in time after injection, the positron is emitted form the radioactive nuclide. After traveling a short distance, the positron interacts with an electron, both are annihilated and are converted to two photons traveling away from each other in opposite direction. The PET scanner detects these photons, and the location of annihilation (and hence the tracer) is determined in a manner similar to that used in CT scanning.

Magnetic resonance imaging (MRI)

⇒ tells us what the brain looks like, i.e. brain structure AND
⇒ tells us what the brain is doing, i.e. brain function

MRI exploits a phenomenon known as nuclear magnetic resonance in which radio frequency energy in a strong magnetic field is used to generate signals from a particular atom — usually hydrogen — contained within the tissue. Minute changes occur in the magnetic properties of blood haemoglobin molecules as they release oxygen in the brain. Using a computer program, these can be used to measure both brain blood flow and oxidative metabolism.

Electroencephalogram (EEG)

⇒ tells us about brain activity ... but at a very large scale (large ... because it measures the simultaneous activity of hundreds of thousands of active brain cells)

The fact that the brain's nerve cells produce electrical signals ... that can be detected as EEG activity, i.e. that electrical "brain waves" exist, was first determined in 1924 ... and greeted with much scepticism until it was replicated in 1934. The EEG is generated primarily by the activity of large numbers of nerve cells within the brain. Because the skull, which enclosed the brain beneath the scalp, is an electrical insulator, under most circumstances, it is impossible to conclude which portion of the brain is generating any particular part of the EEG signal. However, it is particularly useful in studying the sleep-waking cycle and in diagnosing epilepsy.

Brain waves include: alpha, beta, delta, and theta ... more consideration of these under "states of consciousness".

Magnetoencephalography ... SQUID

⇒ tells us about brain activity ... but at a very large scale (large ... because it measures the simultaneous activity of hundreds of thousands of active brain cells)

Just as electrical events in nerve cells generate electrical currents that can be recorded, they also produce tiny magnetic fields. A sensor called a SQUID (super-conducting quantum interference device) is used to measure these weak magnetic fields. Measuring magnetic activity rather than electrical activity is easier as the skull is magnetically transparent but electrically resistant. Thus the source of magnetic signals can be localized.

Microelectrode recording

⇒ tells us about brain activity ... at a very tiny scale (tiny ... because it measures activity of individual brain cell)

Microelectrodes (made from either extremely fine metal wire or stretched glass) are filled with a conductive solution such as potassium chloride ... and used for either extracellular (beside the cell) or intracellular (within the cell) recording of the flow of electrical currents.

Patch clamps

⇒ tells us about the brain activity ... at a very tiny scale (tiny ... because it measures activity at certain spots across the membrane of an individual brain cell)

Brain cells regulate their electrical activity by controlling small pores or channels in their membrane. The electrical current across these pores can be measured using a "patch clamp" which is a tiny electrode that is placed on the membrane of the cell and caused to seal itself mechanically and electrically to the spot. The electrode measures electrical current in that area only ... i.e. the area of an individual channel.

Brain lesion analysis

A lesion is an abnormal disruption of tissue, produced by injury or disease. The study of naturally-occurring brain lesions in human beings formed the cornerstone of early brain research ... by knowing the area of the brain affect, and matching it with the change in sensory, motor, or cognitive function ... specific areas of the brain could be mapped as to their function. Interpretation is, however, tricky ... lesions are not perfectly made, there is often damage to fibers of passage in the area (that communicate with other parts of the brain), and specific functions are often distributed through a number of brain areas rather than being localized to one specific spot.

Brain organizing principles

Major organizing principles ... for understanding the human brain:

■ ***anatomical structure***

The adult human brain is as big as a coconut, the shape of a walnut, the colour of raw liver, and the consistency of chilled butter (Carter 1998).

- it is anatomically structured as a long tube or balloon with:
  - bumps
  - bilateral symmetry ... giving a right half and a left half

- it has major regions and lobes
  - diagrams
    - ❖ Marieb 1998 ... Fig.12.3
    - ❖ Marieb 1998 ... Fig.12.4

- **four major regions of the brain** (discussed in more detail later):
  1) cerebrum
     - left and right hemispheres
       - → each with five lobes: occipital, parietal, temporal, frontal, insula

  2) diencephalon
     - thalamus
     - hypothalamus
     - epithalamus

  3) brain stem
     - midbrain
     - pons
     - medulla oblongata

  4) cerebellum
     - left and right hemispheres

■ ***development***

- The brain develops extensively after birth, through adolescence, and to adulthood.

  → According to Brodal (1998), the brain of an adult male weighs about 1400 grams, and of an adult female about 1250 grams. This adult weight is considerably more than at birth, when it weighs about 300 grams! During the first year of life the brain triples in weight, and after that its weight increases more slowly to almost reach adult values around the age of ten years.

  → Although we are born with *almost all* the brain cells we are ever going to have ... what happens after birth is that the connections between the cells grow at an astonishing rate, becoming ever longer and denser ... so that complex networks of neurons gradually form. Each brain cell may have as many as 5-10 thousand connections!

  → This extremely complex neural "wiring" ... is much more important in determining "brainpower" than is brain size

❖ Marieb 1998 ... Fig.12.3: embryonic development of the human brain ... to adult brain structures

❖ Marieb 1998 ... Fig.12.4: effect of space restriction on brain development

■ ***evolutionary organization***

- The brain shows evolutionary organization ... in which the areas closest to the spinal cord are the oldest and those areas furthest from the spinal cord are the newest.

  - leads to terms such as "higher brain" or "lower brain" ... depending upon location along the tube

  - the oldest parts are shared with all other vertebrates ... and control basic functions related to survival (e.g. breathing, heart rate)

⇨ see discussion of "lizard, leopard, and learning brain" in section on "brain systems"

■ ***electrical activity***

- The brain exhibits electrical activity ... generated by its vast numbers of nerve cells. Nerve cells, like all living cells, maintain an electrical charge across their outer membranes. However, nerve cells are especially adapted to carry and process information by varying that electrical charge (Beatty 2001).

- Major patterns of electrical activity can be recorded using the EEG ... and thus, the concept of *brain waves* ... or *brain rhythms*.

  ⊎ Studying brain waves (rather than brain cells) is like studying the forest (rather than the trees).

  Brain waves are categorized by their frequency range (Hz ... is "cycles per second"):

  - alpha waves ..... 8-13 Hz
  - beta waves ..... "fast" ... greater than 14 Hz, low voltage
  - delta waves ..... 1-4 Hz
  - theta waves ..... 4-7 Hz

  → Voltage is *charge difference* ... often contextualized as the strength of an electrical current or force ... and depicted as the amplitude of a wave.

- Electrical activity that is detectable via EEG is believed to result from the summation of postsynaptic potentials originating in large populations of brain cells (Beatty 2001).

  ⇒ The idea is that the voltage in the EEG pattern increases when the synaptic activity of many neurons is synchronized.

  ⇒ Conversely, if the neurons are acting independently of each other, the EEG will be rather flat because the cells are doing different things at different times.

■ ***function***

- The functions for which the brain is referred to, in Cognitive Science, as an "information processor" ... include:

  - regulatory functions
    - temperature, food intake, water balance, biological rhythms and drives, heart rate, blood vessel diameter, respiration, vomition, coughing

  - muscular co-ordination functions (sensory, motor, and balance systems)

  - integrative functions
    - sleep-wake cycles
    - lower and higher mental functions ... i.e. **building blocks of consciousness**

		Building blocks experienced	
		all mammals and human infants (lower)	*more mature adults* (higher)
• input sources			
- sensation	reception of input data	+	+
- perception	representation of input data	+	+
- attention	selection of input data	+	+
- emotion	feelings about representations of input data	+	+
- instinct	innate propensities to act on input data	+	+
• elaborative processing			
- memory	retrieval of stored representations	-	+
- thought	reflection upon representations	-	+
- language	symbolization of representations	-	+
- intention	representation of goals	-	+
- orientation	representation of time, place, persons	-	+
- learning	automatic recording of experience	+	+
• output actions			
- volition	decisions to act	-	+
- movement	motor acts and behaviours	+	+

? causal function ... for the brain

☞ The Cognitive Science view of the brain, i.e. as an *information processor*, tends to overlook or omit the causal function that consciousness might or can play.

☞ Aboriginal world views clearly include a causal function for consciousness.

❖ Marieb 1998 ... Fig.11.1: overall function of nervous system

- The brain is functionally redundant ... different parts of the brain each contribute to solving the same problems. This redundancy reflects the brain's evolution in that as new parts of the brain evolved and took over old brain functions, the old areas that mediated those functions still retained some control over them.

- The brain's overall **function** is holarchical in terms of organization (from Greenfield 1999):

- function
- systems
- regions
- networks
- circuits
- neurons (brain cells) + synapses (connections between brain cells)

<u>two important points to understand</u>:

- how this holarchy compares to the "staircase to the mind" and the "levels of analysis in neuroscience, as given previously
- what a *holarchy* is (see section on "perception ... a building block of consciousness")

⊎ **metaphor** (Greenfield 2000)
... ***in some ways, a brain is like a <u>brick house</u>*** ... both are organized in particular ways for particular functions, and both can be examined at different levels

- in this metaphor ... the overall function of the brain is like the function of the house which cannot be understood without reference to the lives of the people who live in it
- similarly, the brain cannot be understood solely by talking about cells, neurons, etc.

➜ This "brick house" is a very useful metaphor. Work with it!

Neurons

❒ read *Mapping the Mind*

❖ *Mapping the Mind* ... p. 14: neuron

⊎ in the brick house ... neurons are the bricks, i.e. the "building blocks"

Neurons are cells* ... more specifically, they are the main cell of the brain and nervous system ... carrying electrical signals to each other. Your brain contains 10's of billions of them ... that you were born with!

* The *cell theory* is central to modern Biology (see ThoughtTraps 2).

Actually, there are two basic types of cells in the brain ... and neurons are the least numerous:

1. neurons
   - → create the electrochemical activity that characterizes brain activity
   - → 1 out of every 10 cells in the brain
2. glial cells
   - → create the structural support for the neurons ... "glue the whole thing together"
   - → may also, during early brain development, help direct the growth of sensory receptor neurons so that they hook up with the correct areas in the brain
   - → 9 out of every 10 cells in the brain
   - → includes three types: astrocytes, oligodendrocytes, Schwann cells

Question: What does a typical neuron look like?
Answer: The structural organization of a neuron consists of major parts:

- membrane ..... the outer boundary or surface of each neuron
- cell body ..... each neuron has one
- dendrites ..... generally several ... which are highly, highly branched
  - two parts
    - shaft
    - spines ..... tiny, thorn-like projections
- axon ..... generally with branched endings
  - boutons ..... club-shaped, terminal endings
- myelin ..... fatty sheath formed by many layers of a surrounding cell
- nodes ..... points along the axon that lack myelin

❖ Draw a simple diagram of a neuron ... show the above parts, label them, and *indicate the direction of information flow.*

⊎ How is a neuron like a tree?

Question: What does each part of a neuron do?
Answer:

- cell body
  - → houses the nucleus with its DNA
  - → integrates (puts together) the information received by the dendrites
    - integration may be of information from a variety and a number of synapses
  - → determines the information to be sent, via the axon, to other neurons
  - → houses most of the mitochondria (energy conversion)
  - → houses the ribosomes (protein synthesis)
  - → site of synthesis of neurotransmitters
- dendrites
  - → each receives incoming information ... from synapses (connections with axons of other neurons) ... sends the information towards the cell body
  - → as a result of their highly branched shape, they greatly increase the opportunities for synaptic connections
- spines
  - → form the postsynaptic structures for most synapses
  - → are modifiable ... they change with learning and other factors
- axon
  - → conducts (sends, transmits) information away from the cell body ... to synapses (connections with the dendrites of other neurons)
- myelin
  - → acts to insulate the axon ... which is carrying an electrical message
  - → inside the CNS ... myelin is produced by oligodendrocytes (a type of glial cell)
  - → outside the CNS ... myelin is produced by Schwann cells (a type of glial cell)
- node
  - → "jump to" spots for nerve impulses

Question: How are neurons classified?
Answer: They can be classified in two different ways:

1) based on <u>function</u> (i.e. the affect caused in the *postsynaptic neuron*)

- excitatory
  - → causes partial depolarization of postsynaptic neuron
- inhibitory
  - → causes partial hyperpolarization of postsynaptic neuron
- neuromodulatory
  - → changes membrane properties of postsynaptic neuron, and thus possibly alters its *stimulation threshold*

2) based on <u>distance the axon reaches</u>

- projection
  - → long axons ... that carry information to other areas of the nervous system
- interneurons
  - → short axons (or none at all)

Neurons ... and the blood-brain barrier

information from Beatty (2001)

Although neurons are cells, they are very different from other body cells ... because they are highly adapted to carry information via electrical signals, generated by their membranes. These signals depend on the differences in the chemical composition (specifically, the concentration of ions ... especially Na^+ and K^+) of the fluids inside and outside the neuron ... as is explained in the next section.

But when we eat or drink or smoke, for example, the chemical composition of our blood — and of the fluid that bathes the cells throughout the body — changes markedly.

☺ For most cells, these changes are of small consequence.

☹ But for neurons, the results would be disastrous because even small changes in the composition of the fluids that bathe them would result in false electrical signals, distorting the brain information on which we act.

⇨ For this, and other similar reasons, brain neurons require a very protected, extremely constant environment. They are given this protection by the **blood-brain barrier**.

The blood-brain barrier results from the following structural arrangement of cells:

In the brain and spinal cord, the cells (endothelium) that are the wall of the tiny blood vessels (capillaries) ... are tightly sealed to each other, with no gaps through which substances could pass. Elsewhere in the body, endothelial cells are not so tightly sealed like this.

✶ Some molecules, however, can enter the fluid around the neurons by passing *directly through the walls* of the blood vessel endothelial cells (via a process called diffusion, since the molecules are "lipid soluble"). These molecules include:
- respiratory gases .... oxygen and carbon dioxide
- many psychoactive drugs ... e.g. nicotine, alcohol, heroin, phenobarbital
- anaesthetics, cocaine

✶ Other molecules can also enter the fluid around the neurons by passing *indirectly through the walls* of the blood vessel endothelial cells (via special "gates" called transport carriers ... which are protein molecules). These molecules include:
- glucose
- amino acids
- proteins

There are small regions of the brain in which the blood-brain barrier is incomplete. These include the pituitary and pineal glands, as well as areas thought to monitor various aspects of blood content (e.g. regulation of hunger).

Nerve impulses

The nerve impulse is an electrical current ... traveling down a neuron. Other names for "nerve impulse" are "message" and "signal".

Question: In what language is the nerve impulse, i.e. the message or signal?
Answer: It is in:

- *electrical language* ... when traveling down a neuron
  = in the pattern of charged ions (especially Na^+ and K^+) ... across the cell membrane of the neuron

- *chemical language* ... when traveling across the tiny gap between two neurons
  = in molecules called neurotransmitters

Question: What are the important concepts to understand with respect to the nerve impulse?
Answer:

Note: the importance of **pattern** in the concepts named and then explained below.
Note: ions and molecules cross the membrane of the neuron via protein "gates" (channels).

Three importance concepts all relate to changes in the electrical (ionic) environment of the neuron — changes that result in the "firing" of a "nerve impulse".

1. resting membrane potential
2. action potential
3. stimulation threshold

A fourth relates to changes in the chemical environment at the end of an axon when the message is passed, via a molecule, to the dendrites of another neuron.

4. synapse

❖ Provide, on the next page, a diagram of these four concepts ... to show the starting **pattern** and the changes that occur in it. As you do so, work with the understanding that:

INFORMATION is ...
"something than makes a difference".

This "something" is an environmental stimulus
intense enough to cause a change in the set **pattern**.

1) resting membrane potential

= resting condition of the membrane of the neuron
... because it is an *unequal* concentration of ***ions*** ... an "electrical gradient" is created
→ Na^+ high on the outside
→ K^+ high on inside
→ with an overall negative charge inside the cell (due to anions)

❖ there is a "set **pattern**" (resting) ... draw it

2) action potential

= a brief *change* in the electrical gradient in which:
→ Na^+ flows into the cell
→ K^+ flows out of the cell

✴ drugs that block the action potential include: anaesthetics, cocaine

❖ the "set **pattern**" changes (there is *action*) ... draw it

3) stimulation threshold (= threshold potential)

= the level of change in the electrical gradient that must be reached ... to trigger a moving change in membrane permeability down the length of the neuron, with its accompanying moving change in the electrical gradient ... i.e. a "nerve impulse"

❖ the change in the "set **pattern**" reaches a trigger level (threshold) and then the "changed **pattern**" travels down the neuron ... draw it

4) synapse ... transfer (via chemical means ... a "neurotransmitter") of the impulse across the tiny gap where the axon of one neuron meets the dendrite of another ... *see next section*

Synapses

- ❖ *Mapping the Mind*, p. 14
- ❖ Marieb 1998 ... Fig.11.17: examples of types of synapses
- ⊎ in the brick house ... synapses are the mortar between the bricks

The word "synapse" comes from the Greek "synapsis" ... meaning *connection*.

We are born with billions of neurons ... but it is not the number of them that determines our mental characteristics ... it is how they are connected.

Neurons are highly, highly interconnected (joined to each other) — each neuron connecting with up to 5000 to 10,000 other neurons ... and in some cases up to 100,000.

The neurons connect ... the axon of one to the dendrite of another ... i.e. axon → dendrite ... and there is a tiny gap (about 20-50 nm) between them ... which is called the **synaptic junction** (also the synaptic gap or cleft).

➜ The **synapse** ... is the <u>action</u> of the nerve impulse *crossing this tiny gap*.

Generally, the crossing is in only one direction: axon → dendrite.

To cross the gap, the message (information) of the nerve impulse ... is changed from electrical language into <u>chemical</u> language, i.e. into molecules. These molecules are called **neurotransmitters**, and there are numerous different types and categories of them.

✴ Because the synapse is chemical ... it is the target of almost all psychoactive drugs.

!!! As already indicated, each neuron can connect with 5000 to 10,000 to 100,000 other neurons.

Thus, with respect to the connections between neurons ... there are not just connections ... there are: **<u>interconnections</u>** ... neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons joining to neurons ... etc!

☺ We are born with almost all the brain cells we are ever going to have ... what happens after birth is that the **connections** between the cells grow at an astonishing rate, becoming ever longer and denser ... so that complex networks (interconnections) of neurons gradually form.

→ The activity that leads to this extreme complexity is sometimes referred to as the ***wiring of the brain***.

☺ And, as we get older ***and learn new things*** ... neurons form more and more synapses with each other ... i.e. the wiring of the brain gets more and more complex.

With respect to the specialized connection (axon → dendrite) between two neurons ... the:

- **presynaptic neuron** ..... is the one "before" the connection (it contributes the axon, and it sends the message), and the
- **postsynaptic neuron** ..... is the one "after" the connection (it contributes the dendrite, and it receives the message).

☞ Generally, activity at the axon terminal of the sending cell (presynaptic neuron) affects the behaviour of the receiving cell (postsynaptic neuron)

Since a neuron may have 1000's of synaptic junctions ... it is the sum of their influences that determines how active the post-synaptic neuron will be at any moment (Brodal 1998; p.7).

Although most synapses involve the axon → dendrite connection already mentioned, there are other types ... as determined by the site of placement of the synaptic junction (see below).

It general, the site where the synapse occurs indicates how strong its particular influence may be — an axosomatic synapse is usually more powerful than a synapse far out on a dendrite.

➜ various types of synapses

1) axodendritic ... which involves:
- bouton to dendritic shaft, or
- bouton to dendritic spine

❖

2) axosomatic
- bouton to cell body

❖

3) axoaxonic
- bouton to an axon (generally very close to its bouton)

❖

neurotransmitters

❖ *Mapping the Mind*, pp. 14-15, 29, and many others (see index)

Neurotransmitters are:

... the carriers of the information across synaptic junctions

... molecules (chemicals)

... categorized into "families" ... based on their chemical structure
- variety is extremely high ... at least 50 different neurotransmitters have been identified

... packaged in "vesicles" which are bubbles of membrane (i.e. they are not "naked" in the space between the neurons)

... released by ..... the presynaptic neuron

... received by ..... the postsynaptic neuron ... which has a specialized **receptor** site

The information carried by neurotransmitters (Greenfield 2000):
- is not related to the chemical structure of the neurotransmitters
- is related to the **release pattern** of the neurotransmitters ... both:
  - in isolation
  - in conjunction with release patterns of other neurotransmitters

⊎ ***Question:*** Why does *Mapping the Mind* refers to neurotransmitters as "rivers of the mind"?

Answer: Read the recommended pages (14-15, 29, and many others as indicated in the index).

Your answer:

Some of the most important neurotransmitters and their functions:

Family	Name	Function
Amines		
	acetylcholine	• transmits to muscles • controls activity in areas associated with attention, learning, and memory
	dopamine	• stimulates movement (physical motivation) • controls arousal levels in many parts of the brain
	serotonin	• brain's "reward" system ... produces feelings of pleasure • also effects areas associated with sleep, pain, appetite, and blood pressure
	norepinephrine (noradrenaline)	• excitatory ... mental and physical arousal
	epinephrine	
Amino acids		
	GABA	• inhibitory ... widespread
	glutamate	• the major *excitatory* neurotransmitter, vital for forging the connections between neurons that are the basis for learning and long-term memory
	glycine	• inhibitory ... widespread
	histamine	
Peptines		
	endorphins and enkephalins	• modulate and kill pain • reduce stress ... promoting a sensation of calm • depress breathing
Others		
	nitric oxide	

mind/body/brain unity

Question: Does "**mind/brain/body unity**" exist?

Answer: Yes .... in the sense that receptor sites for information molecules are found all through the body, not just for neurotransmitters on postsynaptic neurons in the nervous system — from the immune system to the gut to the heart muscles to the gonads. Many of the same molecules "dock" equally well in these diverse sites (although with different consequences). In addition to neurotransmitters, for example, there are hormones and immunopeptides ... molecules that can travel to diverse and distant sites via the bloodstream and cerebral spinal fluid ... bringing about an exchange of information among these sites.

Information molecules include:

- neurotransmitters ..... mainly nervous system ..... but also endocrine and immune
- hormones (proteins and steroids) ... mainly endocrine system ..... but also nervous and immune
- immunopeptides ..... mainly immune system ..... but also nervous and endocrine

Question: If neurotransmitters can be referred to as "rivers of the mind" ... can the metaphor be extended to refer to "information molecules" as "rivers of the mind/brain/body"?

Your answer:

care and feeding of synapses: brain maintenance

Howard (2000) provides the information below about brain maintenance, by way of care and feeding of the synapses. In his explanation, note *the power of a metaphor*.

> Just as the condition of the gap in an automotive spark plug is important to effective operation of a car, the receptors on the dendrites of the postsynaptic neuron must be clean and in good condition for our nerves to work properly. You can clean the gap of a spark plug with a wire brush, and you can also clean the synaptic gap. Normal maintenance of the synapse is accomplished by the presence of *calpain*, a compound derived from calcium. Calpain acts as a kind of cleanser, dissolving protein buildup at the synaptic gap like a miniature PacMan. The dietary source of the cleanser calpain is dairy products and leafy green vegetables. Too little calcium in the diet results in protein buildup at the synapse, with resulting loss of mental performance (e.g. memory) as the buildup interferes with the ability of neurotransmitters to "jump" the synapse. On the other hand, if there is too much calcium in the diet, the excess calpain itself begins to interfere with neural transmissions.
>
> One drastic solution to remove protein form the synaptic gap is electric shock.
>
> Additional suggestions for caring for synapses are provided below (Howard 2000).

Source	Examples in the work or learning environment
• environmental richness	posters, artwork, variation in paint, drapes, wallpaper, puzzles, games
• diet	follow the *Canada Food Guide* - do not eliminate fats - avoid extremes of calcium
• snacks	for mental activity: proteins and complex carbohydrates for relaxation: simple carbohydrates and fats ("comfort food")
• exercise	aerobic exercise 4 to 5 times per week
• atmosphere (e.g. ions)	fresh air for invigoration, not simple carbohydrates or caffeine
• breaks	every half hour
• habits	make new learning the norm

☞ Generally, "reticular switching" determines the primary brain strategy that is employed from situation to situation (see section on the reticular formation under "brain systems"), whereas **the condition of the synaptic junction and neurotransmitter receptors determine the effectiveness of the strategy we employ**.

Circuits of neurons

- in the brick house ... circuits are the walls of bricks

The information below is from Greenfield (2000):

- Neurons do not work as individuals ... rather, they highly interconnected with other neurons and constantly interacting with them ... and so ...

  ☞ what each neuron does depends on what the other neurons that it is connected to are doing. Thus, the specific connections among neurons ... the **circuits** ... are of crucial importance.

- The sense of vision offers an excellent illustrative example ... where different circuits deal with the different aspects of vision, e.g.:
  - movement
  - shape
  - color

  ✪ as discussed in the video: the brain-damaged woman who could see cars in the street but could not see their movement

- Memory is a second excellent illustrative example:
  - short term memory
  - long term memory

- Two important types of circuits ... those that consist of:
  1) "global" neurons ..... act over a relatively long time scale, and influence the flow of information between the "serial" neurons but do not instigate any action themselves

  2) "serial" neurons ..... act over a relatively short time scale, and are responsible for the fast synaptic networks responsible for higher-level processing and output of the brain

Networks of neurons

- in the brick house ... networks of neurons are the walls joined together to make structures (e.g. corners, rooms)

Neurons are interconnected, often in identifiable patterns referred to as networks. In this way, the activity in each neuron is passed to other neurons in a "reverberating loop" ... so that the activity in any one neuron is influenced by the activity in many other neurons.

- Some networks are small and localized.
- Other networks are distributed diffusely over wide regions of the brain.

A particular network often has a particular task to carry out ... such as one of the various components in memory (❒ read the example discussed in Greenfield 2000).

The study of "neural networks" is a major area of research in neuroscience.

☺ **Learning is defined as the establishment of new neural networks composed of synaptic connections and their associated neurotransmitter receptor patterns.**

❒ Read *Mapping the Mind* ... pp. 19-20 ... and answer the following questions:

Question: What is the ***firedance*** in these pages?
Answer: neurons all fired up, joined up, and dancing on a huge scale

Question: What does "fired up" mean?

Question: Why is the pattern of the dance important?

Question: Why is the dance always changing?

Question: What is the significance of "feedback" in the dance?

Question: What happens if the pattern degenerates?

Question: What is significant about the brain's "greed for new information"?

Question: Where does this new information generally come from?

Question: What influences whether a particular pattern is considered "beneficial", and thus kept?

Brain regions ... general anatomy and overall functions

☺ in the brick house ... brain regions are the different areas such as the upstairs or downstairs

BRAIN ANATOMY

Anatomy: major regions of adult human brain — *position re spinal cord*

1) cerebrum ..... cerebral hemispheres - furthest
2) diencephalon ..... thalamus, hypothalamus, epithalamus - second furthest
3) brain stem ..... midbrain, pons, medulla oblongata - closest
4) cerebellum ..... cerebellar hemispheres - mid brain stem

Anatomy: major divisions of human brain, embryonic development to adult

- consult: ❖ Marieb 1998 ... Fig. 12.3
- names: the *International Standard* for anatomical research on the brain (Beatty 2001)
  - brain system: limbic system ... parts* that collectively form it
  - brain system: reticular formation ... parts (RF) that collectively form it

1) forebrain
- **diencephalon**
  - epithalamus
  - thalamus
  - hypothalamus*
  - subthalamus
- telencephalon (**cerebrum**)
  - central cortex
  - olfactory bulb
  - amygdala*
  - septal region*
  - fornix*
  - basal ganglia
    - globus pallidus
    - striatum
      - putamen
      - caudate nucleus
  - hippocampus*

2) midbrain (part of **brain stem**)
- tectum
  - pretectal regin
  - superior colliculus
  - inferior colliculus
- central peduncle
  - substantia nigra
  - midbrain tegmentum
    - occulomotor nucleus
    - midbrain RF
    - red nucleus
    - central gray
    - raphe nucleus

3) hindbrain
- medulla oblongata (part of **brain stem**)
  - vestibular nuclei
  - cochlear nuclei
  - medullary RF
  - raphe nuclei
  - solitary nucleus
  - olivary complex
- metencephalon
  - pons (part of **brain stem**)
  - **cerebellum**

Anatomy: evolution and function ... major regions of adult, human brain ... popular science

"Popular science" refers to efforts made to explain science to the average person who is interested but lacks specialized training or education in science. Popular science often has particular phrases or terms (jargon) that scientists would not normally use. With respect to the brain, the following way of referring to different regions of the brain seems to have captured the imagination of many people:

1) lizard brain	[brain stem]
2) leopard brain	[limbic system]
3) learning brain	[cerebral cortex]

❖ Howard (2000): Fig 2.1

The above names are explained in the extract below, from Howard (2000). As you read it, think about how a story is a very effective way of transmitting information ... *the power of the story*, *of storytelling* ... and *the power of a metaphor*!

> Once upon a time there were only lizards and other such reptilian creatures. The ***lizard brain*** was simple, geared only to the maintenance of survival functions: respiration, digestion, circulation, and reproduction. Over evolutionary time, the leopard and other such mammalian creatures emerged. Extending out from the lizard brain stem, the ***leopard brain*** (now called the limbic system) added to animals' behavioural repertoire the capacity for emotion and co-ordination of movement. This second phrase of brain evolution yielded the well-known general adaptation syndrome (GAS), or fight-or-flight response. The evolutionary advantages of this syndrome are attested to by the disappearance of many reptilian species. The third phase of evolution was the ***learning brain*** — the cerebral cortex. This third and most recent phase of brain evolution provided the ability to solve problems, use language and numbers, develop memory, and be creative.
>
> These three stages of evolution have been referred to as:
> - protoreptilian
> - paleomammalian (early mammal), and
> - neomammalian (late mammal).
>
> The millions of years of brain development from lizard to leopard to learner are repeated in each human embryo during the nine months in the womb. Thus, the development of an individual embryo (ontogeny) retraces (recapitulates) the evolutionary path of its ancestors (phylogeny).
>
> **The consequences of poisoning the brain with drugs or alcohol during pregnancy can be seen in infants whose development was arrested or thwarted at the lizard or leopard level.**
>
> ⇨ most severe: foetal alcohol syndrome (FAS)
> ⇨ less severe: foetal alcohol effect (FAE)

Anatomy: adult, human brain ... surface views

❖ various

- frontal
- occipital
- medial
- lateral
- inferior
- superior

→ general features
- gyri
- sulci
- hemispheres

→ specific features ("landmarks")
- cerebral fissure
- cerebral fissure
- central sulcus
- precentral sulcus
- postcentral sulcus
- lateral sulcus

Anatomy: adult, human brain ... sections (planes of dissection) and cut-surface views

❖ various

❖ Beatty 2001: Fig. 2.13 and 2.14

- axial
- transaxial
- sagittal
- parasagittal
- frontal
- coronal

FUNCTION

1) cerebrum

- largest part of the human brain ... about 83% of total brain mass

- divided into two hemispheres: left and right ... each hemisphere having:
  - extensive wrinkling and folding to give:
    - ridges ... = gyri (singular, gyrus)
    - grooves ... if shallow = sulci (singular, sulcus), if deep = fissures (singular, fissure)

  - chief involvement with sensory and motor functions on the opposite side of the body
    - ✘ damage to one side of the brain, as for example from a stroke, results in paralysis on the opposite side of the body

  - five lobes (first four visible from surface, fifth is deep):
    - ❖ Marieb 1998 ... Fig. 12.5: regions of the brain
      1) occipital
      2) parietal
      3) temporal
      4) frontal
      5) insula

  - three basic regions, outermost to deep inner:
    - ❖ Marieb 1998 ... Fig. 12.6: arrangement of gray and white matter in the CNS
      1) cortex ..... gray
      2) white matter ... white
      3) basal nuclei .... gray

1) cortex ... outer, gray matter ... 2-4 mm thick
- "gray" because it contains neuron cell bodies, dendrites, unmyelinated axons (note: has no fibre tracts)

◙ overall: the "executive suite" of the nervous system ... enables one to perceive, communicate, remember, understand, appreciate, and initiate voluntary movements — all qualities associated with **consciousness**

- has three functional areas*: motor, sensory, association

  * However, no functional area truly acts alone, and conscious behaviour involves the entire cortex in one way or another. Furthermore, there is merit in considering two theories as both correct, with respect to cortical function: (1) *regional specialization* ... with discrete, specific areas for specific motor and sensory functions, and (2) *aggregate field* ... with overlapping, more diffuse areas for higher mental functions such as memory and language. [area = domain]:

three functional areas in the cerebral cortex:

- **motor area** ... ◙ control of voluntary muscle movement (body, speech, eyes)
  - involves only the frontal lobe

- **sensory area** ... ◙ conscious awareness of sensation
  - involves parietal, temporal, and occipital lobes
    - parietal
      - primary somatosensory cortex ... receives input from skin and skeletal muscles
      - gustatory cortex ... receives input from taste buds
    - temporal
      - primary auditory cortex ... receives input from ears
      - olfactory cortex ... receives input from nose
        → is part of the rhinencephalon (see limbic system)
    - occipital
      - primary visual cortex ... receives input from eyes

- **association areas** ... ◙ analyze, interpret, and integrate diverse sensory information coming from the relevant primary cortex or relevant cortex, for purposeful or intentional action. All association areas communicate with the motor cortex and other association areas ... yet each has multiple inputs and outputs independent of the primary sensory and motor areas ... creating extremely complex functioning ability

  - somatosensory association area ⇒ touch and spatial discrimination
  - auditory association area ⇒ hearing
  - visual association area ⇒ sight
  - olfactory association area (part of olfactory cortex) ⇒ smell
  - gustatory association area (part of gustatory cortex) ⇒ taste
  - prefrontal association area ⇒ intellect and complex learning abilities (cognition), and personality ... abstract ideas, judgement, reasoning, persistence, planning, concern for others, and conscience ... this area matures slowly and is heavily dependent of positive and negative feedback from the external environment ... is closely linked to the limbic system and plays a role in mood
  - general interpretation area (= gnostic area) ... parts of temporal, parietal, and occipital lobes ... but in one hemisphere only (generally the left) ... receives input from all the sensory association areas ⇒ a storage site for memories associated with sensation, which integrates input into a single thought or understanding and sends it to the prefrontal cortex [which adds emotion and decides on appropriate response]
  - language areas ... various regions, including ... (1) Wernicke's area in the temporal lobe of one hemisphere (normally the left) which is commonly called the "speech area" ⇒ involved in sounding out unfamiliar words, (2) prefrontal area ⇒ language comprehension, and (3) affective language areas ⇒ add emotion to speech, or interpret emotional content in what is heard
  - visceral association areas ... in the insula ⇒ conscious perception of visceral sensation such as upset stomach, full bladder, etc

☞ **sub-topic: cerebral hemispheric specialization**

The two cerebral hemispheres, left and right, communicate with each other regularly, perfectly, and almost instantaneously ... by way of connecting fibre tracts ... plus, they integrate their functions.

Nevertheless, although they are physically similar (almost), they are functionally different, a phenomenon called lateralization, laterality, or functional asymmetry. And, although, one hemisphere or the other dominates each task, the term *cerebral dominance* designates that hemisphere that is dominant for language .... 90% of people are left hemisphere dominant, and most of these people are right-handed.

- left hemisphere ... ◙ controls language abilities, mathematical abilities, and logical thought

- right hemisphere (which is controlled by the left) ... ◙ visual-spatial skills, abstract or intuitive thought, emotion, perception and appreciation of art and music ... it is poetic, creative, and the "ah-ha" side of human nature

→ The general pattern outlined above is reversed in some individuals, or the hemispheres share their functions equally.

✘ the reading disorder dyslexia has, in some cases, been attributed to lack of cerebral dominance

→ Each side of the brain can exert control over the other ... the dominant, more intellectual hemisphere prevents emotional display ... but the emotional side urges us to take time out from routine, to play, to be spontaneous.

2) white matter ... internal to cortex

• "white" because it contains myelinated axons (fibres) bundled into large tracts

◙ communication connections

- commissural fibres ... ◙ connect corresponding areas between the two cerebral hemispheres, with the major connection being called the corpus callosum

- association fibres ... ◙ connect gyri and lobes within a single cerebral hemisphere

- projection fibres ... ◙ connect cerebral hemispheres to lower brain (and vice versa), also to the rest of the nervous system and to the receptors and effectors of the body

3) basal nuclei ... islands of gray matter deep within the white matter
- receive input from the entire cortex

- relay through the thalamus to the premotor and prefrontal cortices ... and thus influence voluntary muscle movement directed by primary motor cortex (but with no direct access to motor pathways) ... a subcortical motor area

- play some role in cognition

2) diencephalon

- is surrounded by the cerebral hemispheres
- consists of three bilaterally symmetrical regions ... thalamus, hypothalamus, epithalamus

1) thalamus

- overall: the gateway to the cerebral cortex ... as the mediator of sensation, motor activities, cortical arousal, learning, and memory

- with respect to sensory input: sorting-out and information editing, such that impulses having to do with similar functions are grouped together and relayed to the appropriate area of the sensory cortex as well as to specific cortical association areas. The only conscious recognition with respect to the sensory stimulus is whether the experience about to occur is apt to be pleasant or unpleasant ... specific recognition is a function of the cortex.

- additional: virtually all impulses on their way to the cortex are funneled through here, including impulses participating in the regulation of emotion and visceral function from the hypothalamus, plus some that help to direct the activity of the motor cortices from the cerebellum and basal nuclei

2) hypothalamus

- overall: the clearing house for both autonomic function and emotional response ... is the main visceral control center of the body and vitally important to overall body homeostasis, including:
  - control centre for autonomic nervous system (involuntary nervous system)
  - centre for emotional response and behaviour
  - regulation of body temperature
  - regulation of food intake
  - regulation of water balance and thirst
  - regulation of sleep-wake cycles
  - control of endocrine system functioning

3) epithalamus ... with the pineal gland

- overall: pineal secretes melatonin which helps regulate sleep-wake cycles and some aspects of mood

3) brain stem

- overall: produces the rigidly programmed, automatic behaviours necessary for survival

- contains three regions ... midbrain, pons, medulla oblongata:

1) midbrain

- contains nuclei associated with the reticular formation
- contains two pigmented nuclei:
  - substantia nigra ... has a high content of the black pigment melanin, a precursor of the neurotransmitter dopamine which is released by the midbrain neurons
  - red nucleus ... is richly vascular and has iron pigment ... relay nuclei in some descending motor pathways that effect limb flexion

2) pons

- contains conduction tracts
  - some tracts complete the connection of the higher brain centres to the spinal cord
  - some tracts serve as the connection between the motor cortex and cerebellum
- contains a respiratory centre ... which maintains the normal rhythm of breathing
- several cranial nerves leave from here

3) medulla oblongata

- serves as the crossover point for nerve tracts by which each cerebral hemisphere controls voluntary movements of muscles on the opposite side of the body

- contains conduction tracts and nuclei that connect the medulla to the cerebellum
  - some relay information on the state of stretch of muscles and joints to the cerebellum, thus mediating responses that maintain equilibrium
  - contains ascending sensory tracts and nuclei that relay general somatic sensory

- autonomic reflex center involved in homeostasis (the instructions from the hypothalamus are relayed through here), including
  - respiratory centre ... which interacts with the pons respiratory center, in a negative feedback way
  - cardiovascular centre ... heart contraction and blood pressure
  - other centres ... vomiting, hiccuping, swallowing, coughing, sneezing

4) cerebellum

- about 11% of total brain mass ... in two cerebellar hemispheres

- overall: processes input from the cerebral motor cortex, various brain stem nuclei, and sensory receptors to provide the precise timing and appropriate patterns of skeletal muscle contraction needed for smooth, coordinated movements in daily life ... it continually compares the higher brain's intention with the body's performance and sends out messages to initiate appropriate corrective measures

- maintenance of balance (in conjunction with the inner ears) and control of certain eye movements

Brain systems ... two specific functional systems: limbic system and reticular formation

- in the brick house ... systems are like the arrangement of a room for different purposes (functions)

definition: a **functional brain system** ... is a network of neurons that work together but span relatively large distances with the brain

- two important functional brain systems:
  - limbic system
  - reticular formation

1) limbic system

- ❒ Read: *Mapping the Mind*
- ❒ Re-read: the explanation from popular science about the "anatomy, evolution, and function" of the brain (section on brain anatomy)

- ❖ Marieb 1998 ... Fig. 12.20: limbic system
- ❖ Marieb 1998 ... Figs. 12.3 & 12.4: adult regions of the brain

... spread widely throughout the forebrain (see previous section: "brain regions")

- ◙ is the emotional (affective, or feeling) brain ... with extensive connections with the lower and higher brain regions ... allowing the system to integrate and respond to a wide variety of environmental stimuli
  - → emotion-induced illness = psychosomatic illness
  - → emotional override of logic
  - → reason override of emotion

- ◙ important role in converting new information into long-term memories

2) reticular formation

❒ Read: *Mapping the Mind*
❒ Read section in these ThoughtTraps about brain anatomy (re evolution)

❖ Marieb 1998 ... Fig. 12.21: reticular system
❖ Marieb 1998 ... Figs. 12.3 & 12.4: adult regions of the brain

... extends throughout the central core of the midbrain and hindbrain, traversing the brain stem (see previous section: "brain regions")

- governs the arousal of the brain as a whole ... unless inhibited by other brain systems, it sends a continuous stream of impulses (via thalamic relays) to the cerebral cortex which maintains the cortex in an alert, conscious state and enhances its excitability

- acts as a filter for the flood of sensory input ... and dampens or filters out repetitive, familiar, or weak signals (and thus we are not driven crazy by sensory overload) ... but allows unusual, significant, or strong impulses to reach consciousness

  - ✘ is inhibited by the sleep centre
  - ✘ is depressed by alcohol, sleep-inducing drugs, and tranquilizers
  - ✘ is overridden by LSD

- helps control skeletal muscles during coarse movement

- medulla has the autonomic centres that regulate visceral motor functions

Howard (2000) [source for the popular science explanation of "lizard, leopard, and learning brains"] provides the following for the reticular formation. Again note ... *the power of the story* and of "catchy phrases" and of metaphors!

> A kind of "toggle switch" controls whether the leopard brain or the learning brain is currently in charge. This toggle, the *reticular formation* (RF), is located in an area beginning in the upper brain stem and continuing into the lower reaches of the cerebral cortex. RF switching appears to occur at one of two times: when we become emotionally charged up or when we relax. When we become emotionally charged, as in the fight-or-flight response, the RF shuts down the cerebral cortex, or learning brain. For all practical purposes, when the cortex is shut down, we proceed on "automatic pilot", where instinct and training take over. When the limbic system, or leopard brain, is shut down as a result of general body relaxation and removal of threat, the RF switches the cortex back on and allows creativity and logic to return to center stage. The RF is a large, diffuse neural process, and its effective functioning is important to both our person survival, and our ability to enjoy life.

⇨ Compare the above understandings with those by Douglas J. Cardinal for "creative thinking" (section on "thought" as a building block of consciousness).

⇨ Howard (2000) lists various "switches" (see below) which foster alertness of the cerebral cortex:

1. a sense of danger, interest, or opportunity
2. muscular activity
3. time of day on the circadian clock
4. sleep bank balance
5. ingested nutrients and chemicals
6. environmental light
7. environmental temperature and humidity
8. environmental sound
9. environmental aroma
10. recency of stressful episodes
11. recency of aerobic exercise
12. environmental negative ions
13. degree of one's self-perception of being in control

As a supplement to this information, Howard (2000) offers the diagram below:

Reticular Formation
(a "toggle switch")

only one of these three states in activated (aroused) at a time:

↙	↓	↘
hot	mild	cold
limbic arousal	cortical arousal	sleep
fight-or-flight	problem solving	relaxation
out-of-control	in control	off-duty
carbohydrates	proteins	carbohydrates and dairy
burnout	achievement	depression
↘	↓	↙

SYNAPSE

NOTE:

• reticular switching ..... determines the primary strategy that we employ from situation to situation.

• the condition of the synaptic junction and neurotransmitter receptors ..... determine the effectiveness of the strategy we employ

QUESTION: What are some of the concepts associated with the various "building blocks" of consciousness

An approach in which CONSCIOUSNESS (the WHOLE) consists of PARTS ... which can be referred to as BUILDING BLOCKS.

- "Modules" is also a word used in the neuroscience literature.
- We will use "building blocks" since this term is also used in physics, chemistry, and biology and thus, facilitates our Toqwa'tu'kl Kjijitaqnn / Integrative Science objective of attempting to "connect the dots" among the different disciplines in Western science.

❒ Read "consciousness ... what has to be studied" in these ThoughtTraps to remind yourself about the reductionist and autocreative paradigms ... and how building blocks can be viewed:
- as *objective neuronal entities* within the hierarchy of the reductionist paradigm ... but also including the *emergent and holistic features* that characterize consciousness as a process (recognizing close ties to Cajete's work on *the ecology of Indigenous education*)
- as *subjective content* (personal, cultural, historical) ... but also including the *emergent and holistic features* that characterize consciousness as a process (recognizing close ties to Cajete's work on *the ecology of Indigenous education*)

☺ **building blocks of consciousness** (Hobson 1999):

		experienced by all mammals and human infants	*experienced by* more mature humans
• input sources			
- sensation	reception of input data	+	+
- perception	representation of input data	+	+
- attention	selection of input data	+	+
- emotion	feelings about representations of input data	+	+
- instinct	innate propensities to act on input data	+	+
• elaborative processing			
- memory	retrieval of stored representations	-	+
- thought	reflection upon representations	-	+
- language	symbolization of representations	-	+
- intention	representation of goals	-	+
- orientation	representation of time, place, persons	-	+
- learning	automatic recording of experience	+	+
• output actions			
- volition	decisions to act	-	+
- movement	motor acts and behaviours	+	+

SENSATION ... a building block of consciousness

sensation = reception of input data

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

Cognitive Science defines ...

- ***sensation*** as: the *detection* of sensory information ... by the *sense organs*
  - sensory information = energy emitted or reflected or manifested by objects in the environment
    [note: this definition is a bit problematic for "immunogenic" and "psychic" information]
  - sensation ... is said to occur when energy in the external environment or the body stimulates receptors in the sense organs

- ***perception*** as: the *organization and interpretation* of sensory information ... by the brain

☞ In other words, sensation is the reception of **environmental information**, and perception is both the brain's attention to this information and its recognition of the information in the form of **pattern** ... leading to awareness, to consciousness.

Recall ... acquisition of environmental information by humans via the:

algorithm for "easy" problems of consciousness

- environmental information → sensory input data → sensory processing in **brain**

- or: environmental information → detected → transduced → transmitted → processed

- or: in more detail yet:
  ➜ environmental information ... i.e. events in the external environment

  → presents itself in different energy forms

  → some forms can be detected by human sensory receptors, as energetic stimuli (singular = environmental stimulus)

  → stimuli are converted (transduced) by the receptors

  → into an electro-chemical language (the universal language of the nervous system)

  → and transmitted along nerves (as nerve impulses)

  → to the spinal cord and **brain** (central nervous system, CNS)

  → and processed in, and exchanged among different parts of, the **brain** to become the building blocks of **consciousness** ☺

Question: What different types (i.e. categories) of environmental information are there?
Answer:

- First, it is important to realize that Cognitive Science may use various labels (terms, words) to refer to this information:
  - environmental information
  - sensory information
  - sensory data
  - sensory input
  - input data

- Second, different categories of **environmental information** are recognized, but only the first three below would be included in any current "standard model" in Cognitive Science.

  1) electromagnetic
     → detected by light sensory organs

  2) chemical
     → detected by chemosensory organs

  3) mechanical (= physical)
     → detected by mechanosensory organs

  4) immuno (non-self, foreign, antigenic, or immunogenic)
     → detected by the immune system ... various white blood cells (leucocytes)

  5) psychic
     → input from one's own consciousness

Question: How do these different types of environmental information relate to consciousness?
Answer: The levels of consciousness or awareness for which environmental information can be **automatically received by sensory receptors** (i.e. which are part of the "easy problems" of consciousness) are marked below with ✔or ✓ (with ✔ indicating greater scientific understanding than ✓).

✔ • Is it awareness of the external environment only?
✔ • Is it awareness of the external environment, and also of one's internal environment?
✓ • Is it awareness of the external and internal environments, and also of the presence of self?
✓ • Is it awareness of the external and internal environments, of self, and also of their boundaries?
✗ • Is it awareness of the external environment, of self, of boundaries, and also of one's ability to participate with and influence these ... i.e. awareness that one has the potential to be creative, awareness of the presence of Self?
✗ • Is it awareness of all the above, and also of the interconnectedness of the Universe and thus, of the "now you see it, now you don't" nature of boundaries ... i.e. awareness of the potential of Self to have a spiritual dimension?

Question: What are "**sensory organs**"?
Answer: **Sensory organs or "senses"** ... detect environmental information.

- As previously indicated: Information arrives at the receptor as an energy form or environmental stimulus, which is then converted (*transduced*) into electro-chemical language ... and transmitted along nerves ... to the spinal cord and brain.

traditional "five senses"

- vision ..... sensory organ = eye
- smell ..... sensory organ = nose
- taste ..... sensory organ = taste buds
- hearing ..... sensory organ = ear
- touch ..... sensory organ = "sense of touch"

✺ vision is the dominant sense in humans
✺ The first four senses listed above are sometimes referred to as the "special senses", and touch as one of the "general senses".

a "sixth" sense: There is no widely accepted use of the label "sixth sense" ... BUT it has been applied to a variety of things ... so, be very mindful of context when encountering the phrase! Also, you should ask "What, exactly, is the sensory organ that is involved"?

1) sixth sense as: proprioception ... considered by Cognitive Science under "mechanosensory"
   - associated with the general sense organs ... *somatosensory organs*

2) sixth sense as: odorless chemical communication ... in the news lately ... as it is now starting to receive scientific study
   - claims for this sense and its associated *vomernasal organ* in humans are controversial ... with current research mainly being funded by pharmaceutical companies that anticipate the availability of new modes of drug delivery (and thus, lots of new $$$$) ... if this sense can be verified to exist, at an exploitable level, in humans

3) sixth sense as: immune system recognition of "foreigners" ... scientifically verified for a long time, but only very recently beginning to be considered as a "sense"
   - foreigners are the viral, bacterial, and other exogenous ("outside origin") antigens that the classic sensory system is blind to ... the immune system converts its recognition of these into biochemical information that can then be communicated to the brain
   - this is a new area for Western science ... encompassing the so-called mind/body connection ... and one with considerable research activity ... in the new discipline of "psychoneuroimmunology" ... where it is recognized that *white blood cells* can serve both in an defense capacity and as a "sensory organ".

4) sixth sense as: extrasensory perception, or psi
   - claims for this sense are not accepted in mainstream Western science ... however, some rigorous scientific research is done (and at some prestigious universities) in the discipline of "parapsychology" ... but it is not generally accepted as part of mainstream psychology or academia

5) sixth sense as: feeling
   - Environmental information, within the context of a "feeling" sense, comes from one's own or one's culture's understandings (i.e. it is a "psychic input") .... and, where subjectivity is embraced as part of a world view (e.g. Aboriginal world views; holistic views), feelings are sometimes referred to as the "sixth sense". I.e., what is your consciousness telling you? Cognitive Science does not normally include "feelings" in a discussion about sensory input or in the "easy problems" of consciousness. They certainly are, however, part of the "hard problem" of consciousness (where Cognitive Science seems reluctant to go). Regardless, they definitely need to be part of the discussion if one wishes to be ***mindfully aware of one's environment***!

Question: Do other animals have additional senses?
Answer: Yes. Read the article.

Question: Does modern Western science recognize the "five traditional senses"for humans?
Answer: Yes, but ... it has modified the concept ... and thus, tends to talk about "sensory receptors" and to classify them by ...the ***type of stimulus*** they detect. Generally, only the first three major categories of environmental stimuli listed below are included. But, it is becoming increasingly apparent that "immunosensory stimuli" need to be part of some broader discussions (e.g. psychoneuroimmunology, human health). And, "psychic stimuli" are included to help begin the "conscientization" process required to discuss and integrate knowledges (an MSIT program objective).

"Conscientization" ... refers to the intentional effort to bring relevant concepts into the consciousness of somebody who may otherwise be ignorant (i.e. not aware) of them, regardless of whether that ignorance be inadvertent or through design. By another phrase ... it is "consciousness raising".

Categories of environmental stimuli (a concept that derives directly from the "different categories of environmental information" outlined previously) ... only the first three would normally be included in the current "standard model" in Cognitive Science

1) light sensory ... **electromagnetic stimuli**
   - vision ... eye

2) chemosensory ... **chemical stimuli**
   - smell (olfaction) ... nose
   - taste ... taste buds on tongue
   - odorless chemical communication* (pheromone detection) ... vomernasal organ
     * not scientifically verified [note: this is a possible "6th sense" mentioned previously]

3) mechanosensory ... **physical stimuli**
   - hearing (audition) ... ear
   - vestibular system (balance) ... ear
   - somatosensory ...skin and body
     - touch
     - thermal sensation
     - pain and itch
     - proprioception [note: this is one "6th sense" mentioned previously]
     - visceral sensation

4) immunosensory ... **non-self, foreign, antigenic, or immunogenic stimuli** **
   [note: this is a possible "6th sense" mentioned previously]
   - immune system ... various white blood cells (leucocytes)
     - self cells with MHC-I and antigen
       - cytotoxic T lymphocytes (T_C): receptor for antigen, and for MHC-I (via CD-8)
     - self cells with MHC-II and antigen
       - helper T lymphocytes (T_H): receptor for antigen, and for MHC-II (via CD-4)
     - free antigen
       - B lymphocytes: receptor for antigen ... receptor secreted as antibody

5) mindful awareness ... **psychic stimuli** **
   [note: this is a possible "6th sense" mentioned previously]
   - Psychic stimuli ... your own feelings! It is not intended that the term "psychic stimuli" be associated with anything alien, spooky, eerie, or supernatural.
   - As already clearly indicated, psychic stimuli are not normally included by Western science in a discussion on environmental information and sensation. They are included here for a very good reason — Aboriginal world views do include them (experience is a major epistemic value)!
   - Review the information in the MSIT ThoughtTraps© "Pursuit of Scientific Knowledge" re objectivity and subjectivity, and epistemology.

** note: stimuli that do not reach the brain via the "algorithm for easy consciousness"

Electromagnetic stimuli

Electromagnetic energy

Modern humans live in a "soup" of electromagnetic energy ... a soup whose ingredients originate from both natural sources and human-made sources.

Natural sources on Earth include:
- ➜ sunlight
- ➜ solar wind (giving rise to the Northern Lights)
- ➜ cosmic rays (from outer space)
- ➜ Earth's geomagnetic field (spinning core of molten iron)
- ➜ Earth's micropulsations
- ➜ radioactive gamma decay of elements
- ➜ electrical storms (lightning)
- ➜ living organisms
- ➜ the human brain

Human-made (i.e. technological) sources include:
- ➜ our electrical power supply and all household or industrial appliances that use electricity
- ➜ computer screens, anti-theft devices, security systems, radio, television, radar, cellular telephone antennas, microwaves

Electromagnetic energy:
... has a dual nature: it can radiate (exist) as waves (at one moment) and as particles (at a different moment)
... is a *vibration of pure energy*
... travels at a very high speed ("speed of light": about 300,000 km/sec or 186,000 miles/sec)

- **waves** ... have length and frequency ... both can be measured

	defined as	measured in
• **length**	distance, from crest to crest	nm, cm, m, or km
• **frequency**	number of complete waves (crest to crest, i.e. a cycle) that pass a given point in one second	Hertz ... Hz 1 Hz = one cycle/sec 1 kHz = thousand cycles/sec 1 MHz = million cycles/sec 1 GHz = billion cycles/sec

➜ the longer the wavelength ..... the lower the frequency and energy level
➜ the shorter the wavelength ..... the higher the frequency and energy level

- **particles** ... are called photons

The electromagnetic spectrum encompasses all sources of electromagnetic (EM) energy ... and

is generally shown in an order based on frequencies in Hz (although this information is often also accompanied by the corresponding information for wavelengths) ... starting with zero and proceeding from lower frequencies (longer wavelengths) to higher frequencies (shorter wavelengths).

❖ Consult a drawing in a textbook ... and make two quick sketches below. Make sure you understand "order by frequency" versus "order by wavelength" ... as they are opposite to each other!

• sketch based on "order by frequency"

• sketch based on "order by wavelength"

<u>parts of the whole ... i.e. parts of the spectrum</u>

➜ **visible light:** Generally discussed in terms of wavelengths, this is the part (400 to 700 nm range) of the spectrum "visible" to humans because our eyes are *sensitive* to these wavelengths (i.e. are stimulated by them, or can detect them). [Note: As should be clear from your sketches above, when you order the spectrum on the basis of shortest to longest wavelengths it results in an order opposite to that based on frequencies.]

400 nm range	⇨	700 nm range
violet	⇨	red

These same wavelengths are among those in sunlight that reach the surface of the Earth with greatest intensity.

➜ **non-visible parts** of the spectrum (to either side of visible light):

- *beyond violet* (higher frequency; shorter wavelength): e.g. ultraviolet, cosmic rays, X-rays, gamma waves

- *below red* (lower frequency; longer wavelength): e.g. infrared, radio waves

Some electromagnetic energy is capable of breaking chemical bonds in molecules, i.e. it can create ions ("ionizing").

➜ **ionizing radiation:**	beyond violet	breaks chemical bonds in molecules
➜ **non-ionizing radiation:**	visible and below red	cannot break chemical bonds

There are diverse human-made sources of electromagnetic radiation in our environment, all associated with our modern, technological world.

➜ **extra low frequency:** ELF
frequencies from zero up to 1000 Hz (1kHz)
→ main sources: transmission and distribution facilities for electricity, all electrical appliances ... 60 Hz is the frequency for homes in North America (50 in Europe)

➜ **very low frequency:** VLF
frequencies from 1 kHz to 500kHz

➜ **intermediate frequency:**
frequencies from 300 Hz to 10 MHz
→ main sources: computer screens, anti-theft devices, security systems (airport security)

➜ **radiofrequency:** RF
frequencies of 500 kHz to 500 MHz
→ main sources: radio, television, radar, cellular telephone antennas

➜ **microwave:**
frequencies from 500 MHz up to visible light
→ main source: microwaves

Electromagnetic energy & human vision

Algorithm for "easy consciousness" ... to frame ***six major points about vision*:**

➜ environmental information

1) Electromagnetic energy (in this case, from the sun) radiates as waves and particles ... the particles are called photons.

➜ detection

2) Photons are absorbed by a pigment molecule called *retinal*, located in the receptor cells of the eye's retina.
   - **Cone cells** absorb photons ... with *three different types of cone cells* absorbing photons in three different wavelength ranges. The range for each type of cone cell is about 1/3 as wide as the spectrum of visible light.

     - range with a peak near ..... 419 nm [1/3 with shortest wavelengths ... blue]
     - range with a peak near ..... 531 nm [1/3 with middle wavelengths ... green]
     - range with a peak near ..... 558 nm [1/3 with longest wavelengths ... red]

     - cones ... need bright light for stimulation
       .... give focused vision in bright light (light-adapted or photopic vision)

   - **rod cells** absorb photons of all visible wavelengths ... which gives a range with ... a peak near 500 nm.

     - rods ..... are very sensitive to dim light
       ..... give night vision and peripheral vision (dark-adapted and scotopic vision)

➜ transduction

3) Absorption of photons causes a change in the shape of the retinal molecule.
4) The change in shape ... causes a change in the function of retinal ... such that it activates a series of events which initiate a nerve impulse.

   - the three different types of cone cells ..... each send their own nerve impulse
   - the cone cells ... send a nerve impulse ..... that differs from those of the cones

➜ transmission

5) Nerve impulse travels via the optic nerve ... as an electro-chemical message ... to the brain.

   ❖ Consult a diagram that shows the ***sensory pathway for vision***.

   ? Where, in the brain, is this sensory information sent?

➜ processing

6) The nerve impulse ... when received in the appropriate region of the brain ... is processed and perceived as ***colour*** (light-adapted vision) or ***a shade of grey*** (dark-adapted vision). ***Read this conclusion of the story on vision in the section on perception.***

Electromagnetic energy & the health of living organisms

Since modern humans live in a "soup" of electromagnetic energy ... some of it natural, but lots of it human-made (or artificial) ... an excellent question is:

Question: How healthy ... ☺ / ☹ ... is it for living organisms to exist in an environment polluted with electromagnetic energy?

Answer: We do not have good or extensive information that would allow us to answer this question in a scientific manner, for all the different wavelengths of man-made electromagnetic energy polluting our environment.

A. Cassette tape: Robert Becker: The Body Electric

(Subtle Energy & Energy Medicine, session 8, produced in the early 1990's)

Important points, on this tape, as outlined below:

1) scientific discipline of *bioelectromagnetics*
   = human physiology & electromagnetic energy

2) *subtle energy* ... origins lost in prehistory ... "an idea often associated with religion" that says living things are different than non-living things

   - in the history of science ... much debate over this issue
     - vitalistic view point ..... something special about living things
     - mechanistic view point ..... living things just fancy clocks (machines)

3) 1920's: prevailing view of science
   - electricity and magnetism have no effect on living things ... a view based on the understandings of physics at that time

   - **chemical paradigm for living things** = life is chemical
     ... at this time, chemistry as the queen of the medical sciences

     ... to cause a chemical reaction ... require enough energy input to overcome KT (KT = kinetic temperature ... every atom is in constant motion except at absolute zero, which is -273.15° C, or 0° K)

     ... *it was thought* that to produce an affect due to exposure to electromagnetic energy, you must have a tremendous amount of energy input (in the order of "being struck by lightning")

4) **in science, ideas change as new information becomes available and knowledge grows** ... i.e. science is a dynamic intellectual activity
   - thus, as knowledge grew ... it became apparent that:
     - → a flow of electric current ... produces a magnetic field
     - → when the electric current changes ... the magnetic field changes
     - → with increasing frequency of the wave ... increasing energy associated with it
       - e.g. microwaves exceed KT of body

   - **chemical paradigm** for living organisms could not explain: growth and healing, biological cycles, or brain function

5) 1950's and 1960's ... lots of interest in the old Soviet Union in the **electromagnetic paradigm for living organisms** ... but not much interest in the United States, where the chemical paradigm prevailed
   - the issue that thrust the electromagnetic paradigm into the public domain in the United States ... and that caused a **paradigm shift** ... started in the early 1970's when the US Navy desired to build an antennae system in Wisconsin to communicate with its submarines via low frequency waves ... chose 45 Hz and 75 Hz
     - US Navy scanned the literature ... chose Becker as one of few American "experts"
     - preliminary experiments ... found important biological affects associated with Hz chosen
     - Becker: high voltage electric lines about 1000 X stronger that the frequencies investigated by the Navy ... must, therefore, be biological effects associated with these, too
     - New York State desires to build new high voltage electrical transmission lines
     - public hearings ... new experiments "to find the truth" by US Dept of Public Health
     - 5 years later ... "yes, there are problems"
     - considerable media attention

6) in science itself, a change (paradigm shift) began ... now OK to investigate
   - *science must measure* ... in this case: the relationship between living things and their environment
   - 1975: three important observations:
     - when brain functions ... a magnetic field is generated outside it that can be measured
     - nerve cells begin to "squirt" Ca^{++} at 16 Hz
     - bacteria that migrate along a magnetic field of the Earth have crystals of magnetite
   - 1978: FDA (Federal Drug Administration in the US) approves electrical currents to stimulate healing of bones (=1st non-pill treatment ever approved by the FDA)
   - 1979: leukemia in children in Denver
     - clusters of disease associated with electric power lines where field is significantly higher than 60 Hz
   - human brain ... electrical current flowing through it (not just synapses) ... and also, magnetite present

7) Earth's normal magnetic field ... is very, very simple (0.5 Gauss, or 0.5 X 10^{-4} Tesla)
   - ☞ strong lab magnets = 2.5 Tesla
   - ☞ our current highly modified environment (modified by human activity and the electrical industry) is not natural and was not here before (i.e., humans did not evolve in it and are not, therefore, adapted to it) ... this is a whole new environment we live in
   - ☞ **paradigm**: there are electrical currents in living things and living things are associated with the Earth's normal magnetic field

8) How reconcile this with KT?
   - ☞ IMPORTANT PRINCIPLE IN SCIENCE:
     - e.g., if you accept electromagnetism as the "subtle energy" that does a lot of things in the body (as shown by a clear pattern of observations) ... then must look at it as the mediator for these processes
   - ☞ science (and medicine, too) wants a **mechanism** for the pattern observed ... an explanation in terms of causation

9) questions that remain unanswered
   - where is magnetite in the human brain?
   - the magnetic resonance scanner (MRI) in modern medicine ... how safe is it?
   - "healers" ... do they give off electromagnetic energy?
   - if you live by high voltage electrical transmission lines ... how safe are they?
     - *chronic exposure* is an *important factor* ... and may be associated with:
       - learning difficulties
       - brain tumours
       - miscarriage
       - leukemia
       - developmental anomalies
       - severe depression

Related books by the same author:

- Becker, R.O. and Selden, G. 1985. The Body Electric; electromagnetism and the foundation of life. Quill, New York.
- Becker, R.O. 1990. Cross Currents; the perils of electropollution, the promise of electromedicine. Jeremy P. Tarcher / Putnam, New York.

B. Update 2001 ... the new millennium

We are in great need of rigorous scientific investigation of the relationship between human health and electromagnetism, especially in the thermal and non-thermal ranges of the spectrum (see below). This is increasingly important in view of the proliferation of new technologies and products that add electromagnetic pollution to our environment.

Based on potential biological effects (✺ impacts on living organisms), the electromagnetic spectrum can be divided into four parts, as outlined below.
(from: www.mcw.edu/gcrc/cop/powerlines-cancer-FAQ/QandA.html)

- **ionizing radiation (#1)** ..... ultraviolet and higher frequencies
  - → breaks chemical bonds in molecules
  - ✺ damages DNA

- non-ionizing ..... visible and lower frequencies
  - **optical (#2)** ..... visible and infrared
    - → excites electrons
    - ✺ causes photochemical effects in cells
  - **thermal (#3)** ..... microwave and radio / TV waves
    - → causes high induced currents
    - ✺ causes heating in cells
  - **non-thermal (#4)** ..... lower than AM radio waves
    - → causes low induced currents
    - ✺ unknown effects

two key definitions

- **biological effect** = a measurable response to a stimulus or a change in the environment ... the response is not necessarily harmful to an individual's health (e.g. listening to good music)
- **health effect** = a detectable impairment in the health of the exposed individual (or his/her children)

ARTICLE: Are cell phones the tobacco of the 21st Century?

WEB SITES on electromagnetic energy & human health:

1) www.mcw.edu/gcrc/cop/powerlines-cancer-FAQ/QandA.html
   www.mcw.edu/gcrc/cop/static-fields-cancer-FAQ/QandA.html
   www.mcw.edu/gcrc/cop/cell-phone-health-FAQ/QandA.html
   • John E. Moulder, Ph.D., Professor of Radiation Oncology, Medical College of Wisconsin

2) www.who.int/peh-emf/publications...s_EMF/EMF_Internet_Version_Pictures.htm
   • World Health Organization (put an "underscore" in the blank spaces)

3) www.who.int/peh-emf/
   • International EMF Project

4) www.iegmp.org.uk/Queries.htm
   www.iegmp.org.uk/IEGMPtxt.htm
   • Independent Expert Group on Mobile Phones (United Kingdom)

5) www.bioelectromagnetics.org
   • Bioelectromagnetics Society

6) www.noradcorp.com/measure.htm
   • NoRad Corporation

Chemical stimuli & smell and taste

The sensations of smell and taste are the result of *chemical interactions* between the human body and the environment.

- smell = a response to chemical stimuli (molecules) ..... in the air
  → receptors that detect these stimuli are located in the nose

- taste = a response to chemical stimuli (molecules) ..... in fluids in the mouth
  → receptors that detect these stimuli are located in the tongue

Smell

☺ Our human sensation of smell can detect about 10,000 individual odors.
☺ For humans, the sensation of smell is much, much more sensitive than that of taste.
  - e.g. Ethyl alcohol can be "smelled" at 1/25,000 the concentration required for detection by taste.

Provide answers for the questions below.

Question: Using the "algorithm for easy consciousness" ... outline the events associated with detection of chemical stimuli in the air

Question: What is the sensory pathway for smell?
❖ Provide a diagram that shows this sensory pathway. Label it.

Question: Where are messages, sent by receptors in the nose, processed in the brain?

Taste

☺ Our human sensation of taste has only four fundamental dimensions: salty, sour, sweet, and bitter (much recent research considers a fifth). These basic four (five) combine with smell and tactile sensations to produce the distinctive flavours that we associate with different foods.

Provide answers for the questions below.

Question: Using the "algorithm for easy consciousness" ... outline the events associated with detection of chemical stimuli in fluids in the mouth.

Question: What is the sensory pathway for taste?
❖ Provide a diagram that shows this sensory pathway. Label it.

Question: Where are messages, sent by receptors in the tongue, processed in the brain?

Physical stimuli & hearing

The sensation of sound is the result of *physical interactions* between the human body and the environment ... the "physical" being vibrations of air molecules produced by moving objects.

Air is an elastic medium that can be compressed ... i.e. individual molecules simply move back and forth over very small distances ... toward a momentary location of compression (squish) and away from a momentary location of rarefaction (stretch).

- These vibrations of air molecules create a "pressure wave" that travels in the air.
  → note: it is not the air molecules themselves that travel

- The pressure wave ("sound wave" is detected by receptors in the ears ... and their messages are interpreted as sound by the brain.

Sound waves are characterized by their frequency and intensity ... as are electromagnetic waves.

- frequency ..... measured in cycles per second ..... hertz (Hz)
- intensity ..... measured in units of pressure ..... decibels (dB)

Provide answers for the questions below.

Question: Using the "algorithm for easy consciousness" ... outline the events associated with detection of sound waves in the air.

Question: What is the sensory pathway for hearing?
❖ Provide a diagram that shows this sensory pathway. Label it.

Question: Where are messages, sent by receptors in the ears, processed in the brain?

PERCEPTION ... a building block of consciousness

perception = representation of input data

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind.*

Cognitive science defines ...

perception as: process of organization and interpretation of sensory information by the brain

Although some texts consider perception as *pattern recognition* together with *attention*, MSIT will consider perception and attention as two distinct building blocks of consciousness. We will consider the central importance of "pattern", first within the context of vision (as a specific example) and then in a more general way.

In the **algorithm for "easy" problems of consciousness** ... the last step is:
➜ processing

- The nerve impulse ... when received in the appropriate region of the brain ... is processed and perceived as _____ (answer depends on the type of sensory signals sent).

- **Patterns, of nerve impulses, are critical in this processing towards consciousness.**

Question: Where in the brain, are the signals for the different senses processed?

Answer: It is in the ***sensory areas of the cerebral cortex*** ... that consciousness awareness of sensation occurs. It involves the parietal, temporal, and occipital lobes.

- parietal
  - primary somatosensory cortex ... receives input from **skin and skeletal muscles**
  - gustatory cortex ... receives input from **taste buds**
- temporal
  - primary auditory cortex ... receives input from **ears**
  - olfactory cortex ... receives input from **nose**
- occipital
  - primary visual cortex ... receives input from **eyes**

The ***association areas of the cerebral cortex*** ... analyze, interpret, and integrate diverse sensory information coming from the relevant primary cortex or relevant cortex, for purposeful or intentional action. All association areas communicate with the motor cortex and other association areas.

☞ Almost all impulses on their way to the cortex are first funneled through the thalamus (of the diencephalon) ... i.e., it is the gateway to the cerebral cortex. This funneling includes impulses for emotion and visceral function coming from the hypothalamus.

Vision

❒ Read the article entitled *Vision: a window on consciousness*

Colour vision

Colour vision will be used as a specific example for "perception as a building block of consciousness".

Perception depends on **PATTERN RECOGNITION** ... by the brain ... of incoming nerve impulses. For vision, these impulses are sent by the retinal cells of the eyes.

An important understanding, re pattern:

... the intensity of a sensation (as perceived by the brain) is proportional to the frequency of nerve impulses sent

With respect to colour vision, the important information for the brain is:

- who is sending the signal ... what type of cell?
  - cone cell ... and what type (three possible types)
  - rod cell (one type only)
- how intense the signal is ... in electro-chemical language

!!! "Colour" does not exist in the external environment ... as anything other than different wavelengths of electromagnetic radiation ... what we "see" (*perceive*) is entirely the result of our brain "constructing" colour from the electro-chemical signals (nerve impulses) sent by the receptor cells in the eyes.

1) grey

Recall: **rod cells** in the retina ... are stimulated by photons of all wavelengths in the spectrum of visible, *but dim*, light (i.e. a range with a peak near 500 nm)

... the signal they send ... when processed by the brain ... is *perceived* only in shades of grey

2) blue, green, red

Recall: **each of the three types of cone cells** in the retina ... is stimulated by photons in a different third of the visible light spectrum ... and each type of cone cell sends its own signal

When cone cells are stimulated by photons with a range whose peak in the spectrum is:

- near 419 nm (1/3 with shortest wavelengths): signal perceived by brain as ..... **blue**

- near 531 nm (1/3 with middle wavelengths): signal perceived by brain as ..... **green**

- near 558 nm (1/3 with longest wavelengths): signal perceived by brain as ..... **red**

3) colours other than blue, green, and red

Perception of **colours other than blue, green, and red** ... depends on the brain "constructing" them ... from combinations of the relative intensities of the nerve impulses (signals) triggered by the above three ranges of wavelengths.

combinations:

red signal	+	green signal	=	yellow perceived
red signal	+	blue signal	=	magenta perceived
green signal	+	blue signal	=	blue-green (cyan) perceived

It is important to understand that the "colour" of an object ... requires a brain, signals, and photons:

- the brain perceives signals
- signals sent depend on the wavelengths of photons absorbed by cone cells in the retina
- photons available to be absorbed depend on:
  - the light source
  - the object (its pigments, its surface, its texture)
  - the medium in which the photons travel between the object and the eye
    ... a medium in which they may be subject to:
    - dispersion ... e.g. why rainbows exist
    - scattering ... e.g. why the sky is blue

➜Assuming that the source of light is the sun (note: sunlight is called "white light"):

- **colour ... and the pigments in an object** (reflection of light from the object)
  - e.g. an object perceived as **red**
    ... pigments in the object absorb all wavelengths except red
    ... object, therefore, reflects only red wavelengths
    ... retinal cells detect only red wavelengths (only red are available)
    ... only a red signal is sent to brain
    ... only red is perceived

  - e.g. an object perceived as **green**
    ... pigments in the object absorb all wavelengths except green
    ... object, therefore, reflects only green wavelengths
    ... retinal cells detect only green wavelengths (only green are available)
    ... only a green signal is sent to brain
    ... only green is perceived

    ⇨ plants
    Question: What wavelengths of electromagnetic energy do plants absorb?
    Answer: Provide one ... in your own words!

- e.g. an object perceived as **white**
  ... no pigments in the object to absorb any wavelengths
  ... object, therefore, reflects all wavelengths in equal proportion
  ... retinal cells detect all wavelengths
  ... blue, green, and red signals are sent to brain
  ... white is perceived

Question: Why is sunlight is called "white light"?
Answer: It contains all the wavelengths, which when added, produce white.

- e.g. an object perceived as **black**
  ... pigments in the object absorb all wavelengths
  ... object, therefore, reflects no wavelengths
  ... retinal cells detect no wavelengths
  ... no signals are sent to brain
  ... black is perceived

Question: Why, on a hot sunny day, do you "bake" in a black shirt but remain relatively cool in a white shirt?
Answer: Think ... take into consideration the understandings that photons are "energy". Make sure you can provide an answer in your own words.

- **colour ... by dispersion** (dispersion = *separating* colours in white light by refraction ... i.e. bending of wavelengths within an object)

Colours of the rainbow ... in the order in which they are generally listed (longest to the shortest wavelength) ... which is the order, highest to lowest colour, in the rainbow

red — orange — yellow — green — blue — indigo — violet

Question: Why do these colours appear in the sky, as a "rainbow"?
Answer: Read ... develop an answer in your own words. Try your textbook! Bear in mind that the rain (i.e. water droplets) is the "object" that refracts the light.

- **<u>colour by scattering</u>** (interactions between photons and tiny particles of matter)

  Tiny particles (atoms, molecules of gas, dust) in the air cause sunlight to scatter, i.e. be sent in random directions (i.e. all over the place). Blue and violet light (i.e. the shortest wavelengths) are scattered the most ... about 10 times more than wavelengths of red.

  Question: Why is the sky blue?
  Answer: Scattering of blue-violet ... causes many of these wavelengths to reach Earth from all sorts of directions other than just the sun ... thus, coming from all directions, more blue and violet wavelengths will reach the cone cells in the eyes than will other wavelengths ... and, the message sent to the brain is dominated by the "blue" signal.

  Question: Why is the sun often reddish at sunrise or sunset?
  Answer: Due to the angle of the incoming sunlight, it must pass through much more atmosphere and thus more pronounced scattering occurs. Much of the blue-violet is scattered <u>away</u> from the Earth ... thus, wavelengths coming to your eyes will be predominantly from the reddish end of the spectrum ... and, the message sent to the brain is dominated by the "red" signal. Dust in the air causes even greater scattering ... so an even more intense red is perceived when the air is "dirty" than when it is clean.

  Question: Why are clouds generally white?
  Answer: The near microscopic water droplets in the clouds scatter all wavelengths equally ... causing a full spectrum of wavelengths to come to your eyes and thus, stimulate all three types of cone cells equally. The messages sent to the brain are not dominated by any one signal ... and a combination of all, i.e. white, is perceived.

  ✶ Lacking an atmosphere to scatter sunlight , the sky around moon appears forever black!

- **<u>colour by interference</u>** (constructive or destructive reinforcement of wavelengths)

  This phenomenon answers the questions below. Its details are not difficult ... a good textbook, plus your mind, will be all you require.

  Questions: Why do the feathers of some birds appear iridescent?
  Why do oil droplets on water appear to shimmer?
  Why do soap bubbles swirl with colour?

PATTERN *... its significance in human consciousness ... in learning and unlearning*

As mentioned in the Introduction, we chose, for Toqwa'tu'kl Kjijitaqnn / Integrative Science, to exploit the natural human desire to work with pattern or the "big picture" — for the purposes of ***learning science ...*** and will do this by focusing on "big answers" to "big questions" ... i.e. the overall theoretical framework or **pattern** of knowledge in Western science.

☺ We pointed out that this approach could be compared to climbing up to a high point, for example the top of a mountain, to get a "big picture" view or understanding of the surrounding countryside. This is something you probably would ***automatically think of doing*** if:
- you were trying to find your way in new territory and wanted some "orienting directions", or
- you felt lost and wanted to re-establish your bearings.

☺ In addition to the above, consider the following thoughts from Grigsby and Stevens (2000) with respect to ***the significance of pattern recognition in human consciousness***, including in science as "a way of knowing" where theories and models are of central importance:

- A systematic set of ideas and evidence (i.e. a theory, a model, or a theoretical framework) is a perceptual heuristic, a way of ***recognizing patterns — something people do automatically and nonconsciously***.

☹ There is, of course, a downside to the natural tendency of humans to recognize and work with pattern, and that is ... not just our desire for any pattern but rather *familiar* pattern ... and thus, changing our familiar habits of thinking or doing can be difficult ... and new ideas may be hard to accept.
As one learns to navigate within a theoretical framework, developing habits of thinking and perceiving, it becomes a relatively effortless matter to find one's way around (☺ good).

At the same time, it may be more difficult to get one's bearings by means of a different theory (☹), since the ***patterns*** one has already learned to recognize are easy to see, while those ***patterns*** that may become apparent through the medium of an unfamiliar model require deliberate consideration and somewhat effortful application if they are to be useful.

more on pattern

☺ Overall, the human brain works on the basis of **pattern recognition**.

- This understanding, about **pattern recognition**, comes from extensive research in neuroscience, cognitive science, and psychology. For example, note its central importance in quote below:

  > "From a psychological perspective, a theory [or model] is not only a systematic set of ideas and evidence; it is also a perceptual heuristic, a way of ***recognizing patterns — something people do automatically and nonconsciously***." (Grigsby and Stevens 2000)

- An understanding of the significance of **pattern recognition** is also reflected in the way of life of the Mi'kmaq and other Aboriginal peoples ... where the skill of drawing spiritual lessons from Nature is based upon the observations of **natural patterns** and then the bringing of one's consciousness into creative relationship with them.

- An informative example about the role of **pattern recognition** for living organisms comes from the game of chess ... which computers play by using their huge memories to look many moves ahead, whereas humans play by looking ahead only a move or two, while analyzing the current board **patterns**. As one ponders this difference between the human and the computer, it is useful to bear in mind that human cognition reflects evolution (natural intelligence) whereas computer cognition has been designed by man (artificial intelligence).

Nature / information / pattern / consciousness

- pattern in Nature / pattern in consciousness/ pattern in information
- information in Nature / information in consciousness / information in pattern

Pattern = entities and the relationships among them
Question: Do patterns exist in Nature, or only in the consciousness of humans?

Human consciousness

☺ Consciousness of our environment always involves a continuous transformation of information from one mode into another ... i.e. **information processing** ... in which information is taken into the brain (which has been discussed in terms of the *algorithm for "easy" problems of consciousness*).

→ **information** ... in the environment
→ **information** ... received by sensory organs
→ **information** ... transformed into electro-chemical language of nerve impulses
→ **information** ... sent as nerve impulses (messages) to brain
→ **information** ... processed by brain
→ **information** ... recognized by the brain as pattern

Again, it is important to note that environmental information goes to the brain ... which has a natural tendency to **process** it in such a way that it "connects the dots"or "imposes order and/or meaning" ... to **create or identify pattern** ... and thus, we humans perceive relationships among things experienced or seen at all levels of awareness (physical, mental, emotional, spiritual). I.e., the human brain is an **information processor**, and we humans are **pattern recognition creatures**.

As humans, we transmit (tell) our understandings of pattern in different ways ... for example, as:

- **simple story tellers:** where we tend to "connect the dots" in *time*
  ... to identify temporal pattern ... and convey our understanding to others ... as stories

- **map makers:** where we tend to "connect the dots" in *space*
  ... to identify spacial pattern ... and convey our understanding to others ... as maps

- **scientists:** where we try to "connect the dots" in both *time* and *space*
  ... to identify scientific knowledge

- **deep story tellers:** where we try to "connect the dots" in *time* and *space* within an overall understanding of the *reality and potential of human consciousness* beyond the memory of our own previous and personal experience, i.e. to involve *spirit*

☞ NOTE: Western science has not generally been interested in the "deep" story ... and has, in fact, historically gone out of its way to eliminate "spirit" from its understandings. However, as the functioning of the brain is better understood, and consciousness studies become more acceptable within Western science, this will undoubtedly change. And thus, one encounters so-called "new paradigm" thinking in science ... which we will return to later.

☺ **"Seeing" the pattern is key to all <u>genuine</u> learning, understanding, and knowledge.**
☹ Otherwise, only memorization is occurring.

☞ And, every student knows that it requires "work" to learn something new.

Seeing the pattern ... requires the **ability to become patternable** ... i.e. sensitive to the patterns displayed in Nature such that one is able to incorporate and adapt them to one's own or one's community's needs, as appropriate. As Douglas J. Cardinal says, this understanding is embedded in Aboriginal world views ... it is the secret to crossing the barrier of fear between the domain of the known and the domain of the unknown. It is essential for creative thinking, creative learning, and creative relationship ... any time when, and any place where, one must do something innovative or for the first time.

<u>most</u>* PATTERNS *... require "seeing" the relationship between whole and parts

WHOLE	←	parts (or pieces)	parts (or pieces)	→	WHOLE
WHOLE	←	details (or data)	details (or data)	→	WHOLE
WHOLE	←	building blocks	building blocks	→	WHOLE
WHOLE	←	levels	levels	→	WHOLE
SYSTEM	←	modules	modules	→	SYSTEM
CONTEXT	←	facts (or items).....	facts (or items)	→	CONTEXT
GENERAL	←	specifics	specifics	→	GENERAL
BIG PICTURE	←	little pictures.....	little pictures	→	BIG PICTURE
FOREST	←	trees	trees	→	FOREST

PATTERN *... and information processing*

Question: Given that humans must *process information* to perceive pattern ... is the "work" that is required when one desires to learn something new ... simply the "information processing" that must occur in the brain before the pattern can be "seen"?

☺ The skill of **analytical thinking** is based in seeing an *ordered or structured relationship* among the parts of one particular whole.

☺ The skill of **metaphoric thinking** is based in seeing *common relationship* between parts of different wholes.

☺ The skill of drawing **spiritual lessons** from Nature is first based on the observation of ***natural patterns*** ... and secondly the bringing of external environment and consciousness into creative relationship with each other.

☺ **Network-logic** is a dialectic (= a discussion back and forth) of *whole and part*. As many details as possible are checked; then a tentative big picture is assembled; it is checked against further details, and the big picture is readjusted. And so on indefinitely, with ever more details constantly altering the big picture, and vice versa. (Wilber 2000)

☺ **Vision-logic** is a logic not merely of trees (parts) but also of forests (wholes). (Wilber 2000)

☞ Hmmmmm: If humans must *process information* to perceive pattern ... then, is:
1) the brain only an information processor, or
2) the brain more than just an information processor?

PATTERN: *external environment ... "objects, or things" in space and time*

☞ for each basic type of pattern identified below ... there is a somewhat different answer to the question "how do the parts relate to the whole?"

1) ***Heterarchical pattern*** ... think of a jigsaw puzzle ... which has a PATTERN: its BIG PICTURE (the whole) made up of LITTLE PICTURES (parts, called pieces)
   - → a pattern of this type ... with *different mutually and laterally linked pieces* ... with no designated "higher" level or boss ... is collectively called a heterarchy
   - → example: different types of rocks

2) ***Holarchical pattern*** ... think of a community ... which has a PATTERN: its BIG PICTURE (the whole) made up of LITTLE PICTURES (parts, called families), with families being the BIG PICTURE (the whole) made up of LITTLE PICTURES (parts, called individuals), with individuals being the BIG PICTURE (the whole) made up of LITTLE PICTURES (parts, called organ systems), etc.
   - → a pattern of this type ... which has *different levels* is called a hierarchy. A hierarchy such as that outlined above, in which each thing can be *a whole at one level, but is only a part at the next higher level* ... is collectively called a nested hierarchy or a holarchy, and "holon" is used to refer to each thing which can be a whole and a part in this way.

3) ***Hierarchical pattern***

4) ***Symmetrical pattern***
   bilateral
   radial

5) ***Linear pattern***

6) ***Non-linear pattern***

7) ***Cyclical pattern***

8) ***Spatial pattern***
   three dimensional (3-D) mapping: length, width, depth
   two dimension (2-D) mapping: length, width

9) ***Structural pattern***

10) ***Temporal pattern***
    time: past, present, future
    time as the 4th dimension
    storytelling
    scientific graphing

11) ***Chaos***

ATTENTION ... a building block of consciousness

= selection of input data

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Enhance the outline of major ideas related to this building block ... by adding ideas to those already provided ... and creating an overall map of ideas for this building block.

information from Carter (1998):
Attention is necessary for thinking, and possibly for consciousness. And, in spite of the all the sensory information coming into the brain — sights, sounds, tastes, smells (the brain is constantly scanning the environment for stimuli) — we are able to selectively attend to some information and ignore the rest How?

Attention requires three elements (❖Carter, p. 186):

- arousal ..... dependent on the reticular formation in the mid brain (see section on brain systems) and the neurotransmitters its neurons release ... dopamine and noradrenaline are particularly involved in activating the prefrontal lobe
- orientation ..... done by neurons in the midbrain that bring about disengagement from non-relevant stimuli, re-engagement on relevant stimuli
- focus ..... done by a part of the thalamus which brings about an emphasis on the relevant stimuli and then sends information to the frontal lobes of the cortex, which then lock on and maintain attention

The evolutionary or survival advantages of attention are in its consequences for behaviour (Bear et al 1996):

- attention enhances detection ... it makes it easier to detect desired stimuli
- attention speeds reaction times ... it alters the speed of visual processing or the time to make a decision

EMOTION .... a building block of consciousness

= feelings about representation of input data

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.
❒ Read section on "brain anatomy" in these ThoughtTraps ... especially re the Limbic System.

INDIVIDUAL PROJECT

⧖ Create a map of major ideas related to this building block.

INSTINCT … a building block of consciousness

= innate propensities to act on input data

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Create a map of major ideas related to this building block.

MEMORY ... a building block of consciousness

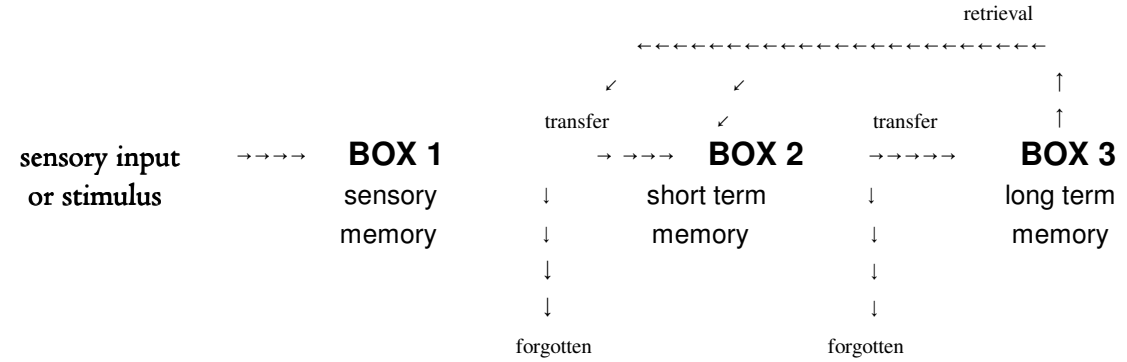
= retrieval of stored representations

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Enhance the outline of major ideas related to this building block ... by adding ideas to those already provided ... and creating an overall map of ideas for this building block.

Psychology's 3 box model of memory:



☞ retention time: less than 2 seconds in sensory memory

☞ Information (the sensory stimulus) is much more likely to be transferred if it (the information) is personally meaningful ... i.e., if ***pattern recognition*** occurs during transfer from sensory memory to short term memory.

☞ ***Pattern recognition*** is the preliminary identification of the information (stimulus) in terms of that already contained in long term memory.

THOUGHT ... a building block of consciousness

= reflection upon representations

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Enhance the outline of major ideas related to this building block ... by adding ideas to those already provided ... and creating an overall map of ideas for this building block.

☺ Crows are notoriously shamanic birds because they know how to think so that their thinking is part of their world, like a wing beat, like the wind.

→ (D. Noel, *The Soul of Shamanism*, 1997, p. 70)

☺ Creative thinking involves overcoming the fear of the unknown. As humans, how do we overcome fear?

- *step 1:* learn to be a hunter ... learn that all animals have PATTERNS
- *step 2:* learn to become a PATTERNABLE spirit being or warrior ... and step out of the fear framework into the unknown

→ (D. Cardinal; *Symposium on Creativity and Innovation in the Arts and Sciences,* at the Congress of the Social Sciences and Humanities, Edmonton, May 25-26, 2000)

Pattern

→ **brain-based learning** ... **requires thought** ... **based on pattern !!!!!!!!!!**

☞ information → brain ... **pattern recognition** ... like attracts like
... the brain takes in *pattern information* from its environment ... in addition to the sensory information that is traditionally discussed

☞ building blocks of consciousness ... **patterned activity** in neural networks
... the brain functions by way of *patterns of electro-chemical events*

☞ multiple intelligences ... based on **pattern recognition**

☞ learning: innate cognitive models ... working with natural **pattern recognition** abilities

Question: How do we arrive at "fact, hypothesis, theory"... about the natural environment?

NATURAL ENVIRONMENT

---------- ☺ ----------

FACT, HYPOTHESIS, THEORY → SCIENCE

An answer: we (humans) naturally tend to organize our perceptions and come to understand phenomena in the natural environment ... i.e. develop knowledge ... via ways that George Lakoff, a Professor of Linguistics at the University of California, Berkeley, calls ***innate cognitive models*** ... and recognizes four (see next section).

Lakoff's "INNATE COGNITIVE MODELS"

1) image-schematic structuring
   - making pictures

2) propositional structuring
   - starting with certain assumptions, and proceeding from them

3) metonymic mapping
   - using a part to characterize a whole

4) metaphoric mapping
   - using parts (of two different things) in a comparative way

Thinking strategies re pattern

1) whole - part thinking

a **WHOLE** is made up of **PARTS**

2) perspective

• 1st, 3rd, and other person viewpoints

a) 1st person ... I (= subjective perspective)
b) 3rd person ... it (= objective, or Western scientific perspective)
c) 4th or 5th person (with 1st + 3rd → potentially leads to spiritual perspective)

3) reaching conclusions

a) inductive thinking
= gathering of large numbers of facts (parts), followed by the **detection of pattern**
⇨ see ThoughtTraps∞∞ for "Pursuit of Scientific Knowledge"

b) deductive thinking
= cutting to the quick of each phenomenon, followed by an attempt to skeletonize it, or ... perceiving an orderly relationship (pattern), and then attempting to provide an orderly explanation for it in terms of "rules, regulations, or laws" ... and preferably stating the explanation in mathematical language
⇨ see ThoughtTraps∞∞ for "Pursuit of Scientific Knowledge"

4) algorithmic thinking

= developing a recipe and following it

5) metaphoric thinking

= comparing parts and wholes between two different things
= seeing overlap (relationship) in similarities of parts of the two different things
= seeing creative relationship

☞ "One of the ways in which science advances is through the use of inspired metaphor." (citation of Dawkins, by Ruse 1998)
☞ metaphoric mapping = using the ideas of one field of understanding to shape and interpret experiences from another field of would-be understanding (Ruse 1998)
☞ an expression (figure of speech) that compares the likeness (similarity, common attribute) of one thing with another thing that is otherwise quite dissimilar (dictionary)

- metaphor vs. analogy
  - BOTH: emphasize similarity ... to facilitate "seeing" the likeness

  - TECHNICAL DIFFERENCE BETWEEN
    - metaphor: purpose is to conjure up a vivid (intensely felt) picture ... **visual aspects**
    - analogy: purpose is more to explain rather than make vivid ... **dynamic aspects** (dynamic ... forces or methods governing activity, motion, change)

the power of the metaphor

from: http://www.uia.org/metaphor/51comfut.htm

Part of the alienating nature of modern society derives from the extent to which everything perceptible is governed by packaged "explanations" provided by authority figures, experts, and the media. Such "models" are essentially non-participative and elitist, whereas metaphors facilitate individual interpretation, each according to his or her ability. An excess of explanations is experienced as disempowering. Metaphor offers a possibility of empowering the individual in that he or she has greater control over what metaphor is to be used when. He or she is not obliged to communicate with acquaintances using an explanatory language effectively imposed by distant third parties.

There is in fact some merit in perceiving conventional "explanations", whether scientific, political, legal, or administrative, as needing to be complemented by appropriate metaphors to enhance the quality of communication.

6) analytical thinking

- taking wholes apart → PARTS

7) synthetic, contextual, or holistic thinking

- putting parts together → WHOLE
- Wilber (2000): the secret of contextual thinking is that the whole discloses new meanings not available to the parts, and thus the big pictures we build will give new meaning to the details that compose it

8) critical thinking

9) classical logic, fuzzy logic, deviant logic

10) creative thinking ... seeing something for the first time

☺ When you need to go from the KNOWN to the UNKNOWN

... and encounter a BARRIER OF FEAR between them ... you can cross that barrier via creative thinking.

☺ The pursuit of scientific knowledge ... is very much a journey from the known to the unknown ... and thus, it is filled with the need for creative thinking.

Douglas J. Cardinal, one of Canada's most renown architects and a member of the Order of Canada, says that in the Aboriginal world view "humans are magical beings" with the power of creativity ... and offered the thoughts below about creativity (from the: *Symposium on Creativity and Innovation in the Arts and Sciences,* at the Congress of the Social Sciences and Humanities, Edmonton, May 25-26, 2000).

- ***problem:*** how to bring out the gift of creativity, how to tap into it ... which is there because:
  ☺ within me is the past (my ancestors), the present (me), and the future (my children)

  - so we must look inward to unleash this power

- ***problem:*** we are locked into our domain of being a human ... we operate too much from the perspective of fear and the mode of survival ... to be able to harness this power ... we want to stand in the comfort zone, the domain of the known ... although power is in the creative, the domain of the unknown

    - the domain of the known is very small
    - the domain of the unknown is very large ... it is the land of the eagle

  - we must go outside this domain of being human, the framework, the box ... become a magical being, a shaman, a sorcerer ... put self in a state where you are like a blank piece of paper, on which something can be created from nothing

- ***problem:*** how do we leap into the unknown ... when we are ruled by fear ... when the unknown has no sense of security, where we may fall out of the sky, where there is total freedom ... need a "comfort guardian" (a spirit or warrior)

  - we must overcome the fear of the unknown
    step 1: as a human, learn to be a hunter ... learn that all animals have patterns
    step 2: as a human, learn to become a "**patternable**" spirit being or warrior ... and step out of the fear framework into the unknown
    - enter the domain of questioning
    - define the problem in a new way
    - create the umbrella of a vision
    - apply process to bring the vision to reality
    - do not come with all the answers
    - be willing to enter a new paradigm
    - approach with a blank sheet of paper

  - look inward and unconceal the solution because it (the future) is already there

  ☺ **The ability to become patternable** ... i.e. sensitive to the patterns displayed in Nature such that one is able to incorporate and adapt them to one's own or one's community's needs, as appropriate ... is the secret to crossing the barrier of fear between the domain of the known and the domain of the unknown. It is essential for creative thinking, creative learning, and creative relationship ... any time when, and any place where, one must do something innovative or for the first time.

- ***problem:*** sharing visions and insights makes one vulnerable and open to criticism ... from those around us who wish the world to operate in the status quo ... so we tend to shut down the creative being that is one's self

  - we need safe places to play ... our educational institutions and businesses are not this safe place

  - a safe place is one where we can embrace risk rather than fear

  - need spirit guardians and warriorship to overcome fear ... to overcome those around us who shut down and say "damn if I will let others be creative when I myself cannot be"

☺ **Creative thinking is central to the pursuit of scientific knowledge.** It is needed in:
- asking questions in new ways
- making observations in new ways
- collecting data in new ways
- testing data in new ways
- explaining data in new ways
- seeing how new ideas mesh with the old

LANGUAGE ... a building block of consciousness

= symbolization of representations

❒ Read the section on "multiple intelligences theory" ... especially the ideas about "symbols".
❒ Review the section on language in ThoughtTraps ∞∞ (Pursuit of Scientific Knowledge).
❒ Read the article *Learning the world's languages — before they vanish* by B. Wuethrich.
❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

✳ The study of language ... was made scientific, as "linguistics" ... by Noam Chomsky.

☞ **Language structures how you "see" the world in which you live.**
Thus, a major component of MSɬT 101/103 is "Mi'kmaq language".

Information from Beatty (2001):
Language derives its power from its hierarchical organization — the fact that it is organized at several different levels. At each level, the rules or grammar, of language are appropriate to the units being organized. Hierarchical organization eases the burden of building extremely complex systems because problems appropriate to each level can be dealt with at that level. Levels in the hierarchy are:

semantic level
• meanings •
↑
semantic level
• words, phrases, sentences •
↑
morphological level
• morphemes: root, suffixes, prefixes •
↑
phonological level
• phonemes •

Phonemes are the basic speech sounds of a language. They are combined into morphemes, the smallest units that carry meaning. **Morphemes** can then be turned into words, and words combined into phrases and sentences.

"Lexicon" for most people simple means "words in a dictionary" ... but to a linguist the word has a special, technical meaning: it is *the total number of morphemes available to an individual*.

Different languages have different numbers of phonemes ... and although different languages use different sets, the total number of phonemes employed by all the world human languages is no more than about 90.

- English has about 56 phonemes ..... written in an alphabet that uses 26 letters.
- Mi'kmaq has 27 phonemes ..... written in an alphabet that use 17 letters (Smith-Francis orthography).

INTENTION ... a building block of consciousness

= representation of goals

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Create a map of major ideas related to this building block.

ORIENTATION ... a building block of consciousness

= representation of time, place, persons, objects

- ❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
- ❒ Read Carter (1998) *Mapping the Mind*.
- ❒ Read the sections on "pattern" in these ThoughtTraps, and in ThoughtTraps ∞ and in ThoughtTraps ∞∞.

INDIVIDUAL PROJECT

- ⧖ Enhance the outline of major ideas related to this building block ... by adding ideas to those already provided ... and creating an overall map of ideas for this building block.

Orientation is considered one of the three necessary elements of attention (see section on "attention" as a building block of consciousness).

Orientation is also highly important in a related but different sense — seeking answers to such life questions as "who we are", "where we belong", and "where we are going".

☺ And thus, within the context of orienting towards a *Sense of Place, Emergence, and Participation* ... considerable importance lies in:

- **story-telling** ..... we create the story, and are created by the story
- **map-making** ..... a map is only and ever a metaphor for some aspect of reality

Story-telling

☞ After you read the thoughts below ... recall that one of the objectives of the Toqwa'tu'kl Kjijitaqnn / Integrative Science program is to articulate the Common Ground, i.e. the similarities, between Aboriginal knowledge and Western science knowledge.

From Peterson (1999), p. 94:

> We humans have spent hundreds of thousands of years watching ourselves act and telling stories about how we act. A good story has a universal quality, which means it speaks a language we all understand. Any universally comprehensible language must have universal referents, and this means that a good story must speak to us about those aspects of experience that we all share.
>
> But what is it that every human being shares, regardless of place and time of birth?
>
> Most objects of experience have some properties in common, while varying with regard to others. Generally, the similarities and the differences are both significant. So it is with individuals and cultures. We seem peculiarly aware of our differences, however, and not of our similarities. I think this is in part because we are not built to focus on the predictable and familiar. Our attention gravitates naturally toward those aspects of our environments, natural and social, that contain information [*information is "something that makes a difference"*] and the differences stand out profoundly.

Map-making

☞ The Toqwa'tu'kl Kjijitaqnn / Integrative Science program explores various areas in Nature ... maps will be consulted ... and maps will be made ... as part of these experiences. Bear in mind the thoughts below.

From Cajete (2000), p. 181:

> In the Western scientific perspective, maps of places are drawn to symbolically represent a place based on previously agreed upon criteria that are logical and measurable with regard to the discipline of cartography. But a map is always just a kind of symbol for a place, it is not the place it is meant to describe. Indeed, to know any kind of physical landscape you have to experience it directly; that is, to truly know any place you have to live in it and be a part of its life processes. Maps also imply a history, and the political and cultural background of its makers.

The concept of map-making extends much beyond its use as a metaphor for physical landscapes. Bear in mind that one universal purpose of a map is to help you stay oriented, i.e. not get lost!

☞ The Toqwa'tu'kl Kjijitaqnn / Integrative Science program explores various concepts in the knowledges of Western science and Aboriginal peoples ... maps will be consulted ... and maps will be made ... as part of these learning experiences.

☞ The Toqwa'tu'kl Kjijitaqnn / Integrative Science program explores various foundations in the ecology of Indigenous education, as "mapped out" by Cajete. The map of their ebb and flow has been made into a poster for this program.

☞ Robin Cavanagh in Environmental Studies at York University has "mapped out" the relationships of various values in the world view of the Cree in Ontario, using a "teaching wands" approach. The Toqwa'tu'kl Kjijitaqnn / Integrative Science program will consider these, and ask whether other Aboriginal people may have used (or still use) similar approaches.

☞ The Toqwa'tu'kl Kjijitaqnn / Integrative Science program is a concentration within UCCB's Bachelor of Science Community Studies four year degree. You can "map" your progress through the degree by following the degree profile provided in ThoughtTraps ∞ . If you wish to pursue a different degree, you can also "map" your progress through it using the appropriate degree profile. Ask at the Registrar's Office.

☞ The Toqwa'tu'kl Kjijitaqnn / Integrative Science program provides ThoughtTraps for the first year MSIT courses ... begin to "map" your way in them by providing page numbers for the entries in the Table of Contents.

LEARNING ... a building block of consciousness

= automatic recording of experience

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Enhance the outline of major ideas related to this building block ... by adding ideas to those already provided ... and creating an overall map of ideas for this building block.

Howard (2000) makes the following points:

☺ **Learning** is defined as the establishment of new neural networks composed of synaptic connections and their associated neurotransmitter receptor patterns (plus other information molecule receptor patterns in the mind/brain/body).

☺ New synapses occur after **learning** ... and it is the density of the brain as determined by the number of synapses that distinguishes greater from lesser mental capacity.

☺ Knowledge can, therefore, be defined as the "pattern of connectivity" between neurons, and **learning** as modifications to this pattern of connectivity.

Brain-based learning works with pattern.

Thus, Toqwa'tu'kl Kjijitaqnn / Integrative Science
and MSIT emphasize pattern recognition towards:

question asking
creative thinking & creative expression
critical & logical thinking
metaphor
map-making
story-telling

Mindful Learning ... using the principles of its "brain basis"

> Human consciousness and human learning
> are
> "brain-based".

→ **environmental information** ... to the brain ... as sensory information input

→ **brain** ... an information processor PLUS

☺ more than just an information processor ... it is also a "boot strapper" ... a causative agent.

→ **brain-based learning ... pattern !!!!!!!!!!**

☞ information → brain ... **pattern recognition** ... like attracts like
... the brain takes in *pattern information* from its environment ... in addition to the sensory information that is traditionally discussed

☞ building blocks of consciousness ... **patterned activity** in neural networks
... the brain functions by way of *patterns of electro-chemical events*

☞ multiple intelligences ... based on **pattern recognition**

☞ learning: e.g. Lakoff's innate cognitive models: working with natural **pattern recognition** abilities
- metaphor
- metonymy
- image schematic ("mapping")
- propositional

VOLITION … a building block of consciousness

= decisions to act

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Create a map of major ideas related to this building block.

MOVEMENT ... a building block of consciousness

= motor acts and behaviours

❒ Read Cajete (2000) *Native Science; Natural Laws of Interdependence*.
❒ Read Carter (1998) *Mapping the Mind*.

INDIVIDUAL PROJECT

⧖ Create a map of major ideas related to this building block.

QUESTION: What are some of the details of different states of consciousness?

CLASS PROJECT

- Provide details and major ideas about the different states of consciousness, using the framework below.

Waking

Sleeping

Dreaming

Altered

types
- shamanism
- vision questing
- drug-induced

induction of
- purification rites (chemical ... internal source / physiological)
- drugs (chemical ... external source)
- drumming (mechanical)

QUESTION: What can science tell us about the "hard" problem of consciousness (self/Self awareness and creative relationships)?

❒ Read the article *Watching the brain, seeing the soul*

Hobson (1999, p. 99) states the hard problem in consciousness studies as the question "How can an object, a brain, become a subject, a self with self-consciousness?".

He then says:

> If the brain is capable of creating an abstract or representation of the externally referenced visual world (and it is), and if that representation is an activated state of the brain (which it is), then it should not be too hard to believe that the brain can create a representation of that representation (i.e. self-consciousness).

To which one could add the statement "... *and work with it*" (i.e. see creative relationships).

WESTERN DEVELOPMENTAL PSYCHOLOGY: "MULTIPLE INTELLIGENCES THEORY"

Howard Gardner is a developmental psychologist at Harvard University who suggests that humans have a variety of intelligences, not just the "linguistic" and "logical-mathematical" ones that traditionally have been associated with "smarts" or "high IQ" or "scientific thinking" (in fact, science requires much more than just word smarts and number smarts). His theory has become known as the "multiple intelligences theory".

Gardner's multiple intelligences may also be referred to as "fields" in common use, or as "domains" in Cognitive Science.

His main ideas are:

- 8-9 different kinds of intelligence exist within an individual
- an individual has differing degrees of ability in each kind of intelligence
- each intelligence is defined as an ability to acquire and retain information in a given field of knowledge, to solve problems, or to create products which are valued ... i.e. talent
- the intelligences are independent. Therefore, high performance in one does not necessarily accompany equally high performance in another. Outstanding performance by an individual in two or more is rare.
- the different intelligences depend on "pattern recognition" abilities: the brain's perception of information based on predetermined tendencies conditioned by the interplay of individual, environmental, and cultural factors

Synopses of the 8-9 intelligences (from Howard 2000):

1. linguistic
   - performs the primary operations of sematics (meaning), grammar, sounds, and rhetoric

2. logical-mathematical
   - performs the primary operations of long chains of reasoning, the capacity for abstraction, and calculation

3. musical
   - performs the primary operations of pitch, volume, rhythm, and timbre

4. bodily-kinesthetic
   - performs the primary operations of controlling the body and manipulating objects

5. spatial
   - performs the primary operations of correct perception of objects and the ability to transform and rotate objects in the mind

6. interpersonal
   - involves interpersonal understanding, or knowing the moods, feelings, traits, abilities, and needs of others

7. intrapersonal
   - performs the primary operation of intrapersonal understanding, or knowing one's own feelings

8. naturalist
   - involves skill in observing, understanding, and organizing patterns in the natural environment, as in the recognition and classification of plants and animals

9. existentialist / spiritualist (note: Gardner, 1999, considers this one as under "consideration")
   - involves skill in speculating about the nature of the universe and existence

Defining criteria for the intelligences

Gardner used eight criteria to identify the intelligences:

1. isolation by brain damage (suggesting it has its own neural structures)
2. existence of prodigies in that intelligence
3. a core set of operations
4. developmental uniqueness
5. evolutionary plausibility
6. validation from experimental psychology
7. validation from achievement tests
8. existence of a unique *symbol system* to communicate its content

Symbols as means to communicate intelligences

Cajete (1999) also points out that Gardner, like many other researchers before him, emphasizes symbols as mediators of cognitive processes (thinking, problem solving, creating) ... and then makes the further point that education is the learning of culturally-relevant symbol systems. He adds, citing Gardner:

> What is a symbol? Very simply, a symbol can be said to be any entity (material or abstract) that can denote or refer to any other entity. However, the dynamic nature of what symbols do is anything but simple. For instance, symbols can represent various levels of human feelings, or they can come together to form complex symbolic systems such as a language, an art form, or a cultural science. They can become, when combined, self-contained creative products such as myths, rituals, poems, scientific constructs, artistic creations, or a host of other conveyances of meaning.

Cultural emphasis for different intelligences

Cajete (1999) points out that most cultures emphasize intelligences that are deemed valuable within their own cultural context.

Many Native American groups traditionally valued interpersonal intelligence along with certain expressions of bodily-kinesthetic, musical, and linguistic intelligences — intelligences that are expressed in leadership, the ability to get along with people well, the ability to sing and dance well, athletic prowess, and the ability to use one's native language eloquently.

Western science, in traditionally emphasizing the "linguistic" (word smarts) and "logical-mathematical" (rational thinking and numbers smarts) intelligences ... has tended to overlook or forget two important facts:

- that a key element in its discovery process is creativity, which draws upon several intelligences ... and
- that the skills inherent in "nature watching" (observing, understanding, and organizing patterns in the natural environment) form the basis of the scientific pursuit of knowledge.

INTEGRAL PSYCHOLOGY: BRINGING IT ALL TOGETHER

Ken Wilber is an American philosopher outside the mainstream of academia who has put forward a philosophy on consciousness under the label ***Integral Psychology*** ... it is leading edge in its breadth and depth of consideration of world spiritual traditions, world philosophies, modern psychology, cognitive science, and neuroscience. He started his work in the 1970's.

> His interest is to create a truly integrative model of consciousness — one that encompasses understandings from around the world — and he has, far beyond any of his academic and scholarly peers, compared literature sources from the Eastern and Western wisdom traditions, and from the premodern, modern, and postmodern eras of human history.
>
> He believes that ***Integral Psychology***, i.e. one that legitimizes the return of spirit to discussions in psychology, will become increasingly prevalent in the coming decades, as will *integral studies* in general, "as the academic world gropes its way out of its doggedly night view of the Kosmos".
>
> The "night view" is a world view that attempts to reduce all body, mind, soul, and spirit to inert matter, empirical processes, or objective systems, i.e. to the physical or material alone, which lacks teleological significance (meaning). It contrasts with the "daylight view" of the whole material universe as inwardly alive and conscious, i.e. as having teleological significance. Wilber indicates that these terms stem from the work of Gustav Fechner (a major father of modern psychology whose work dates to the 1800's), who considered matter and spirit as inseparable. Nevertheless, it is the night view that prevails in modern psychology, and throughout academia. Wilber refers to the night view as "flatland".

"Integral Psychology" considers the totality of reality to consist of one thing, with two sides (like a coin): absolute matter (the physical perspective) and absolute spirit (the spiritual perspective). This immediately separates Wilber from most of academia where convention holds reality to be entirely physical, or reducible to the physical. However, Wilber's ideas in this regard align him, *in some respects*, with many of the wisdom traditions of premodernity, and with perennial philosophy.

Similar to other knowledge approaches, Wilber breaks the WHOLE into PARTS. His scheme discusses issues related to consciousness that go beyond the conventions of Western science ... i.e. they include "Spirit". Wilber uses *Kosmos* (i.e. cosmos spelled with a capital K) to denote an ontology that includes spirit, as well as energy and matter..

☞ Integral Psychology considers ... **consciousness as both "being <u>and</u> knowing"**.
= ontology and epistemology

☞ "Integral Psychology" goes beyond "states", "building blocks", or "modules" in its attempt to answer the question "What is consciousness?"

For Wilber, consciousness studies must include:
1) functions
[some overlap here with the concept of building blocks or modules]
2) developmental potentials ... ability to evolve
3) relational and behavioural aspects
4) quadrants
5) major components of:
- levels
- independent developmental lines
[some overlap here with multiple intelligences theory]
- states
[some overlap here with other theories that consider states]
- self
- self-related lines of consciousness

☞ "Integral Psychology" recognizes that human consciousness <u>evolves</u> through various holarchic levels, from prepersonal to personal ... and with the potential to reach beyond the personal to the transpersonal.

With respect to the <u>highest levels</u>, Wilber considers that:
1. they are <u>potentials</u>, not givens;
2. a person can comes to a realization of their reality through creative relationship with the world; and
3. very few people at any one point in history have ever attained them. Furthermore, he considers the levels as more than just cognitive development, referring to them as levels of "being and knowing" (≈ontology and epistemology).

<u>Web sites for Wilber's Integral Psychology</u> ... numerous ... some informative ones are:

http://wilber.shambhala.com/html
http://www.imprint.co.uk.Wilber.htm
http://members.ams.chello.nl/f.visser3/wilber/overview.html

Major ideas in Wilber's integral psychology

An "integral" discussion of consciousness must include the concepts of:

1) functions of consciousness

- perceiving } ≈ input and processing building blocks
- desiring)
- willing } ≈ output building blocks
- acting)

2) developmental potential — ability of consciousness to evolve

... and thus, its overall developmental **potential** as spanning an entire **spectrum** from:

⇒ prepersonal to personal to transpersonal, or:

= subconscious to self-conscious to superconscious

= id to ego to Spirit

= body to mind to spirit ... with different experiential realities:

spirit: spiritual experience
mind: mental experience
body: sensory experience

✂ Wilber points out that the culture of orthodox Western science and psychology have tended to abandon the transpersonal or spiritual level(s)

✡ Wilber also points out that, setting Western science aside, there is general, cross-cultural agreement as to the reality of the transpersonal level(s) ... and this comparative evidence is the data base upon which he constructs his theory of Integral Psychology.

3) relational and behavioural aspects of consciousness

... which refer to its mutual interaction with both the:
- objective, external world
- sociocultural world of shared values and perceptions

4) quadrants of consciousness ... "four corners of the Kosmos"
... the four quadrants are multi-level, with correlations in levels through all quadrants (❖)

simple version

	Interior	Exterior
Individual	■ I	■ it
Collective	■ we (culture)	■ we (society)

---

more complex version

	Interior	Exterior
Individual	• interior-individual (intentional) • subjective • truthfulness - sincerity - integrity - trustworthiness ■ I	• exterior-individual (behavioural) • objective • truth - correspondence - representation - propositional ■ it
Collective	■ we • interior-collective (cultural) • intersubjective • justness - cultural fit - mutual understanding -rightness	■ we • exterior-collective (social) • interobjective • functional fit - systems theory web - structural-functionalism - social systems mesh

NOTE: Wilber says that validity claims (epistemology) in all four quadrants ... follow the same three steps *that all authentic knowledge claims have in common*:

1. injunction (question) ..... if you want to know this, do this .....a practice or paradigm
2. observation ..... get experience, apprehension, or evidence ... collect data
3. comparison .....exchange and testing of data among those who have also done the first two steps ..... accept or reject data

5) major components of consciousness ... five, as follows:

a) levels (or structures, or waves) in a spectrum of consciousness
... levels which can be arranged in a nested hierarchy, from lowest to highest, which he calls the "Great Nest of Being"

- in his opinion, and in more scientific language, the Great Nest represents a *morphogenetic field*, or *developmental space*, with *structures*
  - ⇨ "fields" and "space" figure prominently in the way modern physics conceptualizes the overall dance of energy in the universe
  - ⇨ "structures" are stable patterns of matter in modern physics, and of events in modern psychology and sociology

  - the higher levels represent <u>potentials</u> (not givens)
  - some facets of the levels can be unconscious rather than conscious

- a simple and rather general, 5 level scheme (for the inner-individual quadrant ... inner I)

spirit
soul
mind
body
matter

- Wilber's complex 13 level scheme (for the inner-individual quadrant ... inner I)

nondual
causal (formless)
subtle (archetype)
psychic (vision)
vision-logic
formal
rule/role
concept ("internal-meaning" ... i.e. idea)
endocept ("felt-meaning")
symbol
image
impulse/emotion
exocept ("external-meaning" ... e.g. touch, temperature, pleasure, pain)
perception
sensation
matter

- Note: as Wilber has developed his theory over the years, or simplified or expanded it for different audiences, he has used schemes with varying numbers of levels ... e.g. 10 or 13.

b) independent developmental lines (or streams, or modes) of consciousness

... unfolding, potentially, into and through all the various levels

- a general 3 mode scheme
  - aesthetic
  - moral
  - scientific

⇒ Wilber characterizes the major eras of human history as follows:

1. premodern ... which did not differentiate the above three lines (not distinguish them)
2. modern ... which differentiated the above three lines, and also began to dissociate them (pull them apart)
3. postmodern ... which has completely dissociated (divorced from each other) the above three lines, such that today we live in a fragmented world

⇒ Wilber suggests a "post-postmodern" era will emerge as integral studies take hold broadly.

- additional lines can be added, or different groupings recognized, such as cognitive developmental lines ... e.g. Howard Gardner's 8-9 multiple intelligences

c) states of consciousness

- two major states:
  - normal ... waking, dreaming, sleeping
  - altered

- normal (with 3 or 4 states available to anyone who wakes, dreams, or sleeps)
  - waking ... offering access to the gross ego ... our everyday world
  - dreaming ... offering one type of access to the subtle soul ... a world created by the psyche
    - a lower subtle or psychic ... with an intense embrace of the entire gross realm, as in nature mysticism
    - a subtle proper ... that transcends the gross realm into the purely transcendental, as in deity mysticism
  - deep sleep ... offering one type of access to the causal spirit ... a world of pure formlessness, of nonduality
    - as in formless mysticism

- altered ... non-normal, or nonordinary,
  - peak (a temporary altered state which can occur to an individual, at any stage of development, while awake ... and moves their experience into the transpersonal)
  - meditative
  - drug-induced
  - near-death experiences

d) self

- two major parts to "self"
  - proximal self ..... = the observing self: I ..... an inner subject or watcher
  - distal self ..... = the observed self: me ..... some objective things that one can see or know about one's self
  - → plus ... overall self .... = the two together: both ..... which go into the sensation of being a self in this moment

- during psychological development (i.e. evolution of a person's consciousness through the spectrum of potentials), the "I" of one level becomes a "me" at the next.

  Wilber suggests that a person's proximate self first identifies with (or embeds in) a particular level (and experiences things at this level very intimately, as an "I"). As development unfolds in time, the self will then disidentify with this particular level (de-embed from, or transcend), but then includes and integrates it from the next higher level. What the self de-embeds from can be seen more objectively, i.e. with some distance and detachment. In other words, the *subject* of one level becomes an *object* of the next.

  Proximate-self development is, for Wilber, at the very heart of the evolution of consciousness ... with the proximate self having both a *constant* and a *developmental stream* ... and thus the proximate self is responsible for balancing and integrating all the levels, lines, and states in the individual ... it is the navigator and the locus of integration.

  The levels of consciousness *per se* do not have a sense of self, rather it is the self of the person that senses them.

e) self-related lines of consciousness

- as a subset of the developmental lines in general ... these are the lines that are especially and intimately associated with the self, its needs, its identity, and its development ... and are likely to be a new set at each higher level in the hierarchy

SOURCES

☞ under construction

ARTICLES

☞ to be handed out in class to those who *purchased* ThoughtTraps I