

# **Brain Mind and Consciousness**

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## *BRAIN, MIND AND CONSCIOUSNESS*

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### **INTRODUCTION**

The human genome has been deciphered, but the brain which is the frontier-most of the neurological sciences, is yet to be 'cracked'. While the atom which was initially supposed to be indivisible has been eventually broken into proton, neutron, and electron, the elementary components of human brain and mind are far from clear. When one tries to crack the brain, the results are concussion, confusion, laceration, loss of consciousness, or a locked-in-state or a state of vegetative existence. When one tries to analyze the mind, one lands up in a vacuum. These observations lead us to the impression that breaking open, splitting, or dissecting cannot help us to understand either the brain or the mind. On the other hand, if we accept that both brain and mind are embedded in nature-consciousness, what the Indian seers have described in the age-old Sanskrit texts as *akhanda* (indivisible), we may do justice to the subject of brain and mind. Nature has not divided brain, mind, and consciousness as distinct entities; such a division is man-made.

Therefore, this Chapter describes brain-mind-consciousness as an indivisible entity.

The human brain is considered a subsystem within the planet earth, which itself is a subsystem of the solar system; the solar system is a subsystem of the galaxy which is a subsystem of the universe. The universe in turn is a subsystem of the multiple universe. In this nested hierarchy of nature-consciousness, consciousness is considered a ground reality and the brain is an evolving organ for the playground of consciousness. For convenience however, brain, mind, and consciousness are viewed as divisions of the indivisible.

The Chapter first describes the brain, the mind, and the consciousness individually, then their interrelation and interaction, and finally the perspectives and the future of the human brain.

### **THE BRAIN**

It is assumed that the psyche-like function and the display of intelligence are ubiquitous in the mechanics of nature-consciousness. Nature-consciousness executes it through a brain-like structure and a brain-like process. This brain-like structure and process have

been proposed to develop as brain through the processes of creation, evolution, and involution (see section **Future Perspectives of the Issue**). There are of course ontological gaps in this. Very little is known objectively about the phases of creation and involution; but we have started knowing some amazing facts about the process of evolution (Cziko 1995, Kaas & Preuss 2003).

### **Evolution of The Brain**

Neuron is the unit of nervous system. It came into biological existence about 700 mya. Neurons differ from all other cells by *polarity* of membrane and *serenity* of genes. The polarity of the membrane of the neuron is most suited for signal processing and communication. The genes of a stable neuron, on the other hand, are minimally engaged in replication activity.

The formation of a network of neurons is first observed in a class of marine animals to which belong the corals, sea anemones, and jellyfish. The network of neurons offers the organism the power to coordinate its movements and to form a database and memory. The neuron network continued to evolve on the following principles: (i) development of a command structure, (ii) centralization of the command, (iii) hierarchical organization of the command network, (iv) concentration of neurons and sense organs at one end of the organism, i.e. encephalization, and (v) plasticity, i.e. the ability to modify the network command structure and the **encephalon\*** from the result of experience.

In the **phylum** Platyhelminthes to which belong the flat worms, we find the first evidence of centralization of the command into a group of neurons (cephalization), which may be termed the most primitive brain. However, this primitive centralization and cephalization are far from complete, because when the group of neurons is removed the organism could move, feed, burrow, mate, and even learn! Flat worms are also the simplest organisms to have, besides the sensory and motor neurons, a third kind of neuron called interneuron.

In insects (phylum Arthropoda) not only the hierarchy of command structure developed a more or less definite shape in the form of segmentations but also the sensory system developed a remarkable expansion. Insects have a variety of sensory receptors. They have, in addition to the common receptors for odours, sounds, and chemicals in the surroundings, receptors for sensing light pattern, texture, pressure difference, and humidity. Their 'brain' has three segments, namely protocerebrum, deutocerebrum, and tritocerebrum. Encephalization is well organized in insects. Probably these factors make the insects the most abundant organisms on earth. The insects have their own language and culture too.

Whereas in the insects the segmented **neuraxis** is ventrally located, in the **Chordata** the nervous system is a hollow nerve cord that lies dorsal to the **notochord**. The mechanism of this significant change is not known. The basic elements of the vertebrate nervous system are present in a simple nonvertebrate organism called lancelet in which the dorsal nerve cord runs along the length of the body and sends out segmented nerves. The size of the brain and the complexity of its network organization have increased

through chordates and vertebrates. In fish, amphibians, and reptiles there are forebrain, midbrain and hindbrain. The hindbrain is continued as the segmented spinal cord protected within the vertebral canal. There is also development of a 'cerebellum' in the hindbrain. It is now known that reptiles can also experience emotions such as fear and pleasure (Cabanac 1999).

Besides the three major components, namely forebrain, midbrain and hindbrain, two new structures, the neocerebellum and the neocortex developed in mammals. Neocortex is also called isocortex. Its growth and development made the brain stem almost hidden within its convolutions. The cerebellum grew 3- to 4-fold its original size. This remarkable cerebellar growth helped achieve coordination of finer and sophisticated movements. With the growth of neocortex, the ability to learn from experience scaled new heights. The neural structures related to motivation, to seek pleasure, and to avoid the unpleasant became more consolidated in the mammals. There is growth of **limbic structures** and their connections with the sensory motor cortex. Connection between the two hemispheres of the brain was maintained through the anterior **commissure** in the pouched mammals (e.g. kangaroo), and through the enormously developed **corpus callosum** in the placental mammals (e.g. cat, dog, monkey, human being).

The size of the brain in terms of weight continued to increase along with the increase in fissure pattern and organizational complexity. From early apes to modern human being, over six million years, the brain size has increased 3-4 times. The human brain is roughly three times larger than the chimpanzee's. In the early hominid the brain size was 600-800 ml. The real leap in brain size, however, is seen from *Homo erectus* (0.5 mya) with a brain size of 1000 ml to *Homo sapiens* with a brain size of 1400-1500 ml. Although dolphins and elephants have larger brains than do human beings, the human being has the highest brain weight/body weight ratio.

Larger the brain the greater are the number of neurons, the cortical areas, and the modules to carry out functions, and more is the tissue devoted to connections than to processing, and higher is the ratio of local connection to long distance connection. A larger brain, however, has design problem and there is loss of bilateral symmetry. Also, a large brain creates more heat energy and requires a better cooling system; it involves greater metabolic, computational, and childbirth costs. This may be why the human brain ceased expanding roughly 100,000 years ago.

In spite of a plateau in brain size for almost 100,000 years (Striedter 2005) the following features make the human brain different from the animal brain:

- (i) The highest brain weight/body weight ratio.
- (ii) The enormous folding of the neocortex, with marked increase in neuronal density and incredible complexity of the synaptic connections within. The ratio of neocortical grey matter to medulla, as compared to 30:1 in chimpanzee, is 60:1 in the human. In addition, the extensive direct connections of the cortex with the lower motor neurons offer dexterity in skill ranging from hands to vocal cord.

- (iii) Extensive growth of the association cortex (responsible for higher mental functions), is in fact quite disproportionate in comparison to the sensory-motor regions.
- (iv) Elaborate development of the language brain. And
- (v) More of prefrontal cortex, specially the dorsolateral prefrontal cortex, which offers more flexibility of behaviour.

Organization of the prefrontal cortex almost characterizes the behaviour of a being, because it is concerned with working memory, planning, inhibition of volition and compulsion, and depth of emotion. All these four functions are seriously impaired in prefrontal injury (Wallis & Miller 2003).

### **What Makes the Human Brain so Complex?**

The human brain is the most complex structure in the universe. Five factors, namely genetics, environment, self-awareness, language, and a process what Stephen Gould called exaptation<sup>1</sup>, may be responsible for this.

#### ***Genetics***

Genes are responsible for gross layout of development, while the interaction with the environment determines sophistication and exaptation. Bruce Lahn's team has identified two genes, Microcephalin (Evans et al 2005) and ASPM (Mekel-Bobrov et al 2005), claimed to be responsible for the characteristic growth of the human brain. Microcephalin appeared about the time of explosion of symbolic behaviour nearly 37,000 years ago (confidence level interval 14,000-60,000 years) and it is now found in 70% of the sample human population. It is much more common in the European, the Asian and the American samples than in the sub-Saharan African samples. ASPM (abnormal spindle-like microcephaly) gene first appeared just preceding the rise of cities in the Near East roughly 5800 years ago (confidence level interval 500-14,000 years). In a sample human population it shows a skewed geographic distribution. Both the genes came under strong natural selection since the chimp-human split. It indicates that both the genes are responsible for remarkable expansion of the brain in *Homo sapiens*. Although both the genes are expressed in other tissues, their expression is stronger in the *developing brains* of mice and human.

Should Microcephalin and ASPM genes be expressed in the developing brain, the roles of the developmental regulatory genes which are prone to be switched on in the intrauterine life appear more significant. Lahn's team has concluded that the evolution of the human brain is not yet complete. A human-specific gene has also been identified in the microglia, the immune cell of nervous system (Hayakawa et al 2005).

#### ***Environmental Stimuli***

Human being is a social animal. The gamut of information a human brain handles in the social context throughout its developmental period since birth is incredible. This stimulating environment has two purposes: (i) to select a network best suited for continued interaction with the environment and *pari pasu*, and (ii) to allow regression of the neurons and their network that are not necessary. There is a huge amount of natural

death (**apoptosis**) of neurons from infancy to adulthood. There is also a proposal (Correa & Bustuoabad 2004) that injury and death play a basic role in self-organization. In this sense, the stimulus of death from the surroundings could help the surviving neurons to organize themselves better and emerge as the fittest.

### *Self-Awareness*

Self-awareness is supposed to be a human characteristic. Human beings could not only be aware of the perceptual/emotional/memory contents of consciousness, but also they could be aware that they are aware of the contents of consciousness. This is reflexive consciousness. Human being could also become aware of cognizing that consciousness which is cognizing. This property of human brain has allowed an incredible growth in its information processing capacity reflected in neuronal density and synaptic density of the cortex. Further, the human brain and mind have the ability to transcend space, time and delve into deeper recess of nature (i.e. nests III, IV and V; see section NATURE-CONSCIOUSNESS).

### *Language*

Development of self-awareness is intimately related to (either preceded, caused or followed by) the development of language (Morin 2005). Language has facilitated communication skill and exchange of information. Communication skill through a common universal code has given the human species preeminence, which was unimaginable ten or twenty thousands years ago.

### *Exaptation*

Stephen Gould (1992), an American evolutionary paleontologist, contributed the concept of exaptation to our understanding of evolution. Exaptation is a process by which structures and behaviours, which were originally selected for one purpose, become involved in another function totally unrelated to the original purpose. An example of such a radical functional shift is the transformation of the stubby appendages, originally meant for thermoregulation in insects, into wings successfully used for flight in birds. Another example; the vocal cords, which were originally designed as watchdog of lungs, to *protect* the respiratory passage from the food particles passing through the food pipe near the voice box, or to produce sounds to communicate, are now being used for musical skill and theatrical expression in the human beings.

Similarly the human brain that was originally meant for responding to environmental signals through a central command structure has been probably exapting toward nonsensory perception. The human brain is not merely an information processing system through a hierarchy of command structure. Neither it is a closed box with sensory antenna as the only window to interact with the environment.

The brain could experience three kinds of perception, namely sensory, extrasensory and nonsensory. Nonsensory perception is the most primitive form of perception which is known to exist even prior to the formal development of a brain. Sensory perception has evolved with the development of the sensory apparatus and differentiation of sensory brain. Extrasensory perception could be an extraordinary mental faculty, which might have neural correlates in the cortical sensory association areas. In the primitive brain,

nonsensory perception outsmarts the sensory perception. In a developed brain sensory perception predominates. The purpose of evolution of brain as an organ is, however, to unify the consciousness inside and the consciousness outside the brain. Further development of nonsensory perception is one of the mechanisms toward this accomplishment. Once it happens, the brain gains access control to nature's nest IV (see section NATURE-CONSCIOUSNESS). Then begins the culmination of evolution. Sociocultural evolution which the humans have so far noticed seems only a passage in this directed journey; probably this compelled many mystical visionaries (e.g. Sri Aurobindo, Teilhard de Chardin) to predict emergence of the divine being from the present human being. In the language of science this emergence may be the emergence of *Homo spiritualis* (supracortical being) from *Homo sapiens* (the cortical being) (see also section FUTURE OF THE HUMAN BRAIN).

## The Human Brain

The principal content of the cranial cavity is the brain; it is nearly 1.5 kg (3 lb), fleshy, soft, pink, and is covered by three layers (meninges) - dura, arachnoid, and pia, respectively from the exterior to the interior. The subarachnoid space contains the cerebrospinal fluid. A barrier between the brain and the blood protects the brain from every chemical happening in the blood. This barrier is weak in eight areas of the brain in its circumventricular region. The brain (along with its meninges) extends downwards as the spinal cord through the **foramen magnum**.

The brain stands on the brainstem which comprises the medulla, the pons, and the midbrain. Eleven pairs of cranial nerves (II–XII) originate in the brainstem. Also, the brainstem houses three biological clocks; the inspiratory-expiratory clock (oscillation time 3-4 sec) which regulates the pulmonary gas exchange lies in the medulla, the NREM/REM clock (oscillation time 90-100 min) in the pons, and the activity/rest clock (oscillation time approximately 24 hr) in the midbrain. All these are interlinked and connected with the suprachiasmatic nucleus of the hypothalamus which is concerned with the **circadian rhythms**. The brainstem is also the site for regulation of the behavioural state by sensory motor integration and neuromodulation. Injury to the brainstem or an infective lesion such as poliomyelitis is not compatible with life.

The pons, the medulla and the overhanging cerebellum constitute the hindbrain. All the vital centres, namely the cardiac centre, the vasomotor centre, and the respiratory centre lie in the hindbrain. The cerebellum occupies less than one tenth the volume of the brain, but has much more neurons than the rest of the brain. It works for coordination and measuring metrics of movements and balance, and acts as a comparator of **servomechanism**, and also participates in maintaining mental agility and metric of thought.

The midbrain is mostly concerned with vision and extrapyramidal coordination.

Superimposed on the brainstem is the forebrain which comprises the diencephalon, the telencephalon, the limbic brain and the thinking brain. In the diencephalon is the

thalamus which is the antechamber for the cortex. All nerve fibers coming out or going to the cerebral cortex pass through the thalamus. The limbic brain is mainly concerned with feelings and emotion. The caudate and the putamen of the basal ganglia region are concerned with motivation.

Ventral to the anterior end of the thalamus is the hypothalamus. In the hypothalamus “lies the very mainspring of primitive existence - vegetative, emotional, reproductive - on which with more or less success, man has come to superimpose a cortex of inhibition”. The hypothalamus remains the integrative centre (Card et al 2003) essential for survival and reproduction, and in the human being it is coupled with emotion. The survival of the human being is achieved by (i) homeostatic control of blood glucose, electrolytes, lipids and osmotic balance, and (ii) means of behavioural control (fight or flight reaction). The hypothalamus controls reproduction both at the level of gametogenesis and at that of mating reflexes.

The thinking brain, i.e. the cerebral cortex, comprises grey and white matter. Grey matter comprises neurons which are information processing units; the white matter comprises millions of networks. Neuropil is relatively an acellular synapse-dense area. There are short horizontal as well as long horizontal cortico-cortical connections and long vertical sensory and motor connections to and from the brainstem and spinal cord. The front heavy thinking brain has two hemispheres divided into four pairs of lobes, namely frontal lobes, occipital lobes, temporal lobes, and parietal lobes. The frontal lobes are concerned with high level coordination in thinking, planning and execution. The occipital lobes take care of mainly vision, and the temporal lobes the auditory function. The parietal lobes are concerned with primary sensory perception and sensory motor integration. Within the temporal lobes there are the hippocampus (which resembles a sea horse in shape) and the amygdaloid (which is almond-shaped).

The cerebral hemispheres are two, which are connected by several commissural systems including the millionaire in fiber count, the corpus callosum. Sperry's (1968) experimental and clinical researches on corpus callosum have convincingly proved that the two hemispheres are concerned with different functions. The left hemisphere is called the categorical hemisphere; the right hemisphere is the representational hemisphere. The neural infrastructure for self-awareness and verbal speech has a left hemispheric bias. Arithmetic and logic, quantification and assertion are outputs more of the left hemisphere, while geometry, qualification and representation are outputs more of the right hemisphere. The hemispherical bias could be grossly linked with gender; the left hemisphere is more active in the male, and the right hemisphere in the female. Evolutionarily, the two hemispheres might represent the brains of chimpanzee (a patriarchal society with anger and aggressiveness) and bonobos (a matriarchal society embedded in love, sex and empathy). The outline diagrams, Figs 2-4, in Chapter 4 “Cultural Evolution – Perspectives and Problems” would help appreciate the description of the brain in the foregone paragraphs.

There are about  $10^{11}$  neurons in the brain. (Interestingly this number is the same as that of the stars in a galaxy and that of the galaxies in this universe). Each neuron,



particularly the neurons in the cerebral cortex has on average 10,000 synaptic connections. The synapse is a neuroneuronal junction, and it is the site for chemical transmission. There are two types of synaptic neurotransmitters - transmitters of small molecules (e.g. some amino acids, acetylcholine, biogenic amines), and transmitters of neuropeptides (e.g. opioids, somatostatin, gastrin). Both can coexist and could be co-released. The chemistry of the brain is related to different states of consciousness such as sleep/wakefulness, depression/mania, anxiety/complacence, and different psychedelic states. The 'chemical brain' is more primitive than the 'electric brain'. Peptides such as endorphins were made inside cells long before the evolution of dendrites, axons or even neurons! The molecules of emotion (Candace 1997) work through the chemical synapses.

In the sensori-motor area of the cerebral cortex, one could find a hierarchical organization of six functional areas, namely (i) primary sensory area, (ii) unimodal sensory association area, (iii) multimodal sensory association area, (iv) multimodal motor association area, (v) premotor area (unimodal motor association area), and (vi) primary motor area. The term unimodal means having only one sensory/motor input, and multimodal means having more than one sensory/motor input. The three well-defined multimodal association areas are (i) the posterior parietal cortex, (ii) the anterior (prefrontal) cortex, and (iii) the medial temporal (limbic) cortex.

For the material scientists, four fundamental hierarchical levels of brain functioning – molecular, cellular, system, and behavioural levels – are supposed to explain completely all the behavioural properties of the brain. In their vocabulary there is no mention of mind, psyche or consciousness. For them these are emergent properties and do not have primacy over brain function.

### ***Extraordinary Properties of The Brain***

The brain has several extraordinary properties. Seven of them are briefly considered.

1. Although the brain appears as the seat of conscious awareness, it is in fact the most unconscious organ of the body. Except on its three protective coverings there is no receptor of any kind of sensation in the brain. One could cut, pulp, and lacerate the brain without it experiencing any pain or any untoward sensation. Therefore, the saying that the conquest of brain is the conquest of the 'unconscious' might be right.
2. The brains of individuals of the same species vary in several parameters. In the human, this intraspecies variation in response to the same stimulus is amazing! Probably it is because of the differences in conditioning of the 'self', in the complexity of networking, and in communication skill.
3. Unlike other vital organs such as heart, kidney and liver, at least some part of the brain goes to the rest phase (sleep) periodically. In fact, if one is compelled to keep awake beyond a critical period of time, one loses sanity.
4. In its structured organization the cerebral cortex is a perfect mixture of primitiveness and sophistication, and simplicity and complexity. The 'primitive' and the 'simple' neurons are situated in the superficial layers, i.e. layers one, two and three, while the 'sophisticated' and the 'complex' neurons are situated deeper down, i.e. layers four, five and six of the cortex.
5. The brain is the only organ in our body which grows in both horizontal and vertical directions. Probably it is meant for corporization of both dimensions of nature, the

horizontal and the vertical. In the horizontal dimension the brain has grown as left and right hemispheres. The horizontal saturation inspires the organ to grow vertically. The consequence of vertical growth is lateralization in horizontal direction. Vertically the human brain *per se* is a composite of reptilian, mammalian and human brains.

6. The brain is vertically open. Its cortical neurons are open to information in the supracortical domain (Mukhopadhyay 2000).

7. In our body the brain is the only organ which is said to be involved in dream, imagination and perception of the domains that are beyond the brain. Probably the brain is the only organ that is still 'open' to nature through transcortical routes!

We reach the crucial point of criticism and skepticism when we forward the argument that beside the five senses the human beings have access to their environment through the upper layers of the cerebral cortex also. The fall out of this argument is, as mentioned earlier, that there are three kinds of perception, namely sensory, extrasensory, and nonsensory perceptions in human beings. The extrasensory perception may be a part under the large umbrella of the supracortical phenomenon, and it is a *sensory* experience without involving the sensory routes *per se* (for example, clairvoyance). The supracortical stimulation of the sensory association areas by information nonlocally communicated (Type II and I) to the brain could be the reason for this.

Nonsensory perception may be a part of the supracortical consciousness. It is an experience which is not sensory; neither its origin is from stimulation of any part of the sensory route. The nonsensory perception originates most likely from the supracortical stimulation of the vortex of the brain by information nonlocally communicated (Type III) to the brain. It involves the paracentral lobules, where the private facets of the 'self' have their neural infrastructure! When successfully transmitted, the message spreads directly and immediately to the limbic nuclei. This explains the emotional nature of the experience, which is often difficult to articulate in third person's perspectives. Because of the involvement of the emotional brain, it leads to selective sensory and motor sensitization.

Nonlocal communications of type I (that are supposed to occur dissolving the barrier of space) and of type II (that are supposed to occur dissolving the barrier of both space and time) may be the mechanism for evoking a supracortical phenomenon in general and an extrasensory perception in particular. Nonlocal communication of type III (that is supposed to occur dissolving the barriers of space, time and causality) may be the mechanism for evoking a supracortical consciousness in general and nonsensory perception in particular.

## THE MIND

As a concept, mind does not exist in any monism, be it materialistic or idealistic monism, or monism of consciousness. Mind originates within the duality of consciousness. Mind cuts consciousness into two and acts as an organ of communication between the two conscious systems. This division is only apparent because in the *akhanda worldview* matter, mind and consciousness form an indivisible spectrum.

## What is Mind?

Mind has been defined differently in scientific and philosophic literature. It would be sensible if we define mind as that which works as an ‘organ’ of communication between two conscious systems, namely the brain-bound and the brain-independent consciousness. Therefore, mind has all the organismic properties.

As there are ‘layers’ of consciousness, so also there are ‘layers’ of mind. Like consciousness, mind also cannot be localized. As consciousness is independent of space and time, so also is mind. Consciousness could be brain-bound or brain-independent. So is the mind. However, there is a difference. Mind processes the information; consciousness does not. Mind could never be information-independent. Consciousness *unconditional* is completely independent of information.

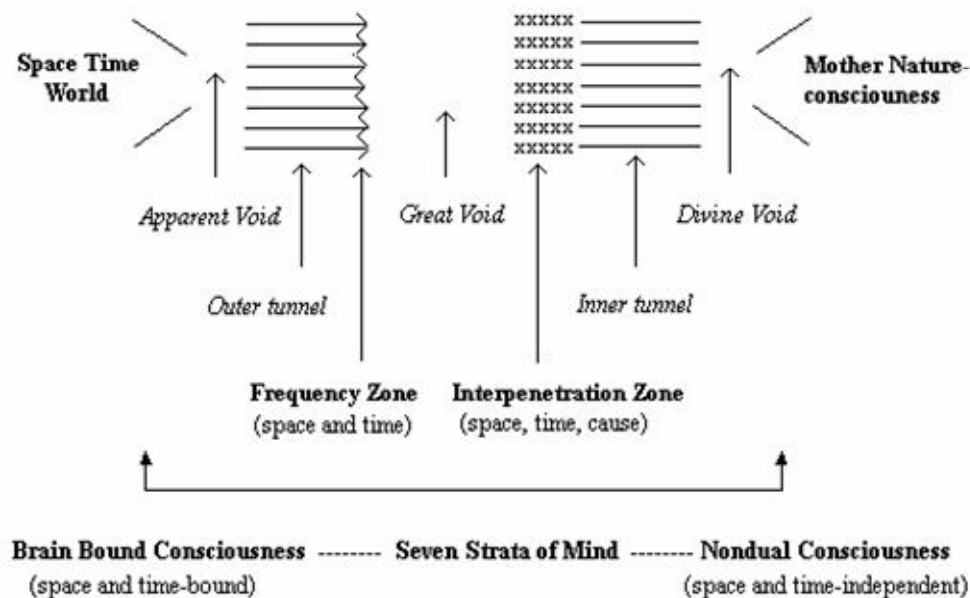
In *sāṅkhya* philosophy, mind is the original sense organ. The important functions of mind are: (i) deliberation on different choices (sense mind), (ii) discrimination and decision making (intelligent mind), (iii) anchoring sensation and decision to conditioned could be that which induces consciousness (*purusha*) to identify with nature (*prakṛti*). existence (ego mind), and (iv) storage, retrieval and recollection (*chitta* mind). Ego<sup>2</sup> could be that which induces consciousness (*purusha*) to identify with nature (*prakṛti*). “*Buddhi* is at once intelligence and will. The subjective principle of *buddhi* is ‘*ahankār*’ by which the *purusha* is induced to identify himself with *prakṛti* and her activities.” (Sri Aurobindo)

Is there a mind inside the brain? The answer to this question depends on what one considers the ‘unit’ of consciousness in the brain? If we accept that each neuron is the unit of consciousness in the brain, then the tentative seat of mind is in the synapse. This could explain how a change in the synaptic chemistry could be the cause of a change in the mind. For example, the biochemical serotonin leads to a depressed state, the cannaboids (narcotic principles from the hemp plant) lead to an intense feeling of well being, excitement and hunger, and the opioids (narcotic principles from the opium plant) lead to a painless state. Gazzaniga (Gazzaniga & LeDoux 1978) demonstrated that the two cerebral hemispheres have independent ‘mind’ (in the western literature, the terms ‘mind’ and consciousness are often used synonymously).

If we accept the cosmos as organic, the ‘mind’ of the universe could be in the way it communicates with the *essence* from which the multiple universes (multiverse) have emerged. Then the mind of the universe could be found within this boundary! The mind of a unicellular organism could have representative structure and process in its cell membrane. When we consider ‘self’ as an informed unit of unconditional *consciousness-as-such*, the layer of mind which is involved as an ‘organ’ of communication between the self and the *consciousness-as-such* could be what Sri Aurobindo characterized as super mind. This layer of mind has no ‘seat’ in the complexity of the organ brain.

Mukhopadhyay (1995, 2006) has suggested a model of mind which would represent both its structure and process (Fig. 1). Matter-mind-consciousness forms an indivisible

stretch. On one side, the mind is in connection with the matter, and on the other side the mind extends to consciousness. With the definition that mind works as an organ of communication between the two conscious systems, one could find seven strata between the space and time-bound Newtonian nature (classical consciousness) and the nature of multiverse, i.e. the boundless consciousness from which several universes originate. There are three `voids', two `tunnels' and two transitional frequency zones as shown in Fig. 1. In astrophysical scale, the apparent void is represented by the interstellar space, the great void by the intergalactic space, and the divine void by the interuniversal space.



**Fig. 6.1** - Structure and process of mind. The seven arrows of different lengths represent the seven strata separating and connecting the brain-bound consciousness (i.e. Space Time World shown on the left) and the Mother Nature-Consciousness shown on the right. Between these two conscious systems, there are two tunnels and three voids. On one side of the Great Void is the Frequency zone (space/time) and on the other side the Interpenetration zone which interprets space, time, and cause.

One can find an astonishing similarity between the strata of mind and the construction strategy of the birth canal (uterine canal). To meet the ‘mind’ of an ovum, the ‘mind’ of a spermatozoon has to pass through three voids (namely the vaginal space, the uterine cavity and the ampulla of the fallopian tube), and two tunnels (cervical canal and the isthmus of the fallopian tube). Fertilization takes place in the third void.

## Theory of Mind

The theory of mind (TOM) merely means that the communicating person understands that the other person with whom the communication is established also possesses a mind. In TOM, the terms mind and consciousness have been used synonymously. A person in communication with another can read the mind of the other person in terms of content and intentionality. Even a neonate can read the ‘mind’ of his/her mother by watching her gaze. This could be the beginning of understanding the other’s mind as far as the ‘local’

communication (communication in space and time) is concerned. Language, verbal or nonverbal, is important in the development of this ability to recognize and read the other's mind.

Some recent experiments have suggested that even the nonhuman primates understand the other's mind. Some people can read the mind of their pets or even the 'mind' of the plants and flowers in their garden. Conversely the pet can also read the mind of its master. Even plants can understand the affection of the gardener! Developing connections with the nature is a skill. With meditation and yoga, the mind reading ability of human being could scale new heights.

## CONSCIOUSNESS

Consciousness is the ground independent of any background. It is the ground Reality of Nature. Consciousness is like the spider, which weaves its web, but itself is outside the web. Consciousness could be brain-bound or brain-independent (see section NATURE-CONSCIOUSNESS). The Sanskrit terms, *chetna* and *chaitanya* may well mean the brain-bound and the brain-independent consciousness respectively. For the scientist however, consciousness is neurocentric; i.e. it is centred on neurons within the brain. Consciousness should be distinguished from conscious experience. Conscious experience is always in the context of a brain or a brain-like structure and process in nature. In describing the relation between brain and consciousness the scientist prefers the theory that consciousness *emerges* from a group activity of millions of neurons. The mystics propose an embedded worldview. According to this view, consciousness appears indissolubly wedded to the brain. It could be explained on the basis of a *neuronophilia* of consciousness, and *consciousness-philia* of neurons (i.e. a specific affinity of neurons to consciousness, and of consciousness to neurons).

### **Biologist's Riddle: How do we become Conscious of Something?**

Until 1990, how the unconscious activities in the brain reached the level of conscious perception was an enigma. However, subsequent researches in neurophysiology, electrophysiology of individual neuron, electrocorticogram, and basic electrophysiological recording of activities of the cortical and deeper neurons, along with the help of advanced technologies such as PET and fMNR have thrown much light on the mechanism of 'awareness' in the brain.

The development of conscious awareness is gradual. It begins with the general awakening, the neural correlates of which lie in the brainstem, the thalamus and the cortex. The access and control to the *contents* of consciousness are achieved through the frontoparietal connections to the posterior attentional areas in the PSPL (posterior superior parietal lobule).

Edelman (1992) distinguishes primary phenomenal consciousness from self-awareness. Animals could have phenomenal experience without having anything to 'attach' the experience to; they lack the notion of self. Crick and Koch (1990) have

ascribed consciousness to 35-75 Hz neural oscillations in the cerebral cortex. It is not known however, whether these oscillations are an observable aspect of consciousness or they form the basis of consciousness.

To develop conscious awareness, the interaction of the brainstem and the forebrain is vital. Damage to either region produces characteristic disturbances in consciousness. The lower brainstem injury leads to *locked-in state*, in which the subject, although awake, is unable to interact with the external world (Iversen et al 2000). The forebrain injury leads to *persistent vegetative state* which is characterized by contentless wakefulness and contentless wake-sleep cycle. Each hemisphere of the brain is independent of the other. Sometimes the two hemispheres issue interfering or even opposing commands.

Self-awareness about an external experience may extend as full-fledged attention concentration, meditation, and *samādhi*. Attention is selection and focusing; it has a hemispherical bias. Concentration is focused scanning of the experience; in concentration, the aim is to make this bias nil. Meditation is getting absorbed into the experience. Transcendental process begins at the depth of meditation. *Samādhi* leads to subject-object unification. In meditation, there is synchronization of vertical hierarchy in the nervous system as a whole and within the layers of the cerebral cortex in particular.

It is possible to make a few generalizations about the generation of conscious awareness. A 'huge' unconscious processing supports conscious awareness. Vertical reticular fibers are meant for general or global awakening determining the states of consciousness, while long horizontal intracortical loops are for *contents* of consciousness and for access control (fronto-parietal connections) to those. The state of consciousness determines the conscious behaviour, while the contents of consciousness determine the unconscious automated behaviour. Automated behaviours are inflexible. Neurologically they exhibit bottom-up recruitment. Conscious behaviours are flexible. They handle information on goal and means, and neurologically exhibit a top-down recruitment. The depth (level) of consciousness depends on the size of the assembly of neurons recruited, the degree of complexity involved in their synaptic connections, and the quantity and the quality of information the neuronal assembly is engaged in integrating. While the theme for sensory analysis is 'divide and rule', the theme for memory and learning is 'synthesis', and that for conscious behaviour is acquisition of information relevant for goal and means, and its coordination with what is already available in the sensory-motor-memory system.

Pribram's (1991) experimental research on monkeys and chimpanzees, and clinical research on neurologically challenged persons suggest that the brain processes the information in the hierarchically located three-tier system. The tiers are independent but are interconnected with each other. Pribram emphasizes that there exists two other types of brain mechanism, one for referential or semantic processing, and the other for conscious processing. Cotterill (1997) is of the view that awareness is a composite of perception, cognition and action. In cognition and perception, a kind of readiness for action is implicit. McFadden (2002) has developed a theory of consciousness on the basic neurophysics. According to his conscious electromagnetic information (CEMI) field

theory, 100 billion electrically active neurons generate an endogenous electromagnetic (em) field and a concomitant information field in the brain. And in this context, the brain processing can be bifurcated into processing which is insensitive, and processing which is sensitive to the endogenous electromagnetic field within the brain. McFadden asserts that “The key to consciousness is not the presence of em fields, but their ability to transmit information to motor neurons.” and the “Agents that disrupt the interaction between the brain’s em field and neurons will induce unconsciousness.”

Besides the three classical neurophysiologist’s views mentioned in the previous paragraph, quantum physicists, and the researchers on neural network, artificial intelligence, and expert system, have their own views on generation of awareness. While Marshall (1989) opined that conscious decision making is in some way associated with the formation of Bose-Einstein condensates in the brain, Hameroff and Penrose (1996) have described conscious events as orchestrated space time selection. On the other hand, Scott (1996) has emphasized the explanatory power of classical nonlinear theory, which when properly appreciated, could “obviate the need for turning (in desperation, one may say) to quantum theory as a source of the mysteries of mind. At the same stroke, it rescues neural network theory from the shallows of narrowly conceived functionalism”.

### **Levels of Conscious Awareness**

Besides object-awareness, which forms the basic level, there is another kind of awareness called the reflective awareness, which is equivalent of cognitive consciousness. ‘That I am aware that I am aware’ is cognitive consciousness. There is yet another level, level three from where the self could cognize consciousness (Rao 2005). This ability to distinguish ‘self’ from consciousness could happen only with a primed ‘self’. The lower levels have no serious business with transcendence. Between a primed ‘self’ and *consciousness-as-such* there exist several layers that could only be known by practice of transcendence. In the total spectrum, toward the bottom level there is more of brain processes than the involved mind. At level three, there is much of mind applied to the brain processes. Awareness across the transcendental layers indicates gradual ‘thinning out’ and final dissolution of mind. At this level, perception is independent of sensory apparatus and is free from cognitive bias. This is probably what has been called *direct experience*. The author prefers to call it the experience of supracortical consciousness, which is an outcome of nonsensory perception of the brain-independent consciousness by the brain-bound consciousness.

### **States, Contents, Levels, Developmental Lines and Planes of Consciousness**

Human consciousness could be discussed as *states* of consciousness, *contents* of consciousness, *levels* of consciousness, developmental lines of consciousness and *planes* of consciousness. It is Ken Wilber (2000) who first categorized the description of human consciousness in this way. It has been done here preserving the *Akhanda* Worldview with modern knowledge of neuroscience.

Interaction of the self with its brain results in experiencing phenomenal and non-phenomenal *states* of consciousness which have their respective contents. The organizing capacity of experience and the self's enduring use of the neuroinformational infrastructure of the brain could create in the long run some more or less permanent *levels* of being conscious. Being conscious at any level has access to different states of consciousness through the self. Besides, there are three developmental *lines* in the brain, namely cognitive, psychomotor, and affective lines of development. The descriptive word 'plane' is usually chosen to characterize the subconscious planes or planes of nature-consciousness.

### ***States of Consciousness***

There are basic, altered, existential, higher, and pathological states of consciousness. Wakefulness, dream, and dreamless sleep are the three *basic* states of consciousness. Psychedelic and holotropic are two of the many *altered* states. Existential states are the *states of experiencing elementary phenomena*. The higher state of consciousness includes the *transcendental/spiritual* state. Depressive state, manic state, 'locked-in' state, and vegetative state are some of the pathological states of consciousness.

The various states of consciousness could be explained to some extent by neurotransmitter substances such as adrenaline, acetylcholine, dopamine and serotonin at the synapses. The psychedelic agents are known to alter the levels of neurotransmitters.

### ***Contents of Consciousness***

The contents could be perceptual, emotional, imagery, and of memory; on the motor side, the contents could be of self-talk and autosuggestions. Whereas the state of consciousness determines the conscious behaviour, the contents of consciousness determine the automated unconscious behaviour of the subject. Sleep is no exception to this rule. Automated conscious movements in sleep are guided by the content of consciousness. In the aforementioned states, the contents of consciousness may be similar or different.

*MEMORY AS A CONTENT OF CONSCIOUSNESS* – According to the re-entry theory (Edelman 1992) memory is the cardinal sign of existence of consciousness. However, consciousness could exist without memory, and without any content, as contentless consciousness. Human being has different kinds of memory (Eichenbaum 2003, Miyashita 2004), each having a definite neuroanatomical basis. All forms of memory involve the cerebral cortex. The seat of short term memory or working memory is the prefrontal cortex.

Long term memory is declarative, procedural, or emotional. Declarative memory could be of facts (semantic memory) or of events (episodic memory). It is explicit and flexible. Its anatomical base is the hippocampus and the neocortex. Both procedural memory and emotional memory are relatively inflexible. Procedural memory involves neocortex, cerebellum and brainstem, and is responsible for execution of procedures and skills. Emotional memory refers to conditioned preferences and aversion; it involves the cortex and the amygdala. In the psychospiritual language, the memory-stuff has been called *chitta* (cf. Patanjali's *Yoga Sutra*). Acute multifocal or diffuse impairment of the



content of consciousness is neurologically called encephalopathy. Psychiatrists call it acute organic brain syndrome. Chronic impairment of memory is designated dementia. Dementia is debilitating deterioration in more than one domain of cognitive function. It is in contrast to single domain deterioration such as aphasia (only speech loss) and amnesia (only memory loss).

### ***Levels of Consciousness***

Within the bounds of the brain, there are seven levels of being-consciousness (Mukhopadhyay 1989). According to MacLean (1973):

We are obliged to look at ourselves and the world through the eyes of three different mentalities - two of which lack the power of speech. The human brain amounts to three interconnected biological computers, each with its own special intelligence, its own subjectivity, its own sense of time and space, its own memory, motor and other functions.

In the supracortical domain, there could be three levels of being-consciousness, namely (i) supracortical being, (ii) supracortical godhead, and (iii) supracortical autonomy. These levels have parallel in Wilber's (2000) description respectively of the levels of saint-consciousness, sage-consciousness and *siddha* consciousness. According to the spiritual tradition of India, these three levels of consciousness could be those of a *brahamachāri*, a *swāmi* and a *paramahansa* respectively.

### ***Developmental Lines and Planes of Consciousness***

Development is an inevitable consequence of the process of education in the experiential. Education is defined as a process to bring about desirable changes in the behaviour of the learner in terms of knowledge, skill and attitude, and thus takes care of the cognitive, the psychomotor, and the affective aspects of brain function. The developmental lines in the process of individuation are therefore three – cognitive, psychomotor and affective.

The term 'plane' of consciousness is usually used in the context of description of nature-consciousness. It is also used in description of the subconscious planes.

## **INTERRELATION OF BRAIN, MIND AND CONSCIOUSNESS**

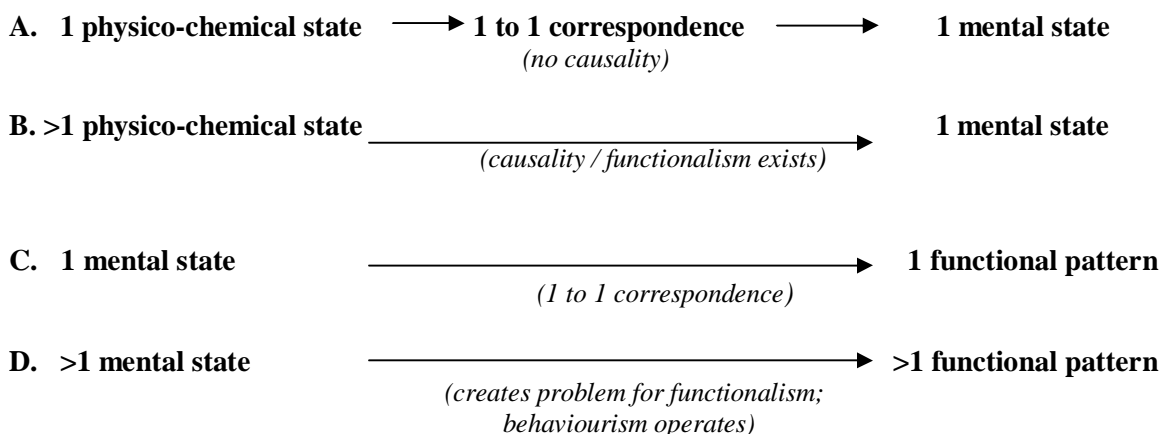
It has been mentioned that consciousness, mind and brain work as an indivisible unit. In this section the connections among the three are described (i) in terms of neural correlates of consciousness, (ii) in the context of 'self', (iii) as connections in the composite model of psyche, and (iv) in terms of mechanism of psychosomatic connection.

### **Neural Correlates of Consciousness**

Presently the consensus amongst scientists is that consciousness emerges from the networking of  $10^{11}$  neurons (Crick 1995). Crick's Astonishing Hypothesis states that "a person's mental activities are entirely due to the behavior of nerve cells, glial cells, and

the atoms, ions, and molecules that make them up and influence them.”

Neural infrastructure is surely required for the manifestation of consciousness. At the classical nest of nature, there are thus neural correlates for consciousness, or neural correspondence of consciousness (NCC). This is not so simple as stated. Four possibilities may exist (Fig. 6.2).



**Fig. 6.2** - Possibilities of relationship between brain and consciousness. In **A** there is no causal relation between the physical and the mental state. When different physico-chemical states lead to a single mental state, causality or functionalism comes into picture (**B**). Possibility **C** is one to one correspondence of a single mental state with a single functional pattern, i.e. a pure functionalism. In **D**, a single mental state could lead to different functional states, this multiple realizability option creates problem for pure functionalism and points toward behaviourism.

Thereafter, following the classical nest of nature, it is expected that there would be quantum correlate/correspondence of consciousness (QCC) in nest II of nature, phenomenal correlate/correspondence (PCC) of consciousness in nest III, and causal correlate/correspondence of consciousness (CCC) in nest IV of nature.

### **Binding Phenomenon**

Neuroscientists wonder how the activity in millions of neurons in the brain are translated into a unitary experience. How does the conscious activity of one neuron become indistinguishable from that of the other neurons? How does the conscious activity of several groups of neurons working together become indistinguishable from the global consciousness of the brain?

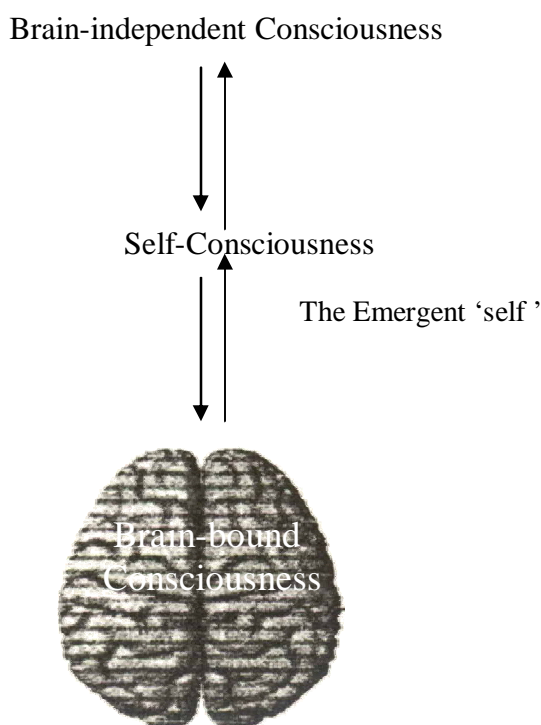
The question of such binding phenomena arises when the parts involved are considered separate entities. The notion of binding is inherent in a dualistic concept. However, if we begin with the integral divisions of an indivisible whole, then the phenomenon of binding has a different connotation. How consciousness is ‘bound’ to neurons (top-down approach) or how a neuron is bound to consciousness (bottom-up approach) is a legitimate question, with different meanings for the term ‘binding’. The close approximation of this situation is ‘avidity’ and ‘affinity’ of a signal-receptor interaction.

Binding is a mid-way step in the spectrum of integral relationship. Any dualistic relation starts with an initial connection. Once connected, binding begins; and once bound, integration of the components into the larger system starts.

It is the ‘purpose’, which binds the various units performing the group activity. Unification of the goal is only responsible for convergence of purpose. In this sense, consciousness and its intentional aspect have a primary role in binding.

### Self Connects Inside and Outside of the Brain

Self-consciousness connects inside and outside of the brain. It is the link between the brain-bound and the brain-independent consciousness. Consciousness in the context of human brain could also be visualized at three ontological levels, namely brain-bound consciousness, self-consciousness and brain-independent consciousness (Fig. 3). The upanishadic scholars use a different terminology to describe these three ontological levels: *jivātman*, *ātman* and *paramātman*, respectively.



**Fig. 6.3** – Three ontological levels of consciousness. The ‘self’ connects the brain-bound and the brain-independent consciousness

Unconditional *consciousness-as-such* is impenetrable and unifying, and has a mechanics for its intention asserted by its own nature. The consciousness in the context of organ brain could be better described as *conscious experience*. Conscious experience has the same three properties as the *consciousness-as-such* namely privacy, binding, and intentionality. This concurs with Edelman’s (1992) characterization of any conscious

state as being private, integral, and differential. For conscious experience and for experiencing the consciousness one requires a brain (as in the human being) or a brain-like structure and process (e.g. in nature-consciousness).

Self-consciousness could be regarded as an emergent property in the brain-consciousness relationship, or as an informed descendent of unconditional consciousness. According to the former view, self-consciousness is the result of an effort of consciousness to free itself from the entanglement and encasement inside the brain. Self could also be considered an indivisible spark of unconditional consciousness, which has to work within the constraints of the brain.

Based on whether the ‘self’ is linked to the brain-bound or the brain-independent consciousness, or the ‘self’ remains as a ‘spark’ of the unconditional consciousness, the body or the *sarira* attains different states (Table 6.1).

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**TABLE 6.1 – THE CORRELATES BETWEEN ‘SELF’ AND CONSCIOUSNESS \***

SELF	NATURE OF BODY	NATURE OF SARIRA
Brain-bound	Gross	<i>Sthula</i>
Brain-independent	Subtle	<i>Sukshma</i>
As an indivisible spark of unconditional consciousness	Causal	<i>Kāraṇa</i>

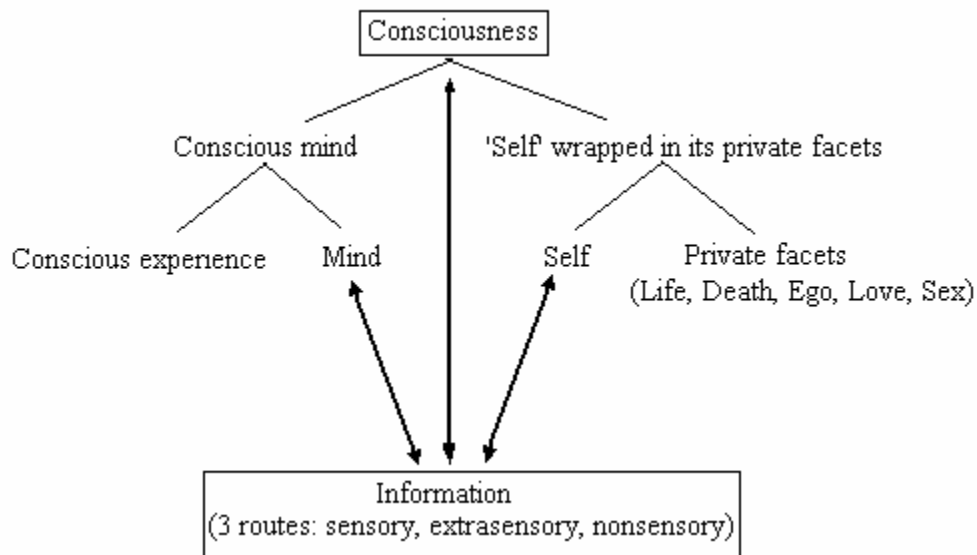
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### **Connection in the Composite Model of Psyche**

Sir John Eccles proposed a putative mental unit which he termed ‘psychon’. At a more concrete level it is proposed that the psyche is a complex structure and process of the five integral elementary ingredients (Mukhopadhyay 2005), namely (i) consciousness, (ii) self, (iii) mind, (iv) private facets of self, and (v) information (Fig. 4). In psyche consciousness forms the ground reality on which the four other elements work to produce a conscious experience. ‘Individualized’ unit of consciousness is the ‘self’; it is the second ingredient of psyche. Self is an informed consciousness – informed in the sense that (i) it is an indivisible spark of consciousness, (ii) it has to work within the given constrain of the system, and (iii) it is eventually the bridging element between the system-bound and the system-independent consciousness. In human beings this system is the brain. With the birth of this duality, i.e. conditional consciousness as self and unconditional consciousness as the ground reality, there appears a working organ of communication between the two. And this organ is the mind, and it is the third ingredient of psyche.

The ‘private facets’ of self constitute the fourth component of psyche. In psyche the ‘self’ is wrapped with the private facets, which it acquires during its genesis from the *unconditional consciousness*. The five facets are the outcome of an interplay of (i) desire, (ii) sacrifice/sharing, (iii) birth of something new in the system, and (iv) conditioning of

existence which is apparent, and (v) conditioning of existence which is evanescent and would vanish one day. The private facets are, therefore, five namely – sex, love, life, ego and death. Also, the five facets constitute the five elementary phenomena, which everyone and everything has to go through. And these five phenomena form the terrain of elementary phenomenology that connects the depth phenomenology of mind and consciousness with the surface phenomenology of the classical and quantum nests of nature.



**Fig. 6.4** — Integral ingredients of psyche

The great leaders of human psyche have emphasized one or the other private facet of self. Sigmund Freud, for example, emphasized the most important and powerful facet, the sex, Carl Jung the mechanics of love, Alfred Adler the ego, and Abraham Maslow the hierarchy and need in life which make life meaningful. Sri Aurobindo (1970) stressed the necessity of physical transcendence of death for the birth of the 'divine' self. Significantly the five facets of self are transcultural, transreligious, and constitute the basic motivational elements in psycho-biology. They may well be called the elements of subjective experience (Nagel 1974).

The fifth component of psyche is information, which makes psyche dynamic. In fact, psyche is an information hub. Even in what appears as silence, psyche continues to process or even generate information. It is information that connects cosmology and psychology, system-independent consciousness and system-trapped consciousness. Information itself has a mechanics; information mechanics is different and independent from classical and quantum mechanics. In fact, many of the behaviours which appear as quantum paradox could be explained by information mechanics. Psychic mechanics and information mechanics are inextricably connected.

If one carefully examines the elementary ingredients of psyche, there is no mention of brain! Does it mean that brain is not necessary to have a psychic function?

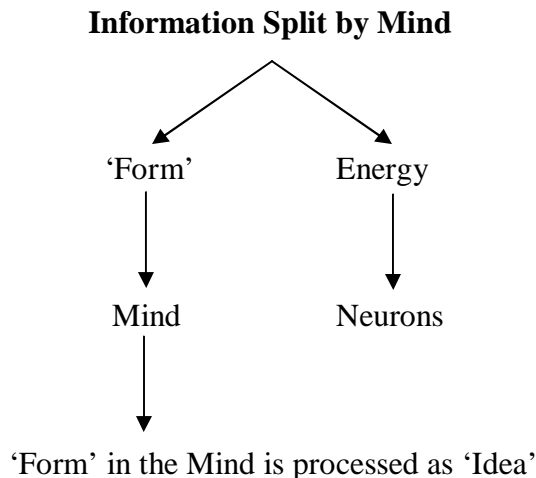
Probably not, if we understand brain in an unconventional way! Psyche could be brain-bound, or brain-independent. However, the psyche works either being embodied in a brain or through a *brain-like structure and process* in nature which are yet undetectable by methods presently available in science, and have probably evolved into an organ as the brain through a journey what we call biological evolution.

What is intelligence then? Intelligence is the measure of response of psyche to a phenomenal or informational input. Like psyche, intelligence could also be brain-bound or brain-independent. Where there is composite integration of consciousness, mind, and self wrapped in the private facets and information, we could expect an intelligent response to a phenomenal or informational input. Therefore, there could be nature-intelligence, cosmic intelligence, and supracosmic intelligence as well.

### Psychosomatic Connection

The basis of psychosomatic connection could be found in the process of ‘splitting’ information. Information has a ‘form’ inside. This ‘form’ is brought out by means of an *inside out* phenomenon executed by the mind-consciousness (nest IV of nature). A prepared and primed mind in the psyche chooses to ‘conceive’ specific information only to deliver a ‘form’ and some energy. ‘Form’ is processed as ‘idea’ in the mind and, energy goes to neurons (Fig.6.5).

The brain is the seat where psychosomatic (and psychospiritual) connections are realized. As the integral ingredient of psyche, mind plays the crucial role in splitting the information.



**Fig. 6.5** - Information-split hypothesis. Information is split into space time (i.e. form) and energy, by activity of mind.

### ***Psychosomatic Interaction during sleep***

Psychosomatic connections work not only in wakeful conscious state but also during sleep. Conservation of both energy and information is an important function of sleep. Bennington and Heller (1995) propose that NREM sleep restores brain glycogen reserve (anabolic effect). Studies on sleep deprivation in rats have shown consecutive development of (i) an inability to maintain body weight in spite of good feeding, (ii) a thermostatic imbalance, and (iii) an overwhelming sepsis due to immune deficiency (Rechtschaffen & Beogman 2002). In addition, REM sleep is intricately linked with the formation of procedural memory, whereas slow wave sleep (SWS) is linked with the formation of declarative memory (Stickgold et al 2001). Sleep is a phase when some information is also expelled from the brain.

## **FUTURE PERSPECTIVES OF THE ISSUE**

There are several unanswered questions in the brain-mind-consciousness issue. For example, which one is primary, the brain or the consciousness? Did 'mind' originate first, or the consciousness? Does mind come out of brain or the brain is an outcome of cosmic or supracosmic mind? The response to these issues is not easy. However, we could prepare the field so that one may address these issues appropriately in the future. To prepare the platform, we would discuss (i) nature's intelligence, (ii) nature-consciousness, (iii) involution as an integral part of the process of evolution and creation, (iv) 'receptor' properties of the cerebral cortical neurons, and (v) the future of human brain.

### **Intelligence in Nature**

“Consciousness is evaluated clinically as the ability of the individual to respond appropriately to environmental stimuli” (Kandel 2000a). Appropriate responsiveness to an environmental stimulus is the hallmark of the presence of consciousness. *Eigenresponse to eigenstimulus* is the scientific measure of consciousness and it forms the basis of awareness test. It is true for both nature-consciousness and brain-consciousness. Nature responds differently in her different nests, and the requirement of stimulus for each nest is specific. Intelligence is measured as a response of the psyche to the informational or phenomenal stimuli.

The great philosophers of science and the scientists who have gone into the depth of nature (e.g. Einstein) have believed that the parsimonious nature has its own way of doing and managing things, and nature does it *intelligently*. But the problem is that we are not *yet* able to establish the presence of this intelligence by currently recognized methods of science. Even before the evolution of the brain, nature's intelligence and nature-consciousness did exist. There are brainless organisms such as insects and worms that respond intelligently to stimuli. Plants interact with their environment without possessing any obvious structure similar to that of brain, but they have 'memory' for environmental cues; inside the soil, the roots of nearby plants compete for space and nutrients (Mahall & Callaway 1990).

Recently some hints about the presence of nature intelligence have started coming from the laboratories of A-life, genetic algorithm, and the programming of genes (Lewin 2005). Brian Josephson (2004) has emphasized nature's intelligence in the following words:

If we want to put God into Science, then the primary feature of God, the one which is most closely connected with the science we've got, is God's intelligence' and God as a supreme being is perhaps a little like us, but at a very much higher level of intelligence. What I want to suggest is that the new science which includes God will start by understanding and describing 'being intelligent'.

Intelligence is not like new energy source. The presence of an intelligence manifests itself via the presence of or the creation of states which are *a priori* extremely unlikely: ... intelligence manifests itself by making certain unlikely situations appear.

This kind of opinion *does not* point toward anthropomorphism wherein one assigns human-like behaviour and properties to nature. On the other hand, it could be assumed that brain-like properties and intelligence, or psyche-like function which already exist in nature, have taken an objective visible form and shape in human brain in the course of time. Human brain is a macrodesign cast in the microdesign of *brain-like structure and process* already existing in the deeper recess of nature. It has happened through the processes of creation, evolution and involution.

### **Nature-Consciousness**

An evolved brain, which could investigate consciousness, mind, and even 'self', is only a few thousand years old. In a very short span of history the human being with this kind of evolved brain has started investigating nature as *scientist*, and consciousness as *mystic*. So far, in our scientific pursuit, we have merely explored only two nests of nature, the classical nest and the quantum nest. In the former the laws and principles of Newtonian mechanics hold well. Einstein made a large-scale extension of the classical nest in his theory of relativity. In the quantum nest the laws and principles of quantum mechanics reign. Quantum mechanists have, however, remained silent on *quantum discontinuity* and *quantum void*. For them, the exploration of quantum void is an enigma and quantum discontinuity is not a scientific issue. Excluding this enigma and the 'nonscientific' issue, they could work comfortably with the properties of quantum particle/energy in mathematical terms, predict events, and do science. However, the presence of quantum discontinuity and quantum void points toward another nest of nature which is subquantum and deals with the existential issues such as conditioning, deconditioning, and reconditioning of' existence, 'ego' of particle/energy and also birth, death, and fomatation of elementary bond of sharing (love). There will be a fusion of quantum language and mystical language, should we penetrate through quantum discontinuity and try to describe the subquantum plane.



If the classical nest is numerically I, and the quantum nest is II, then the subquantum nest of elemental nature will be nest III. The nest of crystal consciousness, pure consciousness, absolute consciousness, nondual unconditional consciousness or *consciousness-as-such* is still deeper. However, consciousness is not isolated or compartmentalized from nature. Consciousness also has a nature through which it executes its mechanics. This nature forms the kinetic front, the mobile facet of consciousness, and may be called the nature of all natures or the Mother Nature. The elemental nest of nature (nest III) is connected with the Mother Nature, which may be numerically designated nest IV. The Mother Nature (nest IV) is a sub-subquantum nest. *Consciousness-as-such* forms nest V of the nature-consciousness spectrum (Fig. 6). Nests IV and V together represent the creative nature or *natura naturans*. The nests II and I are the created nature i.e. *natura naturata*. In the nest III, the nature is under transformation (*natura transformans*).

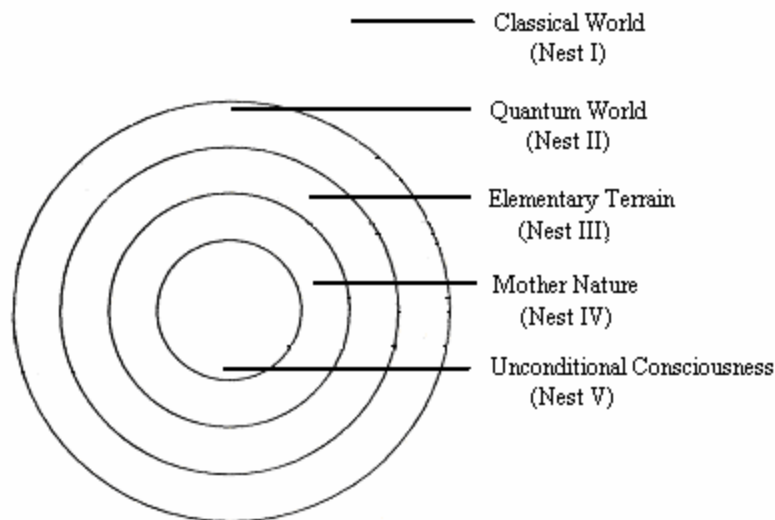


Fig. 6.6 - The five nests of nature-consciousness

Any of the five nests could be expanded almost to infinity. In the pentaune (i.e. an indivisible unit having five divisions) model of nature-consciousness (Mukhopadhyay 2000), each nest of nature has an anatomical boundary, and defined physiological activities governed by characteristic mechanics that is run by a specific 'currency'. During movement from one nest to the other, one requires 'currency' conversion.

In nest III, consciousness is as it *seems* (i.e. phenomenal), while in nest IV consciousness is as it *does* (i.e. causal), and in nest V it is *unconditional*. The *seeming* consciousness remains incomplete if the *causal* consciousness is excluded. Causal consciousness remains incomplete if we exclude its unconditional properties in nest V.

Although nature-consciousness is stratified into a five-nested hierarchy, this exploration is like penetrating through a 'point' and delving into its most rarefied depth. In *Taittirīyopaniṣad* there is a *pancha kosha* model of the human body. The pentaune model of nature-consciousness has many similarities with the *pancha kosha* described in Upanishad.

## Creation, Involution and Evolution

Whether the brain is a creation of cosmic intelligence (which is called God in folk psychology), or a product of the process of organic evolution has been a matter of debate between the fundamentalists belonging to the religious and those belonging to the scientific establishments. A dispassionate diffusion of the paradox requires a third element, namely the process of **involution**.

### *The Creation Limb*

If consciousness forms the ground reality, then from it originates information, time, space, matter, and energy. This is the limb of creation. The ‘how’ and ‘why’ of creation are not known. And as to when did creation start is not easy to answer; even to provide a speculative response, scientists get dumbfounded. Paradoxically, however, we talk of the beginning of the universal time, cosmological scheme of happenings, creation of space and matter, and in the post-**Big Bang** scenario the origin of energy, matter, quantum macro system, amino acids, proteins, RNA and DNA! To the scientist’s surprise there is nothing known about information in the creation limb! We even do not know when did ‘information’ appear in the elaborate scheme of happenings. Was ‘information’ there *ab initio*? Or, did the original information face a process of involution in the course of journey from the Big Bang to the DNA molecule? Or, is it that the *content* of information has remained unchanged, and only the *context* of the original information has undergone a severe metamorphosis in the course of evolution? It is suggested that there are ontological categories of information and unexplainable gaps between the categories.

There are two suggestions on the origin of information. (i) Life is the source of all information, or the universally available information source is the life principle (Grandpierre 2004). (ii) Information originates from the *nature* of consciousness (Mukhopadhyay 2000). The first suggestion assumes that life principle/life pool (and not life form as it is usually meant) appeared prior to information. May be it is the result of synthesis of nest IV and nest V of nature. The second view presupposes the involvement of consciousness in the genesis of information. The first kind of information works on the creation limb, and the second works through ‘self’ along the involution and the evolution limbs (Fig. 6.7).

### *The Evolution Limb*

The end product of creation process is matter. The matter takes a recourse in the journey to go back to the original unconditional state through the process we know as evolution. It happens in steps such as evolution of molecules, organic compounds, amino acids, proteins, RNA and DNA. It is followed by a momentous transition, the enclosure, the beginning of **probiotic** life. This corporality ushers the beginning of biology, the encapsulation of ‘cosmology’ into ‘cell biology’.

Following this encapsulation there is the reversal of flow of information. Prior to encapsulation information was directing toward DNA formation. Following encapsulation, information became centralized in the DNA. DNA could be considered a

stable and secure chemical information storage medium for long term use in the scale of generations where the stored information could be read and interpreted by another molecule, the RNA. Following this, we get the central dogma of molecular biology that the information flows from DNA to RNA to protein. In **prokaryotes**, the DNA is in the cytosol. In **eukaryotes** the DNA is further centralized in the nucleus.

Following encapsulation, i.e. ‘enclosure’, started a reverse journey of life form to return to the original unconditional state. The expression of ongoing information by the evolving **genotypes** with selection pressures resulted in variations in **phenotypes**. The DNA unfolded through complex life forms – from unicellular organisms to multicellular organisms such as plants, animals, fish, amphibians, reptiles, birds, mammals, primates, *Homo erectus* and finally *Homo sapiens*. In this limb of evolution, the present human being seems to be a crowning achievement of nature’s process, particularly if we look at its brain.

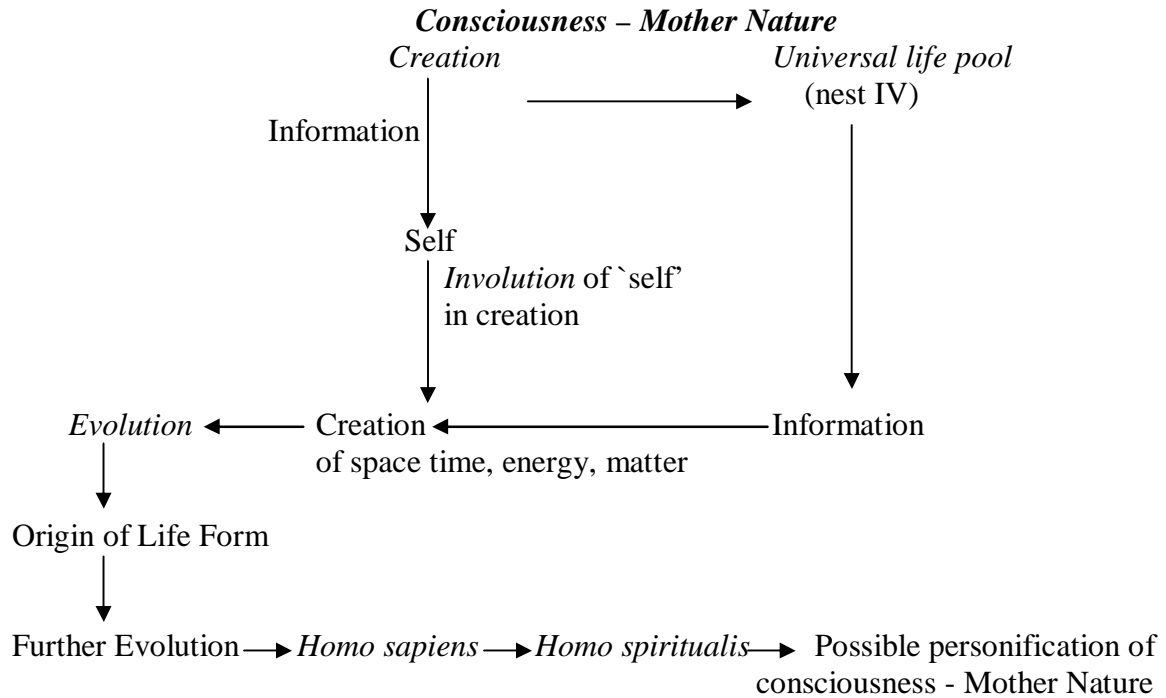
The present synthetic theory of evolution stands on the pillars of reproductive success, natural selection and the model of population genetics. The theory of natural selection is an incredible success, because it is based on evidences from (i) biogeography (spatial distribution of creatures on this planet), (ii) paleontology (temporal distribution of creatures on this earth), (iii) embryology (a small natural laboratory where **ontogeny** recapitulates **phylogeny**), and (iv) morphology (the pattern of analogous, homologous and vestigial organs). In explaining the process of evolution the scientists have largely ignored the communication between the ‘self’ of the self-organizing system and the consciousness in nature-consciousness. This communication is likely to be nonlocal, which dissolves the barrier of space, time and conflicts of purpose, and it has the potential for helping a death-transcending emergence. A system that generally acts locally but also communicates nonlocally reserves the chance to evolve (Mukhopadhyay, 2002).

Besides this there are many unanswered questions in the process of evolution. The most important ones are what drives the process, and why is the process continuous. Evolution literally means ‘unrolling’ or ‘unfolding’. But what is being unfolded and what is being unrolled? These queries bring us to the suggestion in favour of a prior involution.

### ***The Involution Limb***

Involution is a proposal by Sri Aurobindo, an accomplished mystic from India (Joshi & Sengupta 2003). Let us consider the scientific temper in this proposal. Every system that has the capacity to evolve does it through ‘self’. The paradigm of self-organizing system attempts to explain evolution through self-organization process inherent in the system. Unfortunately, there is undue emphasis on the organizational aspect ignoring the role of ‘self in self-organization. According to the present worldview the *self is the involuted individualized form of consciousness* and works as an integral ingredient of the psyche of the system. Unless consciousness involutes as ‘self’ in the system, the system cannot evolve. It is this informationally conditioned self which takes the created matter and energy toward this unconditional consciousness. The descent of an informed self into the system is considered an extension of consciousness into the system. The information

content of self represents the ‘voice’ of consciousness and works as the prime mover in the evolutionary process. If the information produced by the life pool is responsible for the branching of the evolutionary tree and creation of all diversities, it is the informed self that is responsible for elongation of the stem of evolution toward the unconditional consciousness. One category of information (produced by life principle) is responsible for *expansion* of creation. Another category of information (carried by the informed self) is responsible for *contraction*. The property of expansion and contraction is seen in the universe as a whole and in all its holographic representatives including the brain.



**Fig. 6.7** – The interlinks among the creation, the evolution and the involution limbs

### ‘Receptor’ Property of the Cerebral Cortex

Brainstem consciousness, limbic system consciousness and cortical consciousness - all need a cerebral cortex for their rooting as well as manifestation. We assume that the nature of the brain-bound consciousness and the nature of the brain-independent consciousness communicate through the cerebral cortex, by means of local and nonlocal mechanisms.

The present Chapter is based on the premise that the purpose of evolution of the brain as an organ is to unify the consciousness within and the consciousness outside the brain. In this process, the nature within and the nature outside the brain do interact and communicate. That makes the brain naturally an open organ. And this openness is suggested to occur through the cerebral cortex (cf. mystical statements such as “my ‘eyes’ are on the top of my head”, or the yogic version of opening of *sahasrar chakra*).

The **dendritic mat** in the superficial layers of the cerebral cortex, the 'free' spines of the apical dendrites in the cerebral cortex, and the cortical synapses have been suggested to be the three possible sites that can participate in this inside-outside information exchange.

The distribution of neurons in the cerebral cortex shows a laminar pattern that is evolutionarily conserved. Neurons in the top two layers of cerebral cortex are simpler, horizontally disposed, rich in dendrites and have short local network. Dendrites form a sensitive 'mat'-like structure. The neurons in the third layer are mostly for intracortical communication. The fourth layer comprises mostly the receiving neurons, and the fifth layer mostly the output neurons. The sixth layer neurons are engaged in feedback activity. The electrophysiology predominating in the upper strata is different from that in the lower cortical layers. In the dendrite-rich upper cortex there are constantly shifting electrical dipoles. In the lower layers, which are rich in lengthy axons, there are propagating action potentials mostly running parallel to each other. May be, there exists an electrophysiological watershed in the region of midcortex. Another interesting paradox is that the neurons in the cerebral neocortex, although structurally organized in six *horizontal* laminae, are recruited functionally as *vertical* neural assembly modules.

The pyramidal neurons of the cerebral cortex constitute 60-70 per cent of all cells. They have two groups of dendrites, the basal small dendrites and the apical long straight stout dendrite, which intertwine with other dendrites to form a dendritic mat over the surface of the cortex.

The dendritic mat contributes a very sensitive 'membrane' wherein electrical dipoles are found in constantly shifting dynamics. This area is also remarkable for spontaneous 40-60 Hz oscillations (Desmedt & Tomberg 1994, Tomberg & Desmedt 1998, Tomberg 1999). Crick and Koch (1990, 1998) have suggested that this synchronous firing of neurons in the brain is related to the phenomena of 'binding' and consciousness. It is, however, not known whether these oscillations form the basis of consciousness or whether they are an observable aspect of consciousness. The electrical dipoles in the dendritic mat appear vulnerable to information bombardment from outside; Mukhopadhyay (1987) has made a poetic allude to this.

There are spines on the apical dendrites, which do not participate in the formation of synapses. The synaptic density of the human cerebral cortex is .incredible. The number of neurons/gm of brain tissue (neuron density) in the human is 10.5 (Abeles 1991) and in the mouse it is 142.5. Then what makes the human brain far better than that of a mouse? The number of synapses, the variety of the neuro-neuronal junctions, and the complexity of their networking make the synaptic network in the human brain a crowning achievement of the process of evolution.

The unconventional concept of the brain, namely that it is an inverted tree with its roots in the eternity and branches down below the peripheral nerves (inverted neuraxis), could take us beyond the 'closed box' of science. Information exchange by means of nonlocal communication could be the key to explore the science of transcendence.

### ***Psychospiritual connections***

It is a connection of the brain activities, through psyche, with activities in nests IV and V of nature-consciousness. Psychospiritual connections probably exist in all human beings; but most of us are not just aware of it. Possibly psychospiritual connections develop further following intense meditation practice (consciously directed absorption) for a prolonged period. In the yogic language, the topmost connection is through the *sahasrar chakra* at the vortex of the hemisphere. *Sahasrar chakra* is supposed to open up when the brain is elevated to the *state of grace* (Mukhopadhyay 1995). It seems to involve the paracentral lobule in both hemispheres of the brain.

The brain exhibits quantum properties and phenomena in macro and micro scale. Synapse and microtubules are said to be the sites for quantum activities. There is evidence that indicates that brain could behave as a macroquantum object. EPR paradox-like phenomenon has been demonstrated between electrical activities of two brains (persons) synchronized by meditation; Grinberg-Zylberbaum et al (1994) have called this phenomenon the transferred potential. Nonlocal communications of type I, II, and III are possible modes of psychospiritual dialogue. Meditation and yoga open up the access control of the brain to nature's nests IV and V. Transcortical information exchange, nonlocal communication by quantum-brain, bombardment of **neutrinos** on brain-electrics are probably issues involved in development of this stable psychospiritual connection.

Neurologically, it is assumed that life runs because of the activity of the pacemaker neurons in the respiratory centre, the vasomotor centre, and the cardiac centre in the brainstem. However, these spontaneously firing neuronal assemblies are in connection with the cerebral cortical neurons at the vortex of the brain, which are open to the extracerebral 'life-pool'.

### **Future of the Human Brain**

Any hierarchically organized stratified structure will have regional and central integration centers. In yogic parlance and in the context of psychospiritual development the integration centres are called *chakras*. Human brain has two well-developed integration centres: (i) The brainstem has an integration centre concerned with sensorimotor activities, three biological clocks, and neuromodulation; this may be what in spiritual parlance has been called the *vishuddha chakra*. (ii) Hypothalamus is the centre for integrating survival, reproduction and emotion; this may be the *agnachakra* of the yogins. A unique feature of human brain is its ability to handle phenomenology. However, the human brain is yet to develop a centre for phenomenological integration. This integration centre in yogic parlance may be termed *sahasrār chakra*. The author envisages development of this integration centre in the course of journey of *Homo sapiens* to *Homo spiritualis*. The visionaries from the east (e.g. Sri Aurobindo and Pandit Gopi Krishna) as well as the west (e.g. Teilhard de Chardin and Ken) have envisaged the emergence of a new species from the present *Homo sapiens*. But the question is how would we recognize such an emergence. The author (2000) has conceptualized the evolution of a new brain, *the brain of brain*, at the vortex of the brain, i.e. the *sahasrar chakra*; and he has the following thoughts about the new emergence.

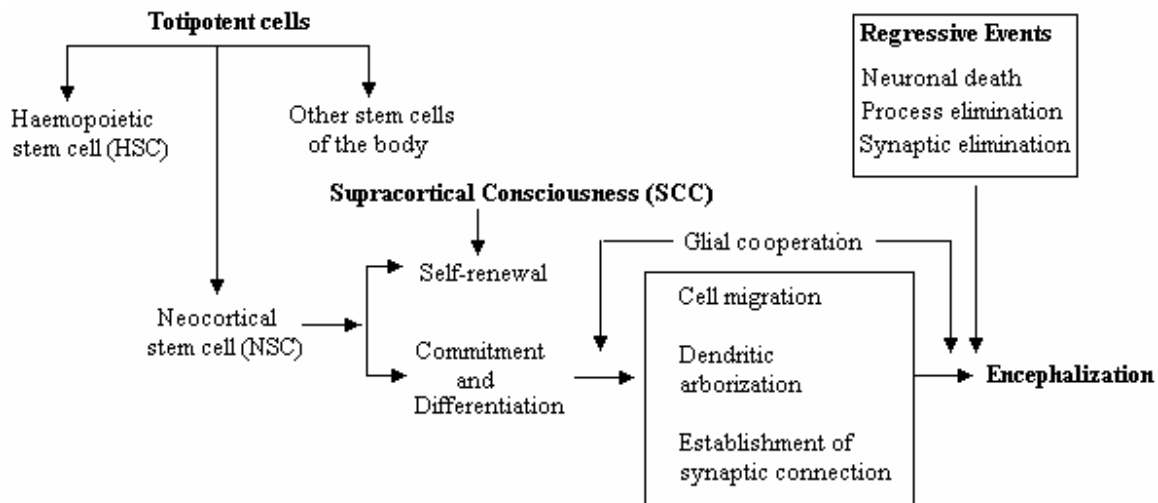
The question remains, if the arrival of a new species on this earth is on the card how would one identify this emergence? ... Would there be any difference in distribution of melanin in their skin or in iris of their eyes! Would there be a third eye on their forehead with another optic nerve joining the optic chiasma! Would there be any physical characteristic unique to them? Surely, we would find a unique behaviour in their life-style. Certainly, in their expression they would observe the Akhanda: view of universe and multiverse. ... However one point, which would be unique to, them, is possession of the 'brain' of a brain – a collection of neocortical neurons at the highest convexity of the cerebral cortex of both hemispheres. This *brain* of a brain is the sine-qua-non of the new species emerging in our planet.

How can this 'new brain' develop in human brain? Does it require new connections or new neurons? We are left with one fundamental question; is there any possibility of renewal of human brain in such physiological condition or in what one might call an evolutionary situation?

Medical scientists dealing with the *science of disease* are attempting to transplant neural stem cells in situations having neuron loss (as for example following trauma or due to degeneration as in Parkinson's disease), or in glial cell disease (e.g. demyelinating disorders). The question however remains whether neuronal stem cell proliferation could be a reality in adult brain, and whether it could support a *science of health* and further evolution of the *Homo sapiens*?

In this context the finding that the adult human 'brain marrow' has *pluripotent neural stem cells* (Moore 1999) is revolutionary. It unearths the potential of human brain for self-renewal at least in part. Fernando Nottebohm (cited in Kolta 1984) reported that in the adult male canary bird thousands of new neurons generate from such stem cells and consequently the bird's 'singing' brain (HVC) grows twice or thrice in size during the mating season when the male bird with its enlarged HVC can sing and attract a suitable mate.

Based on the above findings, the author (Mukhopadhyay1987) has prepared a flow chart to show the involvement of totipotent stem cells and supracortical consciousness in encephalization (Fig. 6.8).



**Fig. 6.8** – Involvement of neocortical stem cells in encephalization

The crux in this proposition is that self-renewal of the neocortical stem cells in an *evolutionary situation* occurs under the influence of the supracortical consciousness; this is the first step in realization of the brain-independent consciousness by the brain-bound consciousness. Most likely the realization happens through the phenomenological integration. This initiates a strong emotional response involving the midline cerebral structures (limbic structures). Supracortical consciousness biologized at the level of limbic nuclei is what has been called in spiritual language, *ānanda*. This emotion of *ānanda* may well be the sustaining stimulus for continued proliferation of the neural stem cells in the ‘brain marrow’. Newly generated cells may contribute toward building not only a phenomenological integration centre but also the prefrontal cortex, hypothalamic and brain stem integration centres. What we expect is a renewal of the brain or the ‘brain’ of a brain!

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