Papers on Biology by M L Kothari et al

Sl.No.	Description	Journal	Co-Contributors
1.	Time Evolution and Man	Journal of Post Graduate Medicine	Lopa Mehta
2.	The Cytoplasmic Basis of Cellular differentiation	**-do-**	**Lopa A Mehta**
3.	Cells and Yin-Yang Polarity	**-do-**	**Lopa A Mehta**
4.	Bipolar Hermaphroditism of Somatic Cell as the Basis of its Being and Becoming	**-do-**	Lopa A Mehta

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TIME, EVOLUTION AND MAN

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TIME, infinite[28] backwards and forwards, punctuated* itself at a certain stage by giving rise to the fundamental unit of life,[38, 74] the CELL, which by a process of EVOLUTION embodied within itself the faculties of creation, growth and maintenance, decay and death** of various lifeforms including MAN.[45] Man, the Lord of the Earth,[21, 40] serving as an agency for psychosocial evolution,[39] put life[10] into matter to bring about a vast array of inanimate evolution on the earth. The terms, time, evolution and Man, form a heterarchical order[35] that allows us to sum up*** the *raison de'tre* of life in general and of Man in particular.

Time (Fig. 1)

Recent symposia on time have presented a plethora of approaches to the definition and understanding of time. Of the many forms of time described, three forms.[30, 43] External, Inner and Biological—have been presently selected for deliberation.

External Time

"Time goes", You say?
"Ah, no! Alas,
Time stays, we go". (Dobson)[20]

The foregoing quotation indicates that the external time is indeed an eternal element. Man, using an arbitrary system of reference relates his existence and that of others to the external, physical, chronological, or the great,[28] cosmic[28] primordial[48, 54] time. The external time is universal, objective and absolute.[49] It exists irrespective of Man, the timer.[27] Its relative span is measured by instruments and expressed within a conceptual framework.[49] Inner time and biological time are entities that run parallel to a segment of the external time. The riddle of the external time[48] is the riddle of the very beginning of everything.[48, 58] We recall the famous words of St. Augustine[70]:

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* "Time has engendered everything that has been and will be". (Atharva-Veda, XIX, 32).[4]

** Lord Krishna: "Time am I, laying desolate the world" (Bhagwad Gita XI/25).[7]

*** "The most incomprehensible thing about the world is that it is comprehensible". (Einstein).[27]

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"What then is time? If no one asks me, I know; if I want to explain it to a questioner, I do not know. But at any rate this much I dare affirm I know; that if nothing passed there would be no past time. if nothing were approaching, there would be no future time; if nothing were, there would be no present time.

But the two times, past and future, how can they be, since the past is no more and the future is not yet? On the other hand, if the present were always present and never flowed away into the past, it would not be time at all, but eternity. But if the present is only time, because it flows away into the past, how can we say that it is? For it is, only because it will cease to be. Thus we can affirm that time is only in that it tends towards not-being."

External time, the fourth dimension of an expanding universe,[75] remains an enigma so that the foremost thinkers rest content by saying that "God is manifested in time"[57] or that "we are time".[48]

Our grasp of the external time is not direct, but is dependent upon the changes we observe. "It is not time itself we perceive but what goes on in time".[26] Bergson[6] distinguishes between the spatial time measured by our clocks, and purely temporal time. The former is a "hybrid concept, resulting from the incursion of idea of space into the domain of pure consciousness".[6] One can count seconds* because they are not time but space. Pure time passes like a river, intangible and unsegmentable.[6]

External time has been personified[28, 57] since ages. It has been stamped as an enemy, and as a friend. It is strange that something that exists (?) as widely, impersonally and indefinably as space should be personified. Shakespeare[66] addresses time as follows:

"So shalt thou feed on Death that feeds on men,
And death once dead, there's no more dying then."

Inner Time

Inner time is subjective, individual and relative.[49] It is the perception of enduring.[49] In the words of Eddington:[25] "Thus we have immediate experience of the time relation....When I close my eyes and retreat into my inner mind, I feel myself enduring. It is this feeling of time as affecting ourselves and not merely as existing in the relations of external events which is so peculiarly characteristic of it". The course of inner time is nondirectional.[43] It consists of a series of single excitations and, therefore, proceeds discontinuously, in quanta.[43] It forms a complementary pair with the unidirectional, continuous external time. The concept of external time, forming a part of inner time, is "the one dimensional continuum of all psychic phenomena".[49]

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* A 'second' has been defined as a fraction of the year 1900 which lasted for 31,556,925.9747 seconds.[63]

Inner time markers are psychic,[49] i.e. the inner-experience of time passing which is often based on the biological substrate of circadian and other organ-directed rhythms.[34, 49] In other words, the interior time dealt with, both in the electronic computer and the cells of the nervous system, is a microscopic time connected at subatomic level with the spin of the electrons, and therefore practically disconnected from any connection with outer space and time.[75]

Both temporal diastole, and systole[28, 30, 71] are functions of inner time wherein 10 minutes appear like 10 years and *vice versa*. The mythological anecdote of *Narad* experiencing passage of 12 years of inner time within half an hour of external time[28, 71] is an example of temporal diastole.

Biological Time

Biological time is the external time during which biological activity has occurred. Since biological activity means change at the level of the organism, biological time is the temporal span between any two biological events. Overtly, these events for a higher organism such as man are birth, growth, puberty, senescence and death. Since the journey over this temporal span cannot be recorded except as the beginning and the end of a biological event, one is forced to make biological time dependent for its expression on the chronological external time. The above events, for Man, are temporally far separated and cannot serve as precise, useful units of biological time. We should preferably select a biological event, applicable both *in vivo* and *in vitro*, to a single cell as well as to a community of cells so as to serve as calendar-events or date-tickets "which allow the description of the time course of change in a particular organ system in a quantifiable manner, or conversely, which can be used to define the lapse of biological time with regard to that organ system, independently of actual physical time."[9]

The one event which is common to most cells and which is quite conspicuous in the lifetime of a cell/cells is the process of cell division.[38, 74] It is proposed that cell division be taken as the date-ticket or the calendar event for the cell itself as well as the individual organism. It is natural that if cell division is taken as a calendar-event in the life of a metazooic animal, a question would arise with regard to the types of cell registering this event.

The cells of the SNM complex,[45] incapable of division in the postnatal life, are concerned with the cognitive aspect of the organism's existence and thus fulfil requirements for conceptual registration of external time and for perceptual experience of the inner time, a statement borne out by their very definitions. External time is recognised by a change in the external world, a concern of cognitive faculty. Inner time is only an experience at the neuronal level, unrelated to the outer space and time, and therefore, a concern of the 'feeling' faculty of the mind.[42]

The cells of the ST complex register biological time, using cell division as a calendar event.[44, 45] The total number of such events possible for a

somatic cell, **in vivo** and **in vitro** have been termed as the Finite Cell Doubling Capacity or FCDC[44, 45] of that cell. The FCDC quantum of somatic cells governs the lifespan of the organism by determining the lifetime of the ST complex.[45] The average FCDC of a human somatic (dividing) cell after cyto-differentiation has been established at about 50 non-differential divisions.[36, 37] It is submitted that cell division as a date-ticket meets with the major needs of the biological calendar of an individual organism. This subject has been elaborated elsewhere.

A distinction must be made between biological rhythms[43] and biological time as referred to presently. The presence of biological clocks is supposed to regulate the rhythmic activities of plants and animals.[33, 34, 43] These rhythms are recurrent and therefore incapable of indicating undirectional, irreversible flow of the (biological) time arrow. As has been clearly mentioned biological time is a corollary of the external time measuring the temporal duration of the existence of an organism or a part of it in terms of external time. Viewed in this perspective, biological time at the ontogenic level assumes unidirection (forward) and irreversibility just as the arrow of physical time.[79]

Resumé on Time (Fig. 1)

External time, being eternal, exists only apparently; it is an illusion. Inner time, also called psychological time, is a chain of single, meaningful

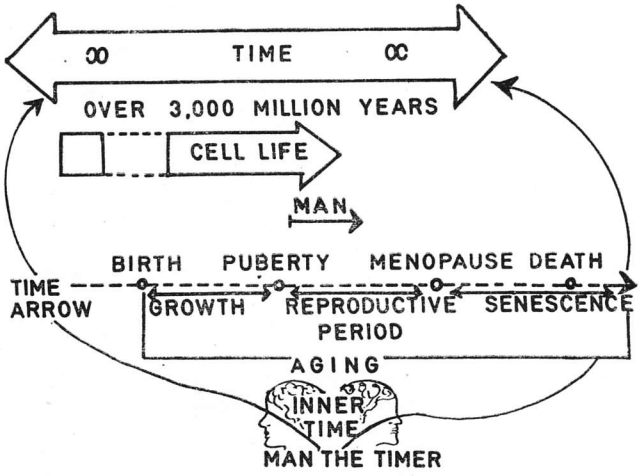

Fig. 1. Man and Time.

experiences identical with the excitation of inherited, imprinted, or learned network within the nervous system.[43] This excitation may be conveyed by sensorium or may occur spontaneously. Biological time presents the most palpable reality because each cell and each organism, extending between birth and death, present a definite beginning and a certain end. External time is incessant while the flow of biological time can be arrested by freezing individual cells, or even individual human bodies as is now being practised

in U.S.A. The external time is now measurable to 10^{-12} of a second and this facility is extendable to the measurement of biological time.[56]

In the universe that we know of, everything at both the microcosmic and macrocosmic levels presents incessant activity and, therefore, incessant change. With this everything evolves continuously, evolution becoming a property of all inanimate and animate existence. Evolution at all levels is a function of time.[12, 39, 57] It is natural now, therefore, to consider evolution.

EVOLUTION

The word evolution has a Darwinian halo[39, 67] around it. In a comprehensive sense, however, it has come to mean not only organic but inorganic and psychosocial evolutions as well.[5, 21, 65, 77] Evolution defies definition. It has been described as the act of unfolding or gradual development. In esoteric parlance it is the unfolding, 'of the eternal play'.[71] Huxley[39] defines evolution as 'a directional and essentially irreversible process occurring in time'. In this unfolding, nothing may really be occurring[27, 48, 57, 79] for in the words of Weyl,[78] "The objectives world simply is; it does not happen."

Inorganic evolution started with the birth of the present universe 3×10^{17} seconds ago.[29] This aspect of evolution is outside the domain of the present article. Psychosocial evolution, though separately categorized, is an inherent function of biological evolution. The present discussion pertains to the latter. The four Emersonian guides to knowledge namely WHAT, HOW, WHY, and WHO, will permit us to view biological evolution in a larger perspective.

What of Evolution (Fig. 2)

The most significant phenomenon was the creation of a CELL which using the four-lettered universal alphabet inherent in DNA[19, 31, 38, 52, 74] gave

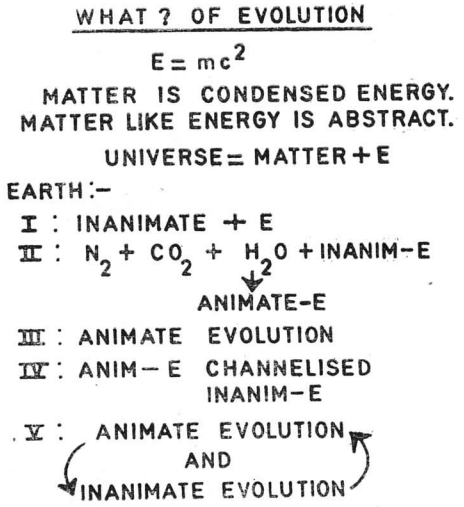

Fig. 2. Schema summing up the quintessence of inanimate and animate evolution on the earth.

rise to the most primitive and the highest forms of plant and animal life With the evolution of DNA, God said, "Let there be LIFE, and there was LIFE".

It's indeed a paradox that the main hero of the evolutionary story, the cell, manifests a structural and functional complexity common to the most primitive and the most evolved organisms.[11, 31] In a way, the cell itself is not evolved but only its repertoire.[11] Conceptual thought, a part of the repertoire stands today as the single, most important force for integrating various energy forces. Though the genetic code has been universally the same,[38, 74] its decoding and its exploitation have been most varied and its repertoire just fantastic. Protoplasm encased within a cell has been the greatest thinker of all. It may be soberly noted that Buddha, Newton or Einstein are merely examples of the biological variations of protoplasmic behaviour. Cell, through its aggregates merely varying in number, type and position, has measured the time, provided the timer and has governed both inanimate and animate evolution on the earth and away from it. It has achieved increasingly efficient energy channelisation and energy transfer within and without itself.

How of Evolution

The ever watchful Natural Selection,[5, 18, 22] the simple, universal genetic code[11, 19, 52] and the food-pyramids[5, 31, 77] are the keystones of biological evolution.

A common blueprint of SNM complex,[45, 46] subserved by ST complex[45, 46] operated from invertebrates onwards, acquiring large, individual, biomass in the vertebrate kingdom. From a very early stage, incredibly efficient cognition[11, 31, 32, 59] became a part of the 'response repertoire'[31] of various lifeforms. For example, the receptors on the lyriform organ of spiders at one end, and the mammalian cochlea at the other end of the biological spectrum, can respond to vibrations smaller than the size of hydrogen atom.[31] The infra-red pit on the head of the rattlesnake can detect a change in environmental temperature of 1/1000 of a degree centigrade.[32] With the emergence of Man, cognitive, cerebrative and conative faculties had a quantum jump and conceptual thought became a dominant vector force. Overt expression of conceptual and correlative thought provided Man with directed and precise conation. Man's conative faculties resulted in parallel inanimate evolution whereby a vast array of energy channelisations and transfers were achieved. Computer, at the moment, represents the pinnacle of inanimate evolution wherein, inanimate matter 'thinks'[22] excelling Man in certain respects.[10] (Fig. 3).

To provide for incessant and varied interactions amongst the animal organisms themselves and with the external world, each individual organism was made different from the other, even in the same species,[21, 22] so that descent with variation[5, 18, 38, 65, 68, 74] became a constant force. Such an indivi-

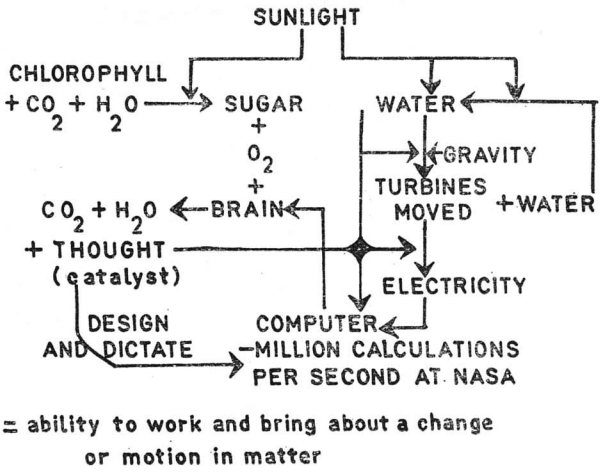

Fig. 3. Man's thought catalysing energy-channelisation and transfer. Channelisation is using one particular form of energy for doing 'work'. Transfer is to change the form of energy.

dual organism was given a finite lifespan[15, 16, 45] so that a continuous variety was assured.

Why of Evolution

This is probably the most difficult aspect of evolution and therefore not generally alluded to by biologists. A *priori* assumption, in holistic, Einsteinian thought[27, 69] is that Nature must be having a definite purpose in creating the whole gamut of life, a purpose as certain as in having the actin-myosin complex for mechanical power at the biological level.

It is submitted that the purpose of evolution is to seek an endless variety of energy conversions and energy channelisations through the agency of protoplasm, with Man as the supreme agent[39, 40] and the prime catalyst for these changes in the inanimate world. While achieving this purpose, Nature has not refrained from cruelly[2] using the various organic and inorganic energy forces against Man himself. While the course of evolution of man is considered unpredictable,[21, 22] it may be prophesized that the trend of inanimate evolution through the agency of Man, will continue in the direction of awesome energy release, one day even by the splitting of a proton. Man may come and Man may go but Energy will stay and sway forever.

Who of Evolution

Darwinian and subsequent writings have at length personified Natural Selection[2, 18, 21, 22, 38, 74] ever watchful; ever critical; sometimes slow, sometimes rapid; mercilessly throwing away anything biologically not useful; steadfastly retaining anything positively helpful, and exhibiting an incredibly large repertoire despite being armed with a genetic code of only four nucleo-

tides. Since the Natural Selection is a force[72] with its own intensity and direction, it becomes a vector[68, 76] and thus one of the directional forms of energy. Vedas have described God as eternal, formless, incapable of being created or destroyed, omnipotent. omnipresent, and indescribable. All these attributes superbly fit onto Energy of which Natural Selection is but one form, therefore, the Who of evolution is Energy=the God principle[71]=the God=Natural Selection.

Man

Time employing process of evolution is configured as Man,[56] the acme of evolution. Man, the Homo sapiens, the Lord of the earth,[21, 40] is the only animal who knows or at least claims to know what or who has evolved.[21, 62]

Some outstanding and almost exclusive human characteristics[5, 19, 21, 22, 39, 40, 50, 59, 62, 67, 76] may be stated: true physical uprightness; legs too long; arms to short; well defined feet; biggest brain as well as the biggest phallus. Faculty of conceptual thought, analysis, synthesis, and quick decision; ability to repress, suppress, his drives and desires and in return be subject to psychologic conflict. Obscessed with conscience, duty, sin, vice, humiliation, penitence and death. Employment of true speech, intensly talkative and the only truly laughing animal. Cultivation of cumulative traditions; acutely exploratory; possessing marked migratory propensities, and the master of all he surveys on the earth and away from the earth. Employment of tools, domestication of other animals including man.+ Exhibiting reticulate evolution and biological dominance. Continuously sexed*, yet a definite female menopause. Longest pre- and post-reproductive periods; longest lifespan; most variable wild species and 'the naked' or the 'hastily overmade' ape.

Man, an eternal enigma, an object of adoration as well as disgust, is indeed the greatest creation of Nature.[23, 24] He has identified himself with Nature, modified her, challenged her and even talked of conquering her. The aphorism 'Man against Nature' is strange for what is man if not part and parcel of Nature.[5, 13, 77] The accusation springs from a lack of total perspective of man.

Alexis Carrel[14] has paused an important question in the title of his famous book 'Man, the Unknown'. This allegation of ignorance is not fully justified, because right from the time of Vedas, Man has actively striven to understand his *locus standi*[53, 71] in the ephemeral and the universal scheme of things. Hence, the invokation 'know thyself'.[71] His *locus standi* can be outlined by stating whatsoever is known about him.

Protoplasm from the time it came into being was endowed with the faculty of being acted upon and reacting to the environment.[1, 62, 77] The entire process of biological evolution has been attributed to this faculty of protoplasm termed as adaptation.[18, 22, 39, 68, 76] Like all other organisms, Man has

+ Animalizing man as in the concentration camps of the second world war.
* It would appear that celibacy is natural to animals but an imposition on man.

been acted upon by the environment[18, 21, 23, 39, 40, 68, 72] or the external world (the world to him) and he in turn has reacted upon the external world (the world because of him).

The World to Him

Through his sensorium[31, 38, 45, 74] and extrasensorium,[32] Man attains an awareness of his surroundings. The 'world to him' consists of a set of images on the basis of a conceptual framework. His knowledge of everything around him is in terms of symbols.[3] His ability of perceiving sensorily or extrasensorily a larger number of objects and events and constructing corresponding number of symbols and schema mark out his superiority over other fellow men in general and the animals in particular.

While the faculty of olfaction has regressed comparatively,[31, 59] those of taste, touch, vision and hearing have reached in him an all time high.[31, 32, 59] Binocular and colour vision single out Man from all other animals.[31, 32] Man's faculty of perception (cognition),[31] sensory or extrasensory,[32] links him up with the external world, for better or worse.[21] It is interesting to note that the most profound motor paralysis in man is produced by blocking the sensory input into him.[8]

The functions of the human brain have been classified[42, 45] as those of feeling (cognition), knowing (thinking or cerebration) and willing (conation). Needless to say, his SNM complex[45] subserves these functions. (Fig. 4) Man

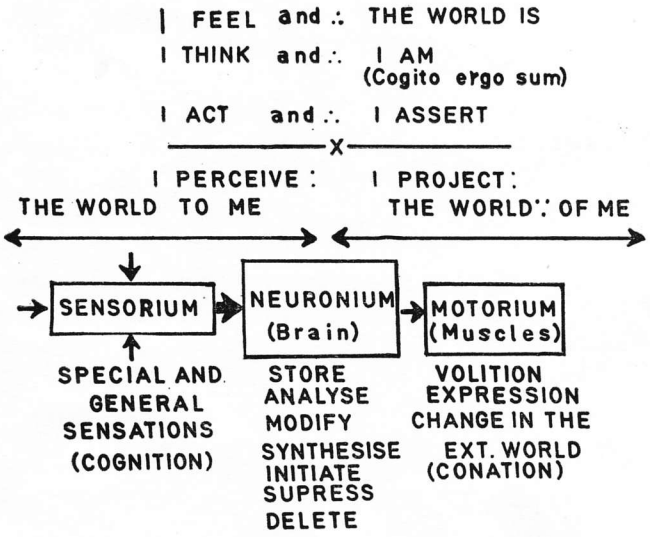

Fig. 4. Man in relation to the world.

with a large cognitive and cerebrative cortex is supremely placed as a perceiver and consequently a modifier of external reality which is defined as the sum total of extrapersonal world of objects, individuals and events.[27, 48] Truly speaking, Man originates nothing new. The external reality[27] (which is felt

as the 'inner reality') filters through Man, taking the tinge of the filter. In this respect, any human thought is a passage of a part of the external reality through Man. The creation in Newtonian and Einsteinian brains was not *de novo*; it was merely perception of external reality expressed in a comprehensible scheme. Man's brain, on the basis of such a concept, becomes a computer whose programme and the programmer are outside himself. (Fig. 5) He does not often recognise the existence of the programmer and there-

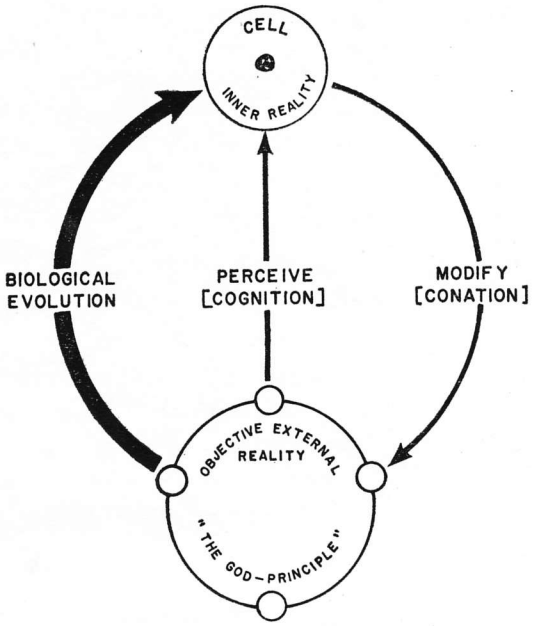

Fig. 5. The interaction of external and inner realities.

fore has the temerity to claim inventing or discovering this and that. One cannot but agree with Einstein that 'ideas come from God'.[69] Human thought may come to mean only a different form of sensation and therefore only a function of cognition. No wonder, that Lord Krishna[7] owns up everything to himself, the good or the bad, in the best or the worst Man.

The World because of Him

Man, with a brain twice the size of the brain of the nearest primate,[5, 76] has been instrumental in bringing about a series of changes which have radically altered the face of the earth and is now threatening to encroach upon other parts of the universe as well. These Man-made changes can be categorised as follows:

1. From Archimedian machines to Apollo-11, Man's thought has served as a powerful catalyst for purposeful energy transfer and energy channelization. Einstein[27, 69] provided a mighty form of catalysing energy through his thought $E=mc^2$ It may be predicted that the direction of inanimate, man-

made evolution will always be towards diverse, increasingly efficient and many a times devastating energy conversions. Man is and will be a helpless agent subserving Energy's need of seeking varied channelization and transformation.

2. Man has been[23, 39, 61, 64] a despair of some of the eminent humane philosophers. Man may have been beastly or devilish. These faculties are however, the balancing polar-opposites[43, 56, 61] of his innate beauty and divinity.[23, 24, 71] Just as matter is balanced by anti-matter and proton by anti-proton,[73] the best in Man is likely to be perennially balanced by the worst in him.[56, 71] Despite all that, he has beheld the beauty around him which he has expressed bountifully.[21, 51, 58] Let us not forget that the population explosion, the sex explosion, and the energy explosion of the twentieth century are not without the blessings of the explosion of creativity in man.[5, 53, 67] We need not despair of Man[23, 24] for two reasons. He is as yet, the best energy-channelizer that Nature has had, and thus Nature will provide for his survival; secondly, with each discovery and with each invention one man is brought closer to another which makes the dream of universal brotherhood[53] more near reality.

3. A few injudicious moves by Man have created for him the population explosion.[5, 17, 41, 55, 60] Beginning from the late nineteenth century, one invention after the other has resulted in the destruction of a large quantum of non-human biomass.[13] Since the total quantum of the biomass over the world is fixed (principle of fixity of biomass[5, 31]), the destruction of non-human biomass has been compensated by the overproduction of human biomass. The destruction of a large quantum of human biomass through the biological phenomenon[40] of the first and second world wars has significantly contributed to the present population explosion. Safely relying on these operational concepts governing the total biomass, we need not fear the threat of the world being overrun by Man, like a swarm of locusts. The answer[47] to this threat will lie in producing useful non-human biomass so that this will deter the production of human, as well as harmful non-human, biomass.

4. The powerful, species-specific ego of the Homo sapiens makes him a ruthless destroyer of all that comes in his way or is needed by him. Naturalists such as Carson[13] have raised a lot of hue and cry against this Man-made destruction of various lifeforms. The number of different animal and plant species that have inhabited the earth only to completely disappear are a legion.[22, 39, 68] Disappearance of species is a way of the working of the Natural Selection and thus Man can be spared the blame of being too inhuman to other lifeforms. The latter are primarily to serve as food pyramids. This biological necessity supersedes human aesthetics and clemency.

Man's anthropomorphic image of God,* his obscession with immortality and eternal salvation are few other examples of his indomitable ego. The

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* "I believe in Spinoza's God, who reveals himself in the harmony of all being, not in a God who concerns himself with the fate and actions of men". (Einstein: 27).

anthropomorphic image is the expression of an average man's inability to conceive of something formless yet universal. Immortality and eternal salvation are a part of highly developed sense of aesthetics but probably devoid of biologic reality. Nature* is no respecter of personalities and governs the mankind by a series of heartless laws, which are so important on a phylogenic and universal scale but are so heartless, merciless and cruel[2] at the individual, ontogenic level.

The heterarchical relationship amongst TIME, EVOLUTION and MAN has been evolved on a general plane. The impact of the former two at individual level in Man has been presented, as a biological trajectory, in a future communication.

SUMMARY

A comprehensive scheme incorporating Time. Evolution and Man has been presented. The various forms of time, the different aspects of evolution and their impact on Man and in turn his impact on the world have been

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Some Forerunners of Celldom Appreciated

1

The Cytoplasmic Basis of Cellular Differentiation—Redressing the Injustice Done to the Cytoplasm

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The riddle of cellular differentiation continues to defy the conceptual and experimental ingenuity of all-logists. Man, like any other metazoic organisms starts as a featureless zygotic cell to end up as a fully formed individual comprising the indivisible neurones, the peripatetic polymorphs, and such other "few hundred different types"[20] that refuse[28] to tell anything about how they came into being. A typical mammalian cell, even in its patently differentiated, stable state, possesses an all-in-one versatility – an actor in the Shakespearean style, playing one role at a time, but capable of playing any role that any act may demand at any time. Any theory on differentiation must account for this seeming paradox of stability in the midst of total versatility. Such a theory must also explain some recent developments[1,10,11,12,13,20] as the success of nuclear transplantation into somatic

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and zygotic cells to spawn some new cell types on the one hand, and some fully formed organisms on the other. The hypothesis advanced in this paper rests on a radical departure[15] from the nucleus-oriented thinking on cytodifferentiation. It proposes that from the very start, namely, zygote-formation, it is the cytoplasm that governs and guides the nucleus to be this or that, do this or that, be "normal" or cancerous, and so on. The cytoplasm gives the lead which the nucleus follows.

Embryological Evidence

The entire embryogenic blueprint lies in the ovular/zygotic cytoplasm. The sperm, at fertilization (more truly, it is diploidization) torpedoes into the ovum, to get decapitated at its border thus giving its nuclear head to the mature ovum and losing its cytoplasmic body and tail to the periovular void. We now have the zygocyte (=zygote) comprising its diploid "somatic" nucleus-formed by the fusion of the haploid female pronucleus of the ovum and the haploid male pronucleus brought in by the sperm, and the cytoplasm contributed exclusively by the ovum. Replacement of either the female haploid pronucleus of the ovum or the diploid nucleus of the zygocyte by the nucleus of a somatic cell of an adult animal - classically, the frog intestinal cell nucleus replacing the nucleus of the frog zygote[10,11,12,22] - is unbelievably compatible with normal embryogenesis. Here, the ovular cytoplasm stands primarily important, unsubstitutable, and knowledgeable, while the "reprogrammed" nucleus plays second fiddle.

Even when the guest nucleus has been obtained from a cancer cell, the enucleated host-ovular-cytoplasm asserts its preprogrammedness on the guest nucleus to initiate and complete embryogenesis.[13,21,27] "The most extreme example of 'pre-programming' of the cell cytoplasm is perhaps to be seen in the ovum itself. A frame of reference in which the ovum is regarded as the undifferentiated cell has the disadvantage that it tends to encourage an underestimate of its structural and functional complexity... Although the

data so far available are rather preliminary, they lead one to suppose that in a wide range of biological material all the organization necessary for the early stages of development is already present in the cytoplasm of the ovum before it is fertilized."[13] Cytologists have nowhere thought of as to when, where, and most importantly why, should cytoplasm abjure its dominance over the nucleus later in life, following embryogenesis, in the somatic cells!

Evidence from Nuclear-Transplantation in Somatic Cells

The avian erythrocyte is a nucleated cell wherein the nucleus is inactive and dormant, devoid of any synthesis of nucleic acid. Such a nucleus, freed from its own cytoplasm, can be made to resume the synthesis of nucleic acid and specific proteins at full steam when placed into the cytoplasm of cells from a wide variety of animal species ranging from mouse to man.[1,4,13] What holds true for avian erythrocyte nucleus also holds true for the frog erythrocyte. "We can therefore conclude that the signals emanating from human or mouse cytoplasm are understood perfectly well by the hen (or frog) nuclei."[13] We can further generalize that the dominance of cytoplasm over nucleus is a panvertebrate feature that even species-barriers cannot abrogate. The cytoplasm dictates; the nucleus deputizes.

Cytoplasm Survives Sans Nucleus but not Vice Versa

The mammalian red cell is not the sole example of the active survival of the cellular cytoplasmic sac after the nucleus has been voided. The giant unicellular alga, Acetabularia, withstands enucleation, exhibiting thereafter growth and regeneration, the regenerative process producing an essentially normal Acetabularia, although, of course without a nucleus.[13] The cells of Spyrogyra, following nuclear excision, survive for more than 2 months during which time they grow, form new cytoplasm containing organelles, synthesize proteins, and carry out all their normal physiologic functions.[13] The enucleated egg of the sea urchin Arbacia exhibits repeated cell divisions to the point of forming a blastula that may

develop functional cilia.[13] The protein synthesis induced in frog oocytes by pituitary hormones is not abolished by enucleation; indeed, for many hours, the rates of synthesis in nucleate and enucleate oocytes are indistinguishable.[13] Enucleate fragments of cultured human cells survive *in vitro* for up to 4 days exhibiting movement, pinocytosis, and the incorporation of amino acids to form protein.[8] We can no longer deny the high degree of structural and functional autonomy that the cytoplasm enjoys regardless of the nucleus.

Cytologic truisms, meant to drive home the "central or crucial"[19] role of the nucleus, usually advance the argument that "enucleated cells will stop dividing and will eventually die."[19] But such assertions lack the mandatory follow-up explanation: What happens to the ecytoplasmed nucleus? Does it survive as long as, and as actively as, the enucleated cytoplasm? The answer, alas, seems to be a big "no"! Such a 'no', however, is not available in cytologic literature. Driven by the obsession about the 'obvious' superiority of the nucleus, nobody has bothered about excising the cytoplasm from about a nucleus and see if the latter really survives. From whatever is available from cytoplasmically-oriented enucleation experiments, one can summarise that: The moment the nucleus is divested of the cytoplasmic matrix, it loses weight and volume, collapses, turns pyknotic, afunctional, and then dies. The dependence of the nucleus on the cytoplasm is absolute; that of the latter on the former is relative. The indispensability of their polar coexistence is an example of mutualism, illustrated by such informational/bioelectric units as the neurones and muscle cells, one sustaining and sustained by the other, by what can best be called[4] a "continuous interrelationship." The evolution of the nucleated cell itself shows that the nucleus was begotten of the cytoplasm - it was the anucleate procaryote that gave rise to its nucleate eucaryote descendant.

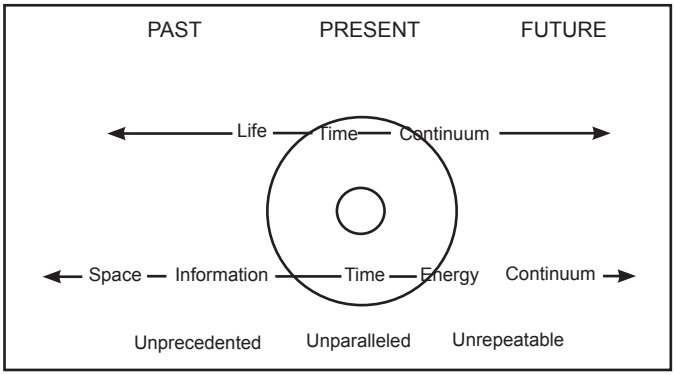

Fig. 1: Differentiation of a cell - zygocyte, somatocyte, cancerocyte – is a tritimensional panspatial, cosmic affair. Because of the Aquinasian *individuation* guaranted to any cell, each cell is conceived and configured in the cosmic womb, and *vice versa*. This invariable variability is a function of the cellular *nouniverse* knowing the total past, present, and future thanks to Life-Time and Space-information-Time-Energy Continua. Cytology's failure at knowing what a cell is stems from the epistemologic incompatibility between the localness of cytology's reach and the cosmicality of the cell's being.

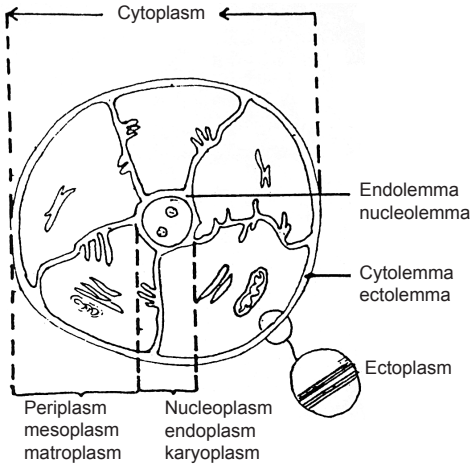

Fig. 2: A debate on cytoplasmonuclear relationship merits clearer terminology. The semantic, and therefore the intellectual schizophrenia thrust upon cytologic throught is rooted in the use of the root *cytos (kytos)* to denote *cytology* and *cytoplasm*, and then hurrying to define cytoplasm as protoplasm minus the nucleus, regardless of the fact that *protos* as a prefix is specifically used to highlight the evolutionary primordiality and biologic universality of this "basis of life". Morever, *protos* makes no reference to an individual cell that the root *cytos* (= a container) so admirably manages. And yet since the nucleus (but 2% of the cell) has been the star attraction, there is the science of nucleology or caryology without the balancing opposite of cytoplasmology or even protoplasmology. it is time cytoplasm is made to connote the whole cell.

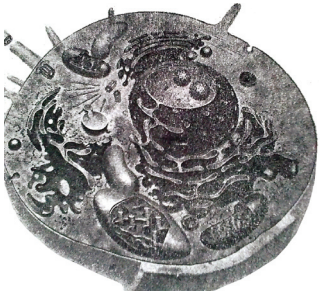

Fig. 3: Modern electronic typewriters have a golf-ball-sized *typing element* that carries on its surface the total alphabet, signs, symbols, figures and punctuation-marks that the keyboard displays. On the pressing of a key, the typing element moves so selectively that the desired type is obtained on the paper.

In the context of this article, a cell is comparable to the above: The nucleus is the typing element; the cytoplasm constitutes the rest of the typewriter. The cytoplasmic keyboard as much "informed" as the nuclear typing element, presses a key to move the nuclear element into a perspectively proper position and thus obtain the appropriate cytoplasmonuclear coordination and cooperation. Informationwise, and choicewise, the cytoplasm and the nucleus are mirror-images. For both, at a time, only one choice can be made; the cytoplasm makes the choice, the nucleus follows suit.

The analogy is extendable: The typing element is easily removable, and replaceable by another element – another nucleus – that is ready to obey the host cytoplasmic typewriter. The striking similarity between the typing elements and the nucleus in a cell makes one wonder whether the IBM people borrowed the idea from the cell.

Cytoplasm *Versus* Nucleus in Heredity

The sheer power of service, in a tennis final at Wimbledon, is traceable to the mitochondria of the mother of the tennis star, male or female. In all vertebrates, the mitochondria (or, shall we say, mightochondria?) are derived exclusively from the mother; to be precise, from the maternal cytoplasm comprising the ovum.[20] There is reason,[15] to believe that what is true of mitochondria is true of all organelles, the paternal contribution being just half of the zygocytic nucleus. And since such a nucleus itself is substitutable, one can say that inheritance is essentially a cytoplasmic affair, a maternal endowment supplemented by the paternal (hemi) nuclear contribution. The fact that cytoplasmic inheritance does not allow the application of Mendelian laws is no reason for denigrating it as non-Mendelian inheritance worthy only of passing mention."The basic embryonic plan of all mammals is inherently feminine."[26] Is this fundamental embryologic truth traceable to the supremacy that the zygocytic maternal

cytoplasm has over the half-maternal, half-paternal nucleus, a state of cytoplasmic dominance from which hereditary transmission can have no escape?

Death of Nuclear Dogma

The nuclear dogma is synonymous with assertive *nucleism* that allows a Nobel laureate[23] to describe, in a *Dictionary of Modern Thought*, nucleus as the administrative centre of the cell, being the repository of all the cell's genetic information, and of all the information. The same dictionary defines dogma[5] as a term used pejoratively to mean an opinion held on grounds, and propagated by methods, that are unreasonable. The central dogma of cytology is *nucleism* propagated despite overwhelming evidence to the contrary, vindicating the observation that consistency, especially in science, is the last refuge of the unimaginative.[29]

A story retold many times by speakers at scientific meetings illustrates the dogmatic befuddledness of cytologists. A man running down a dark street, dropped his coin in the process. He started looking for the coin under the bright street lamp and was joined in the search by a policeman. After several minutes of failure, the policeman asked, "Are you sure you dropped it here?" "No," the man answered, "I lost it back there in the dark street, but I can see better here." The unfathomable, diffuse complexity of the cytoplasm has been like the coin lost in the dark street, and the clear visibility/isolationability/transplantability of the compact nucleus - constituting but 2% of the cell volume - has been like the bright lamp-shine where the search continues. "The development of cariology (nucleology) was somewhat detrimental to the study of cell as a whole."[4] And what has caryology studied but some aspects such as chromosomal structure and choreography, that are admittedly far removed from the cellular reality? A *Textbook of Cytology*[3] makes a confession: "The interphase nucleus is of great biological significance, as demonstrated by biochemists and others. Yet, cytologically, it is not very exciting. The chromosomes can hardly be seen or studied and the nucleus just sits there, as observably inactive as a sleeping dog and as

static as the old term for this nuclear condition, 'resting stage,' indicates." If the nucleismically-biased cytology is not ready to do justice to active, significant, but (structurally) unexciting interphase nucleus, what could we expect of it *vis-a-vis* the largely featureless cytoplasm! No wonder that the father of modern genetics, Morgan[24] was led to pontificate that "the cytoplasm can be ignored genetically," a sermon that has been religiously followed right up to the recent[6] 2-volume, 1500+ pages tome on genetics. Even when experimental findings overwhelmingly suggest[17,20] that the cytoplasm may be endowed with as much DNA and information as the nucleus, the suggestion is strongly opposed on the pragmatic ground that "one is forced to consider the possibility of a widespread duplication of the genes in both nucleus and cytoplasm, a state of affairs that makes nonsense of most forms of genetic analysis."[13] The epistemologic stumbling block to according cytoplasm its due is the Copernican change it would force upon "most forms of genetic analysis." This is yet another example of looking for the coin at a wrong place, for, today, "genes in mammals lie broken into pieces - and so do some of the basic assumptions of molecular biology."[2] The inherent nonsense of genetic analysis[16] is good enough reason to give cytoplasm its due, a state of nucleocytoplasmic equivalence - with the nuclear dogma dead - wherein the cytoplasm enjoys the status of *primum inter pares*, or, first among equals.

Proposed Operational Model for Cytoplasmic Basis of Nuclear Differentiation

The cytoplasm, given its magnificent machinery of microtubules, actin, myosin, ergastoplasm, and so on, is the powerhouse, the workhorse, the active, feminine Yin, whose business it is to be "committed" to a cell type, varying from a zygocyte to a cancerocyte. It drives water and proteins into the nucleus to selectively hydrate, separate, rarify, and thus euchromatize specific areas of the nucleus.

The nucleus, necessarily diploid, is a long twine comprising two - maternal and paternal - chromatin elements which, because of inherent mutual attraction, remain fused (pyknotic,

heterochromatic) except in areas where the two are separated by the cytoplasm driving water and proteins between them, constituting in these regions, the euchromatin. In this light, it becomes clear how a nucleus, when removed from the cytoplasmic bed, collapses and turns totally heterochromatic, nay, pyknotic.

Free of the organellar complexity that the cytoplasm has, the nucleus is, for most of its part, the dormant Yang, this being its heterochromatin, save specifically activated areas called the euchromatin. That the distribution of euchromatin is widely scattered and stereotopic may be guessed from the diffuse rarefaction of the nucleus that euchromatization brings in. It has been estimated[10,13] that an excised nucleus - that is thus totally heterochromatic - enlarges, on being put back into cytoplasm, 20–90 times in volume. This inflation is by hydration and activation of only 2–5% of the nuclear chromatin material. The fact that in any cell the quantum of euchromatin does not exceed the above figure shows that even the euchromatin/cytoplasmic ratio, like the nucleo/cytoplasmic ratio may be fixed for vertebrate cells.

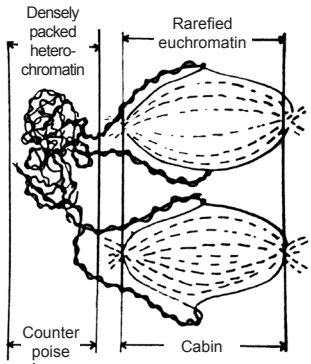

Fig. 4: The nuclear chromatin is an intertwined double strand, 95–98% of which is densely packed to form a ball of heterochromatin; in the remaining 2–5%. the two strands are greatly blown apart – to the point of being invisible – by the interposition of water and proteins between them, so as to render them into functional euchromatin.

The heterochromatin is not so inert and redundant as supposed. It probably forms an anchor, a solid base from where, at multiple places, the euchromatinic expansions take off. Morever, the heterochromatin holds in proper check the runaway expansion of the euchromatinic areas. If the euchromation is like the cabin of a lift, the heterochromatin is like the indispensable counterpoise.

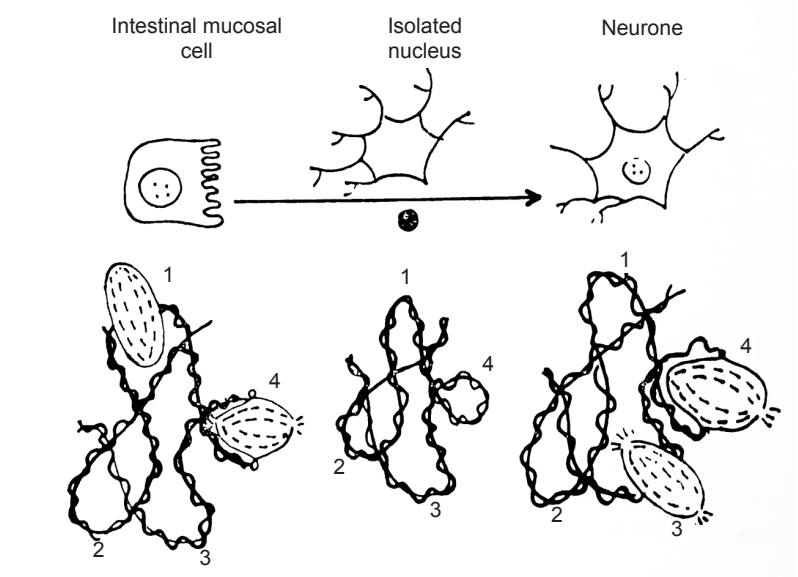

Fig. 5: On being removed from its cytoplasmic bed, the nuckeus (say, of the thyroid cell) collapses to a totally pyknotic state. On being recytoplasmed, yet other parts of its chromatin open out as euchromatin to work with the new host cytoplasm.

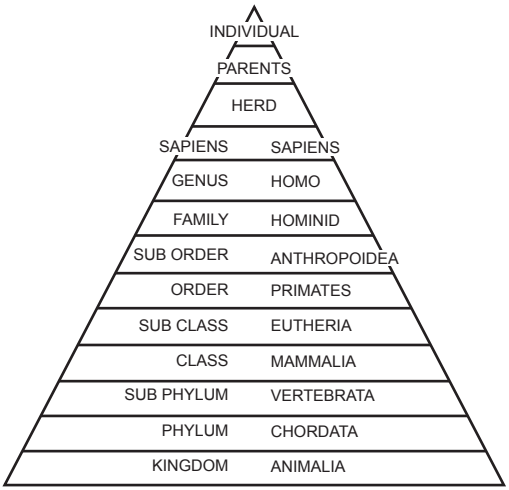

Fig. 6: When a cell differentiates, it respects its entire vertebrate ancestry. it thus has the humility to resemble structurally, functionally, and pathologically a fellow cell from any area of the vertebrate phylum. And yet, it manages to carry and assert the print of uniqueness characteristic of its owner organism, and itself.

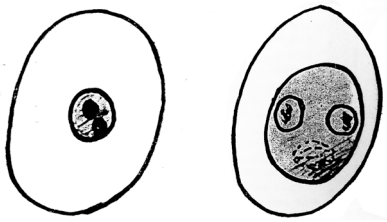

Fig. 7: In microscopic cyto-/histopathology, a cell is accused or exonerated on the basis of its nuclear features. But if every nuclear mood and appearance is dictated by a subtle and dominant cytoplasmic plan, it seems that we have been wrongly blaming the nucleus, so far. Our task of nabbing *the culprit* is marred by the fact that the cytoplasm has nothing like the nucleus that we can apprehend, comprehend, and then hurl a *j'accuse* at.

Merits of the New Hypothesis

The ultimate goal of all science, Hickman[14] generalized, is to devise conceptual schemes to explain the nature of the universe we live in. Each of our cells - "a better chemist and physicist than all the Nobel prize laureates put together"[25] - is a nouniverse (from nou = knowledge universe) the wonders of which are briefly wondered at in this paper. A conceptual scheme, if governed by two important tenets - of Occam saying that the basic assumptions should be minimal, and of Feynman,[7] that "Any discovery of a new law is useful only if we can take more out of it than we put in," - acquires comprehensibility, viability, and wider applicability. Occam's razor stands satisfied, as the new hypothesis only asserts that cell differentiation, in a metazoan, is cytoplasmically determined. Feynman is respected by the ability of the hypothesis to explain, in some measure, the major conundrums of cytology, as touched upon below.

1. Gestalt nature of the nucleus

   The cytoplasmic prerogative to call the nuclear tune allows nuclear equivalence or equipotenhality[14] of somatic cells - the zygotic nucleus, a normal diploid cell nucleus, and a cancer cell nucleus, belonging to an organism, are selfsame genetically. A corollary to this is the all-in-one gestalt nature of the nucleus. The imposition by the cytoplasm, of a differentiating field, on the nucleus,

activates widely scattered areas of the nucleus, beyond the coarser chromosomal, and the finer genetic barriers, thus accounting for the invention[2] of such apologetic terms as polygenes, split genes, jumping genes, and so on.

2. Nuclear redundancy

   "In eukaryons, at any given time, most of the DNA is not genetically functioning."[4] A common lamentation in cytology and genetics is that eukaryocytes carry, in their nucleus, DNA "in vast excess of any genetic requirements[20]- probably 1000 times greater than is needed. "What all that extra DNA is doing is one of biology's great riddles."[9] It has been computed that each of our body cells does not use more than 2–5% of its genetic potential. Why? Ask the nucleus to be all-in-one (see above), and then ask it to work with cytoplasm to produce one cell type-at-a-time and you have the answer. The cytoplasm, while differentiating the nucleus, activates only those areas of the nuclear DNA as are specifically needed to produce a cell type - say, an epidermal cell. The rest of the DNA material - up to 98% - is not "excess" but purposedly quiet in favour of the cell-type in question. That the DNA of all cell types in a human being should exhibit this quality of quietitude more than supports the cytoplasmonuclear relationship proposed here.

3. Individuality and stability of cytoplasmonuclear relationship

   "Differentiation is a strictly limited exercise. Once selected, the programme is normally remarkably stable and confusion with any other programme of gene expression is very rare."[20] The lack of confusion is because of "strong cytoplasmic commitment to the stable state."[20] The stability of the cytoplasmonuclear relationship is because of the differential response of nucleus to cytoplasm's command. As Maclean[20] generalises, "a differential cell is poised in a state of dynamic equilibrium between nucleus and cytoplasm, in which signals from the cytoplasm are necessary for the maintenance of

nuclear gene expression which characterizes that state." The most irreversible differentiation is to be found in cancer cells, entirely because of the cytoplasm calling the cancer-cell-specific-nuclear-tune.

4. Swappability and adaptability of the nucleus

   Nuclear-transfer experiments are, in a way, cytoplasmic-transfer experiments as well. But a cell, under such experimental conditions, is known and behaves by the cytoplasm it keeps. The nucleus, subservient to the differing calls of the cytoplasm in different cells, permits swappability by its ready adaptability to the new cytoplasmic host.

5. Failure of nucleism in cancerology

   Cytological diagnosis of cancer has rested on the assumed aberrations of the nucleus - hyperchromatism, mitotic figures, pyknosis, and so on. But this has led cancerology nowhere. As of today, cancerology is undecided about what a cancer cell is.

   Since even cancer cell nuclei are able to beget embryos on transplantation into enucleate zygocytes, a suggestion[27] has been made that cancer cell nuclei may be "perfectly normal." This exoneration of the nucleus from the cancerous crime makes cancer cytology more or less defunct, both microscopically and experimentally, since the cancerousness moves out from the easily describable nucleus into the amorphous, enormous cytoplasm. This explains why cells without a single microscopic aberration are known to behave most cancerously, whereas the most abnormal-looking cells may be most benignant.

6. Physiodifferentiation of cells

   A cell is an organ of behaviour, being known mostly by what it does or secretes rather than by what it looks. All lymphocytes or plasma cells are look-alikes but differ in their reactive or secretory behaviour. Within a given cancer, there may be a number of cell-lines, that looking-alike, have widely divergent behaviour. Save for such

> structurally specialized cells as neurones or muscle cells, the vertebrate body is composed of like cells - the liver or thyroid cell of one species or phylum refusing to differ structurally from its fellow in the other species or phyla. Differentiation, thus, is more functional than structural.

This state of "non-equivalence"[18] among cells "that look alike to the histologist"[18] is traceable to the fact that the individuality or the uniqueness of a cell is determined by the nebulous cytoplasm to which the nucleus follows suit. Szent-Gyorgyi's lament-"How can I differentiate between a normal cell and a cancer cell when I don't know what a cell is?"[30] - is a sweeping indictment of the failure of (even electron-microscopic) structuralism of modern cytology, readily understandable by the fact that a cell has never bothered to see how it looks as far as it did what it wanted to.

The paper would be incomplete if it did not point to areas of future research based on the new hypothesis. Hayflick limit is now a byword in cytology; future experiments would reveal whether this numerical limit to cell duplication resides in the cytoplasm or the nucleus. The tremendous specificity that a lymphocyte or a plasma cell exhibits against an antigen forms the basis of modern immunology. It will be a great day when an active, specific-antibody-secreting plasma cell will be given a nuclear swap, and the new nucleus would do exactly what its predecessor was doing. That would clinch the highly suspect superiority of the cytoplasm over the oversung nucleus.

Acknowledgement

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2

Cells and Yin-Yang Polarity (Towards Greater Similarity Between the Animate and the Inanimate)

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Abstract

A cell – plant or animal – is proving a bioelectric wonder already boasting of pyro-, piezo-, ferroelectricity, solid state and electretism as eminent exhibits and probable functional mechanisms. A cell, its parts, and its products owe the bioelectric boon to inherent and universal polarity pregnant with dipolar electromagnetic moment.

The cytologic bipolarity prompts a hypothesis that the cell and its world may be no exception to the working of Yin-Yang, the Taoistic concept o f all-pervading reality. Nuclear, cytoplasmic, gametic and zygotic considerations compellingly suggest that Yin-Yang does prevail, making us and,' our cells basically field-effects, thus erasing further the distinction between male and female, animate and inanimate, biomass and bioenergy.

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"The ultimate goal of all science is to devise and explain conceptual schemes about the nature of the universe in which we live. The more we learn of this nature the more we detect a basic unity in all science."[25] The latter generalization in the foregoing is all the more vindicated by recent findings that reveal each cell - animal or plant - to be endowed, in its nooks and corners, with polarity that was hitherto obtained in physics only; the polarity endows the cell with electromagnetism that Einstein[1] found as an all-pervading fundamental physical reality to which also the cell responds in varied manners.[4,39] This paper is an attempt at presenting a multidisciplinary synthesis that promises a better comprehension of cell structure and function.

Bioelectricity

A living cell defies definition. As an acronym, CELL could read Cytologic Embodiment of a Law called Life, or Coordinated Energy-ensemble Labelled Life. With the prominence gained by DNA - "the most celebrated chemical of our time"[19] - a cell is rightly called a biochemical wonder. Recent insights into the electrical activities going on in a cell suggest it being a bioelectric wonder, too.

Lowenhaupt[28] at a recent symposium on "Electrically Mediated Growth Mechanisms in Living Systems," generalised that "the electricity of a living cell is at the essence of its life," subserving such diverse functions,[2,28,29] as cell growth, cell differentiation, intercellular communication, wound healing, hormone actions, muscle tone, vision, other forms of sensory reception, photosynthesis, antibiotic action, the engram, cyclosis, and so on. Cells (plant or animal), their components including DNA, cell products such as cellulose, glucose, cholesterol, collagen, keratin and chitin, and tissues such as bone, tendon, nerves manifest, in varying degrees, piezoelectricity, pyroelectricity, ferroelectricity, solid state and electretism.[2,3]

Athenstaedt[2] pointed out why the recognition of such forms of bioelectricity was delayed: "The fact that the existence

of this material property (of pyroelectricity) was generally assumed to require a crystalline pattern may explain why it was detected in organic structures at such a late stage." Similarly, as Gross[21] remarked, "the strange behavior of electrets revealed by the early experiments, reinforced by Gemant's view that for theoretical reasons `they should not exist,' did much to shroud the electret effect in mystery." It is now being appreciated that living systems possess electromagnetic sensitivities "several orders of magnitude greater than predictable by present concepts of cellular or organismal physiology."[4] Lerchenthal,[27] emphasized the gross conceptual and instrumental limitations of modern physics when it comes to measuring the intracellular events: "Even the finest available electrodes have diameters of about 1 μm. This seems much worse than a sledge hammer and a fine wristwatch, because this diameter (1 μm) is many thousand times larger than atomic distances, which indeed is the level on which biologic systems operate." The potential gradient between two points, within a cell or a collagen molecule, may be thousands of volts per centimeter, not because the voltage is high, but because the distance is in angstroms.[18,27] But such phenomena are extremely difficult to analyse by most techniques.[11,27] Bioelectricity, a giant of the future, is still in its infancy at conceptual and instrumental levels. Today, electrets are industrially manufactured (e.g. microphones,[21] teflon vascular grafts[21]), and our bones have been found to be the loudest electrets.[31]

The Curie brothers Jacques and Pierre discovered piezoelectricity in 1880; pyroelectricity was elucidated by Lord Kelvin in 1877, ferroelectricity in 1920 by Valasek, and the electret state was conceptualized by Heaviside in 1890 and discovered by Eguchi in 1925.[2,21] The foregoing have been recognized as attributes of living material only as recently as 1964 and after. Yet, it seems, a great beginning has been made. Piezoelectricity - the "coupling between mechanical and electrical fields"[23] - involves production of electricity by mechanical changes, while the pyroelectric effect is produced by thermal changes. In ourselves, piezo-electricity may be realized from the observation that it

operates to make nerve "a lossless transmission line"[23] so that, although "nerves are such poor conductors of electric current,"[30] they manage to be "such excellent transmitters of electric signals."[30] Ferroelectricity implies spontaneous electric polarization such that the polarization can be reversed by an electric field.[40] The significance of this may lie in a cell's or its component's ability to check or reverse a course of action. Solid-state is a term borrowed from electronics implying the ability of such an object to control current without the presence of moving parts, heated filaments, or vacuum gaps.[40] Solid-state could also be defined as the physical state of matter in which the constituent molecules, atoms, or ions have no translatory motion although they vibrate about the fixed positions they occupy. An electret is etymologically and functionally analogous to a magnet. "A magnet produces a static magnetic field, an electret produces a static electric field."[21] Just as we regard the magnetic field as a store of energy,[14] the electretic field is an energy store that by its effects could keep cells together, or help store and retrieve information. Bone, collagen, gelatin, DNA, cellulose and many other biopolymers behave as electrets, making it a universal property of all biopolymers.[31] Water bound to biopolymers - "bound water" - is considered of fundamental biologic importance, as it also possesses the electret state.[31,32]

Bioelectricity is a boon derived from the "inherent dipole structure"[2] of all animal and plant tissues - a universal design whereby morphologic polarity imparts inherent direction of electric polarization that gives to the warp and woof of a cell, as also its milieu "electric dipole moment."[2] To name but a few structures that have been shown to be so polarized: DNA, collagen, keratin, chitin, feather, hair, teeth, bone, individual plant cells and organs, sensory receptors. At a grosser level, the human spinal cord constitutes "a permanent electric dipole over its entire length,"[2] with the negative pole cranially, and the positive pole caudally. The role of erect posture, legendarily emphasized in Yoga, may be related to the polarity of the central nervous axis that is best maintained with a straight back.

Hypotheses

The universal prevalence of polarity and bioelectricity could be taken as starting points to construct a hypothetical picture of cell structure and function. This communication presents[4] interrelated concepts: (a) CEM (CytoElectroMagnetism), (b) Polarity, (c) Pancytologism, and (d) Yin and Yang. The evidence for each of the concepts is sufficient, if not compelling.

CEM (CytoElectroMagnetism)

Electricity and magnetism *a la* Oersted and Maxwell are two sides of the same coin.[14] Now that we know of cytoelectricity as a potent operating force, CytoElectroMagnetism or CEM becomes etymologically and conceptually comprehensible. CEM, is then, the electromagnetic effect possessed/exhibited by a cell, its components or its products, not excluding "bound water" which may be tied up to DNA or a protein. The current scientific limitation *vis-a-vis* detection and measurement of CEM is well brought out by Florey:[18] For purely technical reasons it is impossible to measure directly the electric potential differences between individual ions or even those between the organelles of a cell. Undoubtedly there are electric potentials, for instance, between the surface of mitochondria and the surrounding cytoplasm, but there is no recording system small enough to measure them." Florey's[18] 1966 observation warranted no alteration when Lerchenthal' restated science's present limitations in 1974.

That CEM may have a lot to do has not yet hit the scientific conscious. The September 1976 issue of *National Geographic* carries a 42 page article on the "Awesome Worlds Within a Cell."[19] The only allusion therein to electricity is with reference to mitochondrial ATP: "ATP is the electricity of the system." Cytologic texts refer to the electrical potentials at a cell membrane, but there ends the story.

Becker[4] is at pains to underscore our ignorance and indifference: "Over the past decade, there has been a growing awareness that electrical and magnetic forces have specific

effects on living organisms. These effects are produced by forces of very low magnitude and are not explainable in such simplistic terms as Joule heating. They appear to indicate sensitivities on the part of living organisms several orders of magnitude greater than predictable by present concepts of cellular or organismal physiology." Becker[4] then cites a number of biophenomena mediated by electromagnetism, including the direct relationship between reversals of earth's magnetic field and the extinction of whole species in the geologic past. `Unfortunately, none of the effects are based on an adequate foundation of biological theory, and in fact, the key proposition of these effects, namely, that cells are capable of sensing and responding in a specific fashion, to levels of electric current/voltage or electrical or magnetic fields, is hardly universally accepted."[4] A brick in the conceptual foundation desired by Becker[4] could be formed by the proposition that CEM **(Figure 1)** is a cardinal feature that permeates the length and breadth of a cell, and that CEM operates by its field effects.

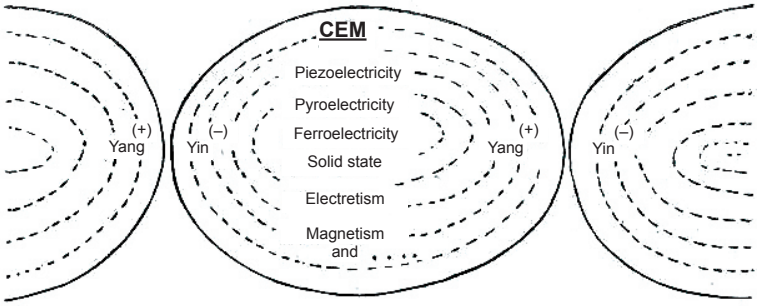

Fig. 1: The bioelectric wonder that we are. CEM may be discovered to have more faces than enumerated above. CEM consideratins do not exclude the pericellular and intercellular formed elementes and fluids.

The concluding para in *The Evolution of Physics by* Einstein and Infeld[14] bears the title "Physics and Reality", wherein the masters describe the mutation in physical thought: "The difficulties connected with the deflection of the magnetic needle, the difficulties connected with the structure of the ether, induced us to create a more subtle reality. The important invention of the electromagnetic field appears.

A courageous scientific imagination was needed to realize fully that not the behaviour of bodies, but the behaviour of something between them, that is, the field, may be essential for ordering and understanding events." The concept of CEM operating by its field may be taken as a paradigm of the "courageous scientific imagination," much needed in biology. As Einstein and Infeld[14] emphasize, "The field language" dictates that "the action is determined by the field." Cybernetically speaking, CEM pregnant with EM wave with velocity "equal to the velocity of light" may account for some awe-inspiring megafeats achieved in a split second by a microminiaturization called a cel1.[14]

A typical animal cell - "each cell a better chemist and physicist than all the Nobel prize laureates put together"[36] - is a microuniverse brimming with 300 trillion molecules[19] comprising discrete pieces of life "each performing with exquisite precision, and often in thousandths of a second."[19] The cell's master choreographer DNA operates its over 100,000 genes in a mass no greater than 0.00000000001 (10^{-11}) gm by acting as an "information tape" that duplicates itself, with incredible point-to-point precision, by its pair of polynucleotide chains unwinding (and simultaneously rewinding) at the rate of 10,000 revolutions per minute, the mechanism of this unwinding being entirely unknown, there being no enzymes to mediate it.[11] The genic genius of this information-tape lies in its capacity to give rise, in an almost omniscient manner, a unique individual, an Einstein, an elephant or a cancer, each unfailingly unprecedented, unparalleled, and unrepeatable. The whole tape is so compactly packed that the total human DNA would occupy a space no greater than an ice cube, but if joined end-to-end could stretch 400 times to and fro the Sun[19] (37.2×10^9 miles). Surely, we are dealing with entities that necessitate concepts that transcend the intricacies and the speed of the most advanced computers. If it is the EM field that makes a computer work, it is very likely that it is CEM that makes a cell work, the way it does.

Each one of us is made up of about 100 trillion cells, bound

into a cooperative whole without screws, rivets, or any "demonstrable intercellular material."[11,19] (What of a blue whale whose tongue alone is the size of a fully grown elephant, and whose cells are no larger than that of a mouse or man). And yet in this closely packed cytogalaxy, cells move ceaselessly with planetary ease and speed, during health, disease and repair. The cells do so without any pseudopodia or the space for them. It is proposed that only CEM could account for this, so to say, mobility in inseparability by variations of "attraction energy" and "repulsion energy,"[5] and by polarity that keeps the myriad cells stay put.[15]

Some other compelling facts are in order to drive home the conceptual imperativeness of CEM. A cell is a cold machine[30] that carries out its activities at temperature and pressure, surprisingly low in mechanistic terms, a point favouring the consideration of a cell as an electronic/electromagnetic entity. The temperature optima for unicellular and multicellular life is well below 50°C[6]. Cell membrane, stronger than stainless steel, can build up a potential difference across it so much as to generate 10,000 volts as in an eel.[30] The same membrane modifies itself to form receptors that transduce and amplify varied forms of input energy into different forms of output energy, with incredible sensitivity: "The hair cells in the mammalian cochlea and the sensory cells of the lyriform organs of spiders (to mention only two examples) respond with generator potentials to vibrations, the amplitude of which is lower than the diameter of a hydrogen atom."[18] The human retina can respond to an energy input of 5×10^{-17} watt, which at the input rate of 5×10^{-17} watt/sec. would take 10 billion years to accumulate enough electricity to light up a 15 watt bulb for 1 second.[18]

A cybernetic view of the human nervous system may suggest that the memory storage and retrieval may be occurring in it in much the same way, as in a computer. The CEM fields of dividing/divisible cells lack permanence that the inherently non-divisible nerve cells enjoy. Looking at it the other way, nerve cells had had to be indivisible so that the structural permanence allows the recording/reading-out of

information. Arthur Koestler[26] cites neurologists as claiming that only about 3 per cent of the human brain's capacity is called into use under normal circumstances. In Leonardo da Vinci or Einstein, it may be 5 or 10 percent. That makes human brain unimaginably efficient in its function, which in the current cybernetic context, sounds very much computer-like. Even if a nerve cell engrams itself by manufacturing a protein, the latter has its own electrical activity, so that the concept of CEM remains relevant.

Polarity, Complementality

In anatomic/biologic description, the popular descriptive term is *bilateral symmetricality*, a feature that allows the organism to be divided into "equivalent right and left halves."[25] But this equivalence is more an assumption than a reality In a human being, the right hand differs from the left in shape, palmprint, finger print, the right cerebrum from the left in gyri and sulci, the right eye from the left in refractive error, the right testis from the left in vasculature and position and so on. May be we are not bilaterally symmetrical, but complemental, a feature that makes its start right at the DNA/cell level, a master stroke that keeps the whole bio-world going.

James Watson,[43] in his celebrated The *Double Helix* mentions that a starting point in his discovery of the DNA was the realization that biologic things come in pairs. But then, in electricity also *there are only two kinds of charge, and magnetic poles always occur in pairs.* The electric/magnetic pairs are no way symmetrical but polar or complemental. The double helix that Watson and Crick gave to biologic thought comprises of two spirals that are in no way symmetrical, but polar or complemental. One cannot but conclude that Nature works, not only in pairs, but polar ones at that. Opposites are apposites.

It has been generalized that the cell uses and may be found to be using mechanisms that are not very different from processes which are already available in the surface films

of nature. If one travels backwards from the Watson-Crick pairity right down to the day DNA was conceived and formed, terrestrially or extraterrestrially[41] by Nature, one could say that She took hint from, say, magnetism wherein the north pole instantaneously induces the south pole and *vice-versa*. The outstanding quality of one DNA spiral is to induce the complementary spiral, and this singular feature seems to account for the whole history of biology. Such complementation by DNA extended to RNA solved the problem of manufacturing proteins/enzymes, the key operators in a cell. Life delights in begetting life precisely because the existing half-life delights in inducing the other-half. Even the so-called *repairing* of DNA is. in fact, re-pairing as may be clear from what follows: In the "dark repair process" mediating "Repair of genetic material in living cells," the intact strand of the damaged double-stranded DNA is utilised to induce the formation of the damaged complementary strand, thus repairing itself, or more truly, re-pairing itself.[24] Hanawalt[24] generalized that "the existence of such a mechanism provides a possible explanation for the evolution of a double-stranded (redundant) form for the genetic blueprint in all living cells." Even the replication of "single-stranded" virus[30] is no exception to the above re-pairing. The "+" (plus) viral strand gets into a bacterium to induce the "-" (minus) strand, thus forming, the double-helix which then copies itself as usual.[30] The branding of double-stranded DNA as "redundant"[24] form betrays (a) the obsession that only a single strand of DNA is enough for directing RNA for protein synthesis, and (b) the lack of appreciation of the polarity/complementality that permeates a cell right up to its heart, called DNA. Does this redundancy idea mean that all the somatic cells carrying both paternal and maternal chromosomes/DNA, have triply redundant DNA, as well as redundant chromosomes, the latter redundancy being thought of, since *E. coli* manages with a single unpaired chromosome, and since it has almost become an article of faith that if it happens in *E. coli*, it must also be happening in an elephant?

"For every paternal chromosome in diploid nucleus, there is

usually corresponding maternal one with same form, size, and genetic function. Cell structure, function and replication become greatly clear if it is realized that the two sides - paternal and maternal - of a cell represent a fundamental polarity/complementality, or as the Chinese would put it, the Yin-Yang halves of a cell, Yin-Yang **(Figure 2)** represent the eternal opposition of, and balance between the female (Yin) and the male (Yang) principles of the universe.[44] The Taoists use this symbol to represent their basic law of existence: harmony through dynamic balance of opposites.[40] "One Yin and one Yang," so generalizes Alan Watts[44] in his *The Two Hands of God*, "that *is* the fundamental principle. The passionate union of Yin and Yang and the copulation of husband and wife is the eternal rule of the universe." Describing Yin and Yang as the polar-opposites, Watts[44] explains: "What, exactly, is polarity? It is something much more than simple duality or opposition. For to say that opposites are *polar* is to say much more than that they are far apart; it is to say that they are related and joined - that they are the terms, ends, or extremities of a single whole." As Lin Yutang,[46] the modern Chinese philosopher puts it, the interplay **(Figure 3)** of the dual forces - Yin and Yang - is "the basis of all life, all universe, and all history." The purpose of this article is to generalize that, taking, say, a human being as an example it is possible to appreciate the Yin-Yang polarity at gametic level (ovum as Yin, sperm as Yang), at the somatic cell level where throughout the cell Yin

Fig. 2: Symbolic representatin of "two principles, one negative, dark, and feminine (Yin), and one positive, bright, and masculine (Yang), whose interaction influences the destinies of creatures and things."[40] Phonetically and etymologically, Yoni and Lingam the Indian counterparts of Yin and Yang, appear closely comparable.

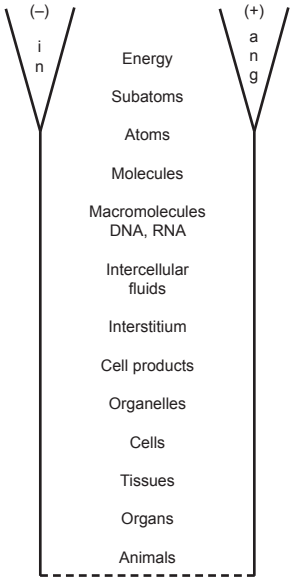

Fig. 3: We know not where does Yin-Yang polarity starts or leaves off.

and Yang polarity prevails as best exemplified by the pairing of paternal and maternal chromosomes, and at the molecular level where the polarity of charges gives the tiniest thing in the cell a dipole moment responsible for production of CytoElectroMagnetism (CEM) to run the affairs of the cell. Before taking up Yin-Yang, however, we may profitably be through with pancytologism.

Pancytologism

Nucleus, chromosomes and mitosis have, for too long, dominated, as terms and concepts, the cytologic scene by the reason of their compelling visibility, making many more important aspects of cell structure and function appear insignificant. "The development of cariology (nucleology) was somewhat detrimental to the study of the cell as a whole."[11] Chromosomes, representing a convenient organellar mechanism for conjugation and/or carriage during cell division, are basically functionless entities that form the most dominating feature of a "morphological event"[34] called mitosis. A functioning cell - interphase cell - shows no chromosomes, and non-dividing cells such as

neurones show them never. A cell-to-divide doubles all its components during interphase – the most featureless and yet the truest, functioning state of the cell.[11,34] The choreography of cell division (mitosis) needs the structural convenience of chromosomes that show up during metaphase. And the chromosomes just show up: "The use of the electron microscope has contributed disappointingly little to precisely those areas of cytology that were at their most developed stage during the heyday of the light microscope. The best electron micrographs of the metaphase chromosomes show only homogeneous granular masses."[30] The totally passive role of the oversung chromosomes even during the mechanical function of mitosis is piquantly expressed by Mazia[33] who parodied that "the role in mitosis of the chromosome arms, which carry most of the genetic material, may be compared with that of a corpse at the funeral; they provide the reasons for the proceedings but do not take an active part in them." Significantly enough, RNA-synthesis (indicating that a cell is functioning) stops during mitosis because condensation of chromatin as chromosomes prevents all DNA function. Nucleus, with its dominating chromosomes, is no longer the be-all and end-all of a cell, as has been thought of and taught so far.

A change in cytologic thinking is discernible. The neglected Cinderella named cytoplasm is coming into its own. Teminism – cytoplasmic RNA-directed DNA synthesis in the nucleus – is a disproof of the *central dogma* of molecular *biology* that has so far been denying cytoplasm this right to direct its presumed master, the nucleus. Various mitogenic stimuli are, directly or indirectly, controlled by the cytoplasm.[22,34,35] During mitosis, the nuclear membrane disappears, and the nucleoplasm is continuous with the cytoplasm.[11,34] Cytoplasm has "self-replicating" organelles - centrioles, plastids, mitochondria - that are endowed with genetic autonomy, a fact that underscores the role of the cytoplasm in transmission of the information from one cell generation to the next.[7,11,12,34] Cellular differentiation involves not only the nucleus but all the cytoplasmic components as well.[7] Nuclear transplantation experiments involving transfer of nuclei from

somatic cells into enucleate zygotes suggest that embryonic organizers are more likely a function of the cytoplasm rather than the nucleus.[17]

Summarizing, one could say that cell structure and function can no longer be viewed in such isolationistic concepts as of nucleus, chromosomes or mitosis. A cell should be viewed as a gestalt entity exhibiting throughout its length and breadth Yin-Yang polarity, vital to its existence and function.

Yin-Yang

The assumption of Yin-Yang (female-male, Eve-Adam, negative-positive) polarity in a cell offers explanations for such remarkable cytologic features as rapid duplicability with total fidelity (ToFi), cell differentiation and function, gametogenesis, and embryogenesis.

ToFi Duplicability

Loewy and Siekevitz,[30] in the epilogue to their voluminous *Cell Structure and Function* remark almost in Galilean style, that although we are ignorant, "yet the cell replicates with remarkable precision and predictability."

The pancellular Yin-Yang polarity provides a rapid, almost automatic and precise way of duplicating a cell as unique as an individual organism. The astounding rapidity - in a developing fetus, cells form at an average rate of 240000 per second;[37] repairing liver cells multiply as fast as the fastest liver cancer;[29] roots of rye plant grow by an aggregate length of 53 miles per day by average addition of 99,000 cells per second[38] — is a function of Yin's ability to induce Yang and *vice-versa*. The mitotic wave travels in a cell probably along a predetermined path, separating Yin and Yang pairs all along. Yin stays not without Yang and vice versa and the whole cell doubles itself. The double Yin and double Yang, so formed, repel each other leading to repulsion of the doubled cellular contents equally and precisely into two daughter cells, where restitution completes the formation of two individual daughter cells. The operational mechanism

could be expressed as SIRRR: mitotic wave → Separation → Induction → Replication → Repulsion → Restitution.

The converse corollary of the SIRRR mechanism is that in the absence of the mitotic wave the juxtaposed polar-opposed Yin-Yang components exercise a restraining influence on each other providing the cell great stability and no chance for any DNA duplication. The non-dividing cell populations, also called static or perennial, may be enjoying their legendary stability against a wide variety of mutagenic/mitogenic agents due to the facts that (a) there is no cytoplasmic arrangement for the transmission of a mitotic wave, and (b) the juxtaposed Yin and Yang stabilize each other. A proof of point (a) is available from the observation that the never-dividing nerve cell nucleus readily duplicates when transplanted into suitable cytoplasm.[10] The proof of (b) is an involved one: E. coli, for example, has almost continuous and rapid replication,[11] *a unicellular* feature dispensed with by Nature with the emergence of a *multicellular* organism which, for being itself, needed the faculty of *eutely*[25] meaning constancy of cell number. Eutely is mediated by cell replication, but more importantly by the check on replication - a faculty enjoyed by cells that have paired chromosomes with Yin-Yang polarity. Eutely in an organism and the diploidy of cells seem to have evolved hand in hand.

As a paradigm of the SIRRR process, one could take DNA, which in a body cell is in two polar forms - maternal and paternal. Juxtaposed, they form a stable quartet of 4 DNA-helices. Separated, on passage of mitotic wave, the two maternal helices replicate, and so do the paternal, leading to a double-dose of Yin (maternal) and Yang DNA. Yin repels Yin, Yang repels Yang, accounting for the so-called cytokinesis whereby a pregnant cell separates into two. As a convenience, the helices condense as chromosomes which then travel over the mitotic spindle. Brown and Bertke,[7] in their chapter on mitosis, generalize that, "all of the extant hypotheses of chromosomal motion were discussed by Schrader in 1953. Then, as now (up to 1977), there was no acceptable hypothesis to account for all chromosomal

movements. But that is true of all cases of protoplasmic motion. Cells and cell organelles do move, but we cannot explain the movement, we can only describe it." Yin-Yang polarity explains this and more. It is of interest that the mitotic spindle that stretches between two centrioles (which themselves multiply in Yin-inducing-Yang fashion) has close resemblance to a magnetic field between two magnetic poles. Further, the mechanical work of splitting the chromosomes and the cell is least energy-consumptive,[11,34] a point in favour of CEM operating.

The ToFi with which cell duplication occurs is a function of *my* Yin inducing only *my* Yang, and in *my* kidney cell, *my* kidney *Yin* inducing only my kidney Yang. It is common knowledge that a kidney cell is one in which the kidney genotype is manifest, all the rest of it being suppressed. When a kidney cell duplicates itself, it should not happen that during the apparently chaotic process of cell-duplication, a change occurs and instead of two kidney cells, there get produced two gastric cells. With metazoism, came differentiation and with that came the need not only of a templatory-mechanism but a regulatory-one too, to see that the liver cell begot liver cell and not a goblet cell, like the one lying in the adjacent intestine. With Yin and Yang together, Yin serves as *a regulate* for Yang and *vice versa*. An immediate corollary of this is that cells having only Yin (ovum) or only Yang (sperm) are neither differentiated nor can multiply. How true! The gametes are the most non-functional and non-differentiated cells that are biological dead-ends, manufacturing no protein and incapable of dividing despite being endowed with enough double-helical DNA.[7,11] DNA, with all its genius for duplicating itself by templatory mechanism as so simplistically illustrated in textbooks, fails to replicate itself (in a gamete), being able to do so, (in somatic cells) only where it finds that a regulatory polar opposite is available.

Differentiation

"In the case of phenomena such as cell differentiation, we have not even begun to conceive of a productive experimental

approach."[30] We know nothing about cell differentiation - "a riddle wrapped in a mystery inside an enigma"[19] - whereby our 10,000 billion cells behave in a 100 different and specific ways despite the fact that each cell, like the parental zygotic cell, enjoys the total genotype. *A la* Jacob and Monod, such a process is explained by "the modern but very significant aphorism that all genes do not function all the time."[7] Another way of putting it is to say that "large amounts of DNA have no apparent function. Nobody knows why it is there. What all that extra DNA is doing is one of biology's great riddles."[19] Yin-Yang concept could help.

A zygote is formed by union of Yin (ovum) and Yang (sperm) cells, both of which are metabolically inert, endowed as they are with totally "inactive DNA."[7,11] No wonder that the zygotic cell is so featureless and functionless, secreting neither, say, saliva nor secretin. The zygote primarily functions[17] to rapidly form a large bunch of like cells which after a certain number of divisions, programmedly secrete embryonic organisers that induce differentiation.

The way to make a cell be it a gastric or prostatic cell when it could be everything else is to make Yin and Yang DNA (derived from mother and father) create field effects **(Figure 4)** in the functional area (less than 5%) of the genotype. This could be done by pushing Yin and Yang apart, making them thus look rarified and invisible - a prime structural feature of functioning DNA called euchromatin. In the much larger (over 95%) remaining genotype, the Yin and Yang could be allowed to be close together, too close in fact, automatically because of mutual attraction, to obviate a field effect, and to create a compact, visible mass of DNA that is functionless and is called heterochromatin. As De Robertis et al[11] observe "heterochromatin represents condensed regions of the chromosome. Electron microscopic studies have demonstrated that it consists of chromatin fibers identical with those of the nonheterochromatic region, except that fibers in heterochromatin are more tightly folded. This property may account for some of the metabolic peculiarities of heterochromatin, particularly the absence of RNA

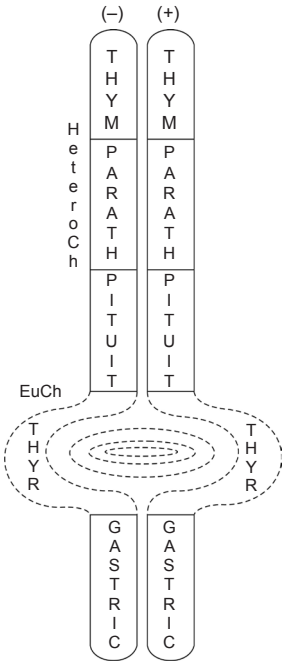

Fig. 4: Euchromatin is justifiably puffed up with the pride of working actively for a cell, albeit invisibly behind the prominent foredrop formed by the inactive heterochromatin. "Puffs ... can be interpreted as sites in which genes may be active ... in transcription of specific RNA molecules."[11] It is likely that the euchromatizing influence on the nuclear DNA is exerted by the cytoplasm, keeping the cell thus "differentiated." A cell functions a la the fields that its Yin and Yang create. If Eddington felt that the stuff of the world is mind-stuff then one could say that the stuff of cells and life is field-stuff.

The bio-innovation of spore/seed is an ingenious mechanism of "desicatting" a diploid, zygotic cell to the point of inactivation of euchromatin by denying the cell bound-water enough to keep the Yin-Yang elements of euchromatin apart. The process renders the cell metabolically dead, but survivably almost eternal. On re-entry of water, the spore/seed germinates to give birth to a fully formed bacterium, protozoon, or a plant.

synthesis, the genetic inertness and the late replication." This explains why cancer cells which are busy doing nothing have the highest quantity of heterochromatin that makes the nuclei hyperchromatic and pyknotic - a diagnostic feature of cancer cells that cancer pathologists and cytologists heavily rely on, but falsely so for nuclear transplantation experiments[45] strongly suggest that the malignancy of a cancer cell lies in, and is governed by the cancer cell's cytoplasm, the nucleus playing a subservient role.

Differentiation thus becomes, in cells cancerous or normal, the selective synergization of Yin and Yang elements in a diploid cell. Such mechanism must be operating with ease and uniformity throughout the vertebrate phylogeny from the fishes to the ferrets making the liver cells from different species exhibit similarity - in fact, a clannish disposition.

What could be the mechanism of selective Yin-Yang separation/fusion in the nucleus of a differentiated cell? (Cancer cell, too, is a differentiated cell). Cytoplasm seems the answer. It is accepted that cytoplasm, "the true internal milieu of the cell", mediates cell differentiation by controlling nuclear DNA.[7,8,11,14,22,34,35] The cytoplasm of thyroid cell pulls apart the nuclear Yin from Yang in the thyroid region of the genome to create functional field-effect; the rest Yin-Yang not subjected to any pulls get struck together, like the N and S poles of a magnet to form the inert but very much visible part of the nucleus. The early replication of euchromatin and the late replication of heterochromatin get explained by the fact that the former is already separated (thus sort of poised for SIRRR initiated by the mitotic wave) in contrast to the compactness of the latter.

Granting cytoplasm the onus of differentiating a cell brings home the relevance of pancytologism: A cell begetting a cell in ToFi fashion must not only have the nucleus duplicating it precisely point by point, but even the cytoplasm, for it is the latter that is going to *keep* the nucleus "differentiated." Let us hail pancytologism and cytoplasm.

Cells: Gametic and Zygotic

"A hen is only an egg's way of making another egg."[9] But Butler's facetious aphorism.[9] fails to convey the true story. A hen, can produce an egg, but an egg can not reciprocate, being biologically but a dead-end. It can neither produce another egg, nor can it produce a hen (an organism) unless complemented by another biologic dead-end, a sperm. An egg that makes a hen is not an egg, but a zygote. In polar parlance, an egg is Yin (a negative cell) that must be complemented by

the positive Yang before anything can happen.

The Need for Gametes

In 1892, the need for meiosis (halving of chromosomes) in gametogenesis was intuitively theorized - "a postulate that was quickly confirmed cytologically by others".[25] But gametogenesis is not mere halving of a cell or its chromosomes, but the production of polar opposite cells: "Rather typically, the gametes that unite are somewhat different from one another.... the extreme contrast (is) of sperm and ova."[7] And these cells, although a great contrast one from another, have a pristine powerful affinity for each other - reminiscent of Yin's love for and dependence on Yang, and vice *versa*. Introduction of a microneedle between the two pronuclei of a recently fertilized egg, revealed that the two pronuclei acted as if attempting to overcome the resistance and complete the conjugation.[7,11]

The generalization that the "formation of gametes is more widespread than even sexuality"[7] more than emphasizes the indispensability of gametes in the genesis of metazoic organisms. At unicellular levels too, polarity exists as exhibited by the *plus* and *minus* strains of some algae, fungi, and protozoa.[7] Even a plus strand virus getting into a bacterium, first gets for itself a minus strand, and the two together, constituting Yin with Yang, as it were, multiply. The host bacterium eventually releases only the plus strand to the outside.[30] This viral phenomenon most cogently illustrates what happens at the, say, human level: A sperm (*plus* gamete) meets an ovum (*minus* gamete), and the two put together form the adult male which then releases only the plus cells - sperms. If the adult is a female, only the *minus* cells are released - ova. Butler could be paraphrased to say that an egg meets a sperm to produce a hen or cock to get once again an ovum or a sperm.

The Nature of Gametes

An ovum and a sperm are more important than the sexes they represent. If in mammals and drosophila, it is the sperm

that determines the sex of the offsprings, it is the ovum that dictates this in birds, reptiles and fishes.[11] In bees, it is the sperm that makes a female, the unspermed egg producing a male.[25] Further during the meiotic conjugation preparatory to the formation of an ovum or a sperm, the paternally derived chromosomes freely exchange genetic material with the corresponding (homologous) maternal chromosomes,[7,11] sex chromosomes being no exception.[16] Thus **(Figure 5)** a testis prepares sperm without any paternal bias, and so does an ovary, without any maternal bias. What the testis does is to give rise to a Yang (active) cell, homologous to the Yin (passive) produced by the ovary.

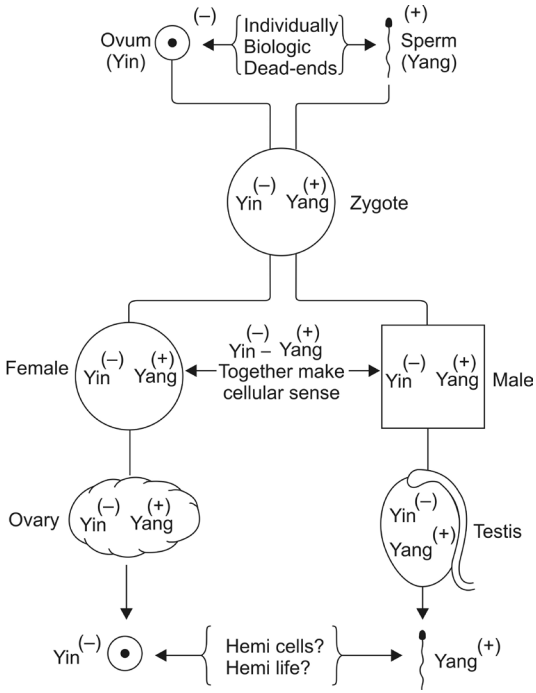

Fig. 5: Cytogenetically, male and female are not sex-tight compartments; biology thus offers great rationale for the unisex cult. May be this inspired Emerson to say that the finest people marry the two sexes in their own person.

Just as the foregoing asexualizes sperm and ovum, the individual they produce, female or male, is neither exclusively female nor exclusively male, but a balance of the two, a

phenomenon that is the best tribute to the inseparability of and the cooperation between Yin and Yang. "Sex determination is the result of a genic balance between factors of maleness and femaleness that are present simultaneously in each sex."[11] In genetic terms, in every human being, factors controlling maleness and femaleness are codominant. Each human being is thus a hermaphrodite, the HERMaphrodite being males, and the hermAPHRODITE being females, depending on which way the balance tilts. (No wonder, there are many shades in between, mindwise and/or bodywise). "The realization of the wholeness of human personality always depends on the development and integration of both (feminine and masculine) sides. This discovery is deeply confirmed by the Asian symbol of Tao, the great life swinging between the poles of Yin and Yang."[42]

It is interesting to note that testis produces both adrogens and estrogens, and so does the ovary, in differing proportions. Even gross anatomic structures tend to be sex-indifferent:[20] "The arterial blood supply, venous and lymph drainage and the nerve supply of the structures comprising the external genital organs of the female are similar to those relating to the homologous structures in the male." In endocrinologic practice, the terms feminization of a male and the masculinization of a female speak for the inherent balance of two polar forces, in clinical terms.

"It is an intimidating thought that there is more information on organic chemical synthesis packed into the head of a spermatozoon than in all the 200 volumes of *The Journal of Biological* Chemistry."[8] The same could be said of an ovum. Yet, left on its own, a sperm or an ovum behaves as a biologic dead-end, incapable of doing anything. No cell could be metabolically more inert - "for weeks, months, or even years."[10,11] Yet these dead cells (sperm can be stored frozen-dead for a millenium) beget *life*, once brought together. Could one say they constitute half-life or half-cell? Knowing the universality of Yin-Yang, it would be quite scientific to say that an ovum is Yin, sperm is Yang and we all are the embodiments of Yin-Yang, - the Wattsian *Two Hands of God*.[44]

CEM, Yin-Yang

A la Einstein,[1] CEM (CytoElectroMagnetism) and Yin-Yang are, as concepts, free creations of mind which have the merit of allowing us cytologically, genetically, and biologically to take out more than we put in. As such the borderline between the animate and the inanimate is hazy; CEM and Yin-Yang erase the line further thus justifying the growing basic assumption that living matter and physical matter are part of the same continuum and subject to the same natural laws. If Einstein abrogated the dichotomy between matter and energy, CEM and Yin-Yang could do a similar job by presenting all of we living as essentially field-effects. The molecules making us provide the matter, the abstract but greater truth between the molecules makes us what we are, for better or worse.

Modern genetics and cytology has had a chequered career: We taught that there are 48 chromosomes in a human cell, till Tjio and Levan proved them, in 1956, to be 46.[16] We gave Beadle and Tatum Nobel prize for their one-gene-one-enzyme hypothesis. Soon things changed completely, upsetting this Nobel-winning view. Without ever defining it precisely even for once, we have talked and talked *of a gene* or *the gene*, to learn only recently that a gene or the gene is far more complicated.[13] May be, one service that CEM and Yin-Yang may do is to provide some more denouements in our thinking on cytology and genetics. CEM and Yin-Yang claim no more than pointing a finger towards a possibly different way.

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5

Bipolar Hermaphroditism of Somatic Cell as the Basis of its Being and Becoming: Celldom Appreciated

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"Our planet has the wrong name. Our ancestors named it Earth, after the soil they found all around them …. If the ancients had known what the earth was really like, they would undoubtedly have named it Oceanus after the tremendous areas of water that cover 70.8 percent of its surface".[1] The modern humans, knowing that the earth is the only place in the entire universe that can boast of an entity called cell, could do better by renaming or additionally naming earth as the planet *Cytos*. The Orwellian red light[2] that thought corrupts language and vice versa has its antithesis in innovative language expanding human thought and vice versa.

The term cell was rather unpoetically conceived by Hooke[3] in 1665 while viewing the spaces in a piece of dry cork. Partridge[4], the ace etymologist, traces cell to *hall*, being

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synonymous with *cellar, hell, hole*, with Webster[5] going one worse by synonymising it with grave and Roget[6] matching the same by equating *cell* with *jail* or prison.

From the time it evolved over 4 billion years ago, the cell has remained unchanged in its omniscience and omnipotence manifestly enshrined in DNA, D signifying Development, or Brahma, N nurture or Vishnu and A annihilation or Shiva, thus meriting its equivalence with GOD that Generates, Operates and Destroys. The Greek concept of cosmos as signifying supreme order finds its configuration as cell that can rightly be called CosMos, the Mos representating Maternally organised self, and Cos its Contrarily (hence paternally) organised self. Biology, comprising microbial/phytal/animal kingdoms orchestrates its entire play using a single player, called the cell that like the Lord in Indian scriptures proudly declares *Eko aham bahusyam*, I am one, I become many. The amazingly immeasurable versatility of this entity called cell forces upon us some poetry to acronymise it as Cosmic Ensemble Labelled Life, a bipolar unit that can be called CosMos. The compelling bipolarity[7] of a cell is reason enough to rename cell as CosMos, governing as it does cell structure, function, and gametisation as well as replication.

Towards a Definition of Cell

A cell is what it is, for it does what it does, and it does what it does, for it is what it is. This definitional circumlocution deserves its inspiration from the way matter was attemptedly defined in the 1960s.[8] The circumlocution is helpful in elucidating the why of what a cell is, and the how of what a cell does. Towards that end, let us analyse some of the outstanding features of a cell.

"The evidence strongly affirms that all life on Earth descended via this branching process from a common ancestor. That is, every person, every animal and plant, every invisible bacterium, can be traced back to the same tiny microbe that lived billions of years ago, and thence back to the first living thing.

"The living cell is the most complex system of its size known to mankind. Its host of specialised molecules, many found nowhere else but within living material, are themselves already enormously complex. They execute a dance of exquisite fidelity, orchestrated with breathtaking precision. Vastly more elaborate than the most complicated ballet, the dance of life encompasses countless molecular performers in synergetic coordination. Yet this is a dance with no sign of a choreographer. No intelligent supervisor, no mystic force, no conscious controlling agency swings the molecules into place at the right time, chooses the appropriate players, closes the links, uncouples the partners, moves them on. The dance of life is spontaneous, self-sustaining and self-creating".[9]

The foregoing poesy and eulogy aren't the prerogative only of an Einsteinean cell, but are fully deserved by the first bug that inhabited the earth. British biologists have discovered[10] the *Methuselah Bug* that as the world's oldest creature has lived up to 260 million years, and is rightly called the "Mother of all life forms". The much-sung Vedic attributes of *Brahman as smaller than the smallest and larger than the largest* are readily seen in celldom's range from Methuselah bug to the blue whale of 100 tons. The genius enshrined in both is *identical*, their manifestations only seemingly different.

Such Vishnuesque versatility of cell cannot reside in a cell's materiality, for a cell is hardly any matter. If the whole earth when reduced to pure mass measures no more than "the size of a Ping-Pong ball",[11] then a cell that needs 100 of its members in a file to measure a mm. can really be no matter. A cell's consistent unchanging selfsameness from the time of creation, allows it be qualified as a fundamental bioforce of Nature, best called Biomattergy, short for Biological Matter-n-energy, that is as fundamental as a light wave, and like it, behaving both as matter-n-energy.

A cell's mind/heart is the nucleus which is but 2% of the cell's volume which by itself is unimaginably tiny. Cytoinformatics decree that the DNA of any cell is triscient, endowed with the total history of biology backwards, and forwards to

see to it that a particular cell asserts its individualality, its uniqueness. Therefore in terms of sheer knowledge content, a cell behaves like a microchip, a nuclear feature that has its perfect bipolar mirror image in the cytoplasm. The Indian concept of *trikalgnan* or tritimensional knowledge is effortlessly exhibited by the minutest microbe. It's been said that the difference between *E. coli* and Einstein is too small, and that between *E. coli* and the supermost computer is too big, albeit in favour of the knowledgeability of the cell. Lewis Thomas[12] to illustrate the genius of a cell, suggests a wager: In the intestine of the white ant is a symbiont micro-organism *Myxotricha paradoxica*. He implores that the world's atomic warheads be linked to a computer that would fire them all the moment science knows all about the microbe. Thomas hastens to assure that, even a 1000 years from now after 1000 years of work, the computer read-out will be: "More information, please!"

In the paradox of a cell's dividing so that it can multiply, microscopists discern chromosomal choreography played on thready spindles, hence called mitosis, from *mitos* = thread. To what the chromosomes do, the myriad cytoplasmic structures generally called organelles follow, at such remarkable precision and speed that the whole drama in its ease and rhythm resembles the effortless replication of electromagnetic waves. "In a way DNA acts as cell's god, a designation appropriately spelled out in the Latin word *deo*, which forms the first three letters of deoxyribonucleic acid. And, godlike, it broadcasts its omnific decrees at electronic speed through a technique so intricate and awesome."[13]

If all the tightly wound DNA in even a single cell nucleus of your body were uncoiled and the pieces laid end to end, the invisible genetic thread would extend five feet, which would make the DNA in all your 100 trillion cells stretch out 100 billion miles or enough to reach to the moon and back 200,000 times. The gastro-intestinal track exfoliates in 22 days a cell number equal to the entire cell population of the human body. So just the gastro-intestinal tract manufactures 2.25 billion miles of genetic thread in a day, a feat that can

only happen if the cell's choreography works at the speed of light. A cell, then, is a configured wavedom.

Rounding up, one can say that a cell comprises a trinity of immeasurable knowledge and communication stretching over areas of space-time, a materiality of nucleus and cytoplasm, both exhibiting the greatest complexity in the whole universe, and a speed of working that reminds you more of electromagnetism than anything else. Just as God makes no mistake, a cell actually never does. It is the highest state of configured order, a true CosMos. Between the ever-expanding macrocosmos and the microcosmos of atomic particles and superstrings, a cell represents a perfect in-between and rightly merits the appellation CosMos. CosMos is then no longer a mere concept but a palpable reality visible, experimentable, culturable and with all that, totally inscrutable.

It is time to essay a definition of cell, which *prima facie*, is *little matter* and *a lot of mind. A Dictionary of Science*[14] defined *matter* as "A specialised form of *energy* which has the attributes of mass and extension in *space* and *time*". The foregoing permits de-mattering a cell. A cell, then, is cosmically configured constellation of energies with eminent attributes of electromagnetism and thus of bipolarity, wherein the mind or information content of the cell asserts its uninterrupted continuity with life's total past, total present and total future by manifest uniqueness of form and function, thus illustrating, amongst many others, the principle of (Lovejoy's) *Great Chain of Being*[15], and the TITE axiom that through *Total Inclusion* a cell achieves *Total Exclusion*[16, 17] to beget its unfailing uniquation. An ordinarily labelled "Spheroidal cell carcinoma of the stomach"[18] is what it is through its effortless communication with all spheroidal cell stomach cancers of the total human past, present and future, a cosmicality that is, alas, too large, to be amenable to the hopeless locality of all forms of cancer treatment.

Blessing of Bipolarity

Isaac Asimov, the most prolific science-writer, pointed that

the universe is electrostatically neutral for there is as much negative charge as there is positive. Magnetically too, the universe must be neutral, there being as many N poles as S poles. These, and other such, *polar-opposites* are more truly *polar-appositeS*. Without one, the other is naught. Each polar-apposite evokes, gives meaning to, balances the other, their co-operative symphony begetting the manifest universe. In the epochal Einsteinean equation $E = MC^2$, the C stands for the unflagging constancy at which "light" and all other electromagnetic radiations travel. This C owes itself to the polar-appositeness of particle/wave that comprise light, the *yin* of which begets *yang* and vice versa, on and on, till eternity. All this is through the divine faculty of *pairacity* of a template begetting its polar-apposite. The electronic spin in an atom and the alacrity with which the DNA double-helix duplicates itself are all an outcome of the duet sung by polar-apposites, each pair representing so to say, the *Ardha-Nar-Narishwar* or the *HermAphrodite*.

The burden of this article is to propose that much as the duplication of the bihelical DNA is interplay between the Pa-helix and the Ma-helix, all components of the cytoplasm play a similar game to provide rapidity of cell-multiplication, with assured Total Fidelity to the original. The oxymoronic synonyms, namely cell-division is cell-multiplication are rooted in confused concepts that merit clarification.

Does the cell divide to multiply or multiply to divide? An unhurried look at the divine choreography called mitosis universally reveals that the cell first multiplies not only nuclearly but, *pari passu* cytoplasmically. The cell Siamese-twins itself to double all its components, as it were, from cell's head to foot. Thereafter, the twins "divide" to beget 2 cells. The holy indifference accorded to cytoplasm in all descriptions on mitosis is traceable to its nebulousness that refuses to lend itself to microscopic studies. Much of cytology is nucleology for the nucleus is, now and again, dense enough to be describable. When it is not, cytologists do not mind giving it a short shrift even when the nucleus is at its functional best: "The interphase (or postmitotic or

nonmitotic) nucleus is of great biological significance, as demonstrated by biochemists and others. Yet, cytologically, it is not very exciting. The chromosomes can hardly be seen or studied and the nucleus just sits there, as observably inactive as a sleeping dog and as static as the old term for this nuclear condition, 'resting stage', indicates".[19]

Much of microscopic cytology is *nucleism* that concentrates on the nucleus to the point of neglecting the cytoplasm. And much of nucleism is *mitotism* that takes advantage of the dysfunctional condensation of the cell's DNA to form compact identifiable chromosomes whose irrelevance even vis-à-vis mitosis was summed up by Mazia[20] 4 decades ago: "The role in mitosis of the chromosome arms, which carry most of the genetic material, may be compared with that of a corpse at the funeral; they provide the reason for the proceedings but do not take an active part in them". The whole science of karyotyping that has now culminated into the Human Genome Project is a science of chromosomal shapes and sizes that are irrelevant to the actual workings of any cell.

Nuclear transplantation experiments have assigned primacy to the cytoplasm with the nucleus playing a second fiddle.[21] Sans cytoplasm, nucleus fails to survive; cytoplasm can carry on all alone for months together.[22,23] The most galling point against nuclear supremacy is Dolly-making, or cloning whose success demands the ovular cytoplasm as the indispensable *sine qua non*. You could do away with the nucleus of the ovum, of the zygote, as also with the sperm itself as far as the ovular cytoplasm is given a diploid nucleus of the same species. If one were to search for the most informed/evolved cell, one need not look beyond the cytoplasm of an ovum that *alone* carries the entire blueprint of a worm or a whale. *Vive le cytoplasm*.

A glaring semantic error characterising the cytoplasm *versus* nucleus controversy is the prefixial inconsistency of having 83 terms[24] beginning with *cyto*, meaning the *whole cell* in 82, and connoting cell-minus-the nucleus in the single exception

cytoplasm. This indefensible lexical laxity is correctable by logically matching nucleus/nucleoplasm/kerneloplasm versus periplasm/ambiplasm (from L. *ambire* = go around; hence e.g., ambience)/matriplasm. Simply put, nucleoplasm plus periplasm = cytoplasm.

A New Concept: Cytoduplication by Induction

Dynamics of Cell Division[25], representing *Frontiers in Molecular Biology* is a learned tome dealing with mitosis and meiosis. The many chapters render a few points clear: Firstly, during cell replication, the distinction between nucleoplasm and periplasm gets blurred; there is pancytoplasmic duplication comprising both nucleoplasm and periplasm; there is electromagnetic precision and rapidity; there are special motors mediating the various phases; there is enough of distinct polarity to allow the concept of *cytoduplication by induction*.

What is meant by induction? Induction is Nature's universal mechanism of begetting by appositing. Put simply, *Yin* when parted from its apposite *Yang*, refuses to survive without *Yang* which is induced afresh, and the parted *Yang* induces *Yin* so that you end up with 2 pairs of *Yin-Yang*, whereas you started with a single pair. A positive charge induces negative charge and vice versa, a magnetic north pole induces south pole and vice versa. When the 2 helices of the double–helix-DNA part, the Ma-helix induces Pa-helix and vice versa, so that DNA duplication occurs with electromagnetic ease and effortlessness. Going more subtle, Adenine induces Thymine and vice versa, and cytosine induces Guanine and vice versa. Ditto holds true for the Ma and Pa components comprising the entire periplasm (cytoplasm). After the nucleus and the periplasm have doubled or twinned themselves, the twins part to beget 2 cells in place of one. Even at the cell/nucleus/periplasm/DNA/organelle level, Nature has acted smart, taking a cue from electromagnetism, thus bringing a cell and electromagnetism in line with each other and with all such other inductive processes in the universe.

A cell is the smallest protoplasmic unit capable "of

performing all the fundamental functions of life"[5], that is "capable of independent reproduction"[26] being "the unit of all living organisms which is capable of independent survival."[27] The ostensibly mythological but intuitively correct apposite-pairing of yin-yang in the Chinese ethos and the yoni-lingam in the Indian ethos, as also the Indian concept of *Ardhanaranarishwar* (God/human as half male and half female) is traceable to a cell whose apposite-polarity allows it to function in interphase, and twin in mitosis. The gametes ovum and sperm on account of their haploidy and hence unipolarity are the most non-functional cells that are biological dead ends, manufacturing no proteins and incapable of dividing despite being endowed with enough of double-helical DNA.[19, 28]

Meiosis or de-parenting Unipolarisation/Haploidisation

Meiosis, the biologically entrenched term, is from Gr. meioun = lessen and meion = less and is etymologically closely related to the term minor. This Greek word means lessening[29] and denotes the figure of speech, litotes (meaning "understatement").[30] In 1887 Weismann foresaw that prior to the union of ovum and sperm there must be a halving of the elements of each germ plasm. This hypothesis proved to be correct and the term meiosis was later applied to the reduction division.

The term, as old as Hippocrates, has the obvious demerit of rendering very precise *halving* to the indeterminate state of lessening or reduction. Now that the Weismannean intuition of halving of chromosomal complement of a somatic cell has been established as a principle, why not call meiosis as haploidising division or, simply, haploidisation? It tells what needs to be told.

Haploidisation is then to make *2n* into *n* plus *n*, thus rendering the bipolar 2n into two unipolar n's. Hence an alternative term to haploidisation is unipolarisation, a neologism that serves to emphasize the bipolar nature of all somatic cells zygote-onwards.

Hitherto all descriptions on meiosis have failed to emphasize the next most important feature of haploidisation, namely de-parenting. To ensure the Darwinian vertical descent with variation whereby no child is denied individuality free of parental dominance, haploidisation involves *crossing over* whereby Pa-chromosomes intercourse with Ma-chromosomes to richly exchange genetic material so that the resultant gametes no longer resemble the parental somatic oogonium or spermatogonium they came from. "The total possible number of chromosome arrangements due to reassortment in meiosis alone is 2^{23}, which is more than 8x10.[6] Further rearrangement takes place because of crossingover, so it is not surprising that individual zygotes from the same parents are never alike genetically".[23] The individuation or uniquation that every offspring exhibits is not only by differing from all the siblings but also both the parents. Meiosis deserves to be renamed de-parenting haploidisation/unipolarisation. The very term puts an end to the myth of heredity. It also puts an end to the myth of cloning, for how do you get a clone if no two ova agree to be identical genetically!

Fertilisation or Bipolarisation/Diplodisation?

Fertilisation:[5] The process of union of two germ cells whereby the somatic chromosome number is restored and the development of a new individual is initiated in animals typically involving penetration of large passive female cell by a smaller active male cell followed by completion of the maturation of the female cell and by fusion of the haploid gamete pronuclei to form a diploid synkaryon within a new initially unicellular zygote.

Typical of Webster,[5] the above definition is as perfect as it can be: Two unipolar haploids – ovum and sperm – meet to beget a diploid cell or a synkaryon. The classical passivity of the ovum, however, is demolished[13] when one watches "the anomalous sex of sea horses, where she injects ova into him, and he gives birth". So, it is safe to say that in fertilisation, the sperm fertilises the ovum, and vice versa.

The term *fertilise/-sation* is rooted in L *ferre* and Skt.*bharati*[31] both

related to *bear* and meaning to carry or bring forth. To fertilise means "to apply compost, manure or commercial fertiliser in order to supply nutrients"[5], none of which avails in the union of two gametes. The arrival of Dolly-making or cloning has rendered the sperm highly dispensable, provided the indispensable condition of the diploidy of the ovum is somehow maintained or restored. The true aim of fertilisation, then, is diploidisation or bipolarisation. It is chastising for the male-of-the-human-species in general and all the human-sperms in particular, that (the so-called) paternality rides piggyback on the indispensable but otherwise non-specific process of diploidisation.

In parthenogenesis, the ovum has a nucleus that is bipolar or diploid to start with and hence proceeds to offspring-making sans any sperm. In cloning, the ovum is first made to lose its haploid nucleus and then a diploid one from any somatic cell is put into it to beget Dolly and its likes. In ordinary mating or in IVF, the haploid sperm meets the haploid ovum, to diploidise the cytoplasm and beget an offspring. So the bottom line, truly, is diploidisation or bipolarisation, and not, fertilisation.

The merit of the new terms diplodisation and bipolarisation lies in underscoring the haploidy of the gametes and the resultant diploidy of the zygote and all cells that follow. It also emphasizes the oppositeness/appositeness of the male and female gametes who individually can not function but meet to abolish their haploid individuality and to beget a typical, functioning bipolar cell that once again must eventually haploidise itself to ensure the so-called continuity of the germplasm.

The terms haploidisation/unipolarisation for gametogenesis and diploidisation/bipolarisation for fertilisation are truly pregnant neologisms that convey far more than their immediate meanings. The fertilise/fertilisation is a semantic error, that needs to be corrected.

A comparison: Cell *versus* Communication Revolution

This is an ICE age – one of Information Communication and

Entertainment, all dependent on engramming an audio or videotape or a floppy/CD or the hard disc of a computer. All these are dependent on their working on the bipolarity of the ferromagnetic material they carry. A tape/floppy/disc begets its twin by its information-content–and–corresponding–bipolarity *inducing* the same in another as yet blank counterpart. The templating and the end-product are abstract or informational and not, so to speak, material or formational.

A cell has been a few billion years ahead of the infotech revolution. It works on bipolarity, twins itself through bipolarity, but the major difference from the infotech extravaganza is that the whole process of induction is not only informational but also formational. When any cell twins itself, the duplication is both in terms of information as well as structure, abstract as well as concrete.

Let us say we are witnessing the multiplication of a liver cell or a cancer cell. Each of them is bipolar nucleoperiplasmically comprising Pa-components and Ma-components, with the cell-specific information in between, much like between the positively and negatively charged ferromagnetic particles of any electronic recording device. When such a cell wants to multiply, it separates the Pa-components from the Ma-components, within the confines of a single cell. Each Pa-component induces as if from nowhere, not only the structural Ma-components but through the information it carried, the complementary information to beget information typical of the original liver cell or cancer cell. Each Ma-component likewise induces the Pa-component, and you now have two twins juxtaposed. When they part through so-called cell fission, two cells are born. Cell duplication is complete.

When a somatic cell wishes to sexualise itself, it gives up its bipolarity to end up in unipolar cells that, finding the sexual opposite and fusing with it, restore bipolarity to start somatogenesis all over again.

The lightening speed with which all electronics work is used

with equal felicity by any "primitive" cell. The seemingly long time that the fastest multiplying cell takes is because not only should information double, but the machine itself should double its innumerable parts. The whole process is, to borrow Churchill's words, "a riddle wrapped in mystery inside an enigma", but perhaps there is a key. That key is "the concept of bipolarity" of a somatic cell that has all the features of male verses female, positive charge verses negative charge, yin verses yang, north magnetic pole verses south magnetic pole. Bipolarly, the cell is somatic and functional. Unipolarly, the cell is gametic and non-functional. The game is too subtle to allow the science of biology to know beyond that. No wonder, Albert Szent-Gyorgii,[32] when asked to define a cancer cell, declared that he could not because he did not know what is a normal cell. A cell, any cell, normal or cancerous, is what it is for it does what it does, and it does what it does, for it is what it is.[33]

Summing up

The conceptual solution to the cellsameness of all cells - beginning with the very first cell that Nature spawned billions of years ago, coupled with the individuality of every single cell, compounded by its structural and functional complexity, and heightened by the speed and precision with which cells can duplicate themselves - is the concept of bipolarity, which in any case dominates the whole inanimate universe. This establishes the selfsameness[7] between inanimate and animate universes which is consistent with the Vedic concept of *Advaita*. The inanimate animate dichotomy lies in the eyes of the beholder.

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