Article ID: WMC005418 ISSN 2046-1690

Biological microworld vis-a-vis astrophysical world of gravitation

Peer review status:
No

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Article ID: WMC005418

Article Type: Research articles

Submitted on:27-Dec-2017, 04:01:43 PM GMT **Published on:** 05-Jan-2018, 05:37:58 AM GMT

Article URL: http://www.webmedcentral.com/article_view/5418

Subject Categories:BIOPHYSICS

Keywords: Self gravitation,Astrophysical

How to cite the article: Bhattacharjee IR. Biological microworld vis-a-vis astrophysical world of gravitation. WebmedCentral BIOPHYSICS 2018;9(1):WMC005418

Source(s) of Funding:

None

Competing Interests:

None

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Abstract

On completion of few decades of in-house as well as outdoor investigations, the author has come out with the opinion that various little understood phenomena in life science could be compared and explained through gravitation based astrophysical principles.Â Gravitation plays an extensive role in astrophysical world in macroscopic length scale, or as quantum gravity at microscopic world. The recent detection of gravitational wave in realty might be an eye opener to the biologists. As measure of mass, gravitation has no upper or lower limit, nor does it have any restriction. Unfortunately biological micro-world at mesoscopic scale (10^0 to 10^-12m) is kept outside the purview of gravitation because of historical oversight.Â Interaction phenomena of mutual gravity are now-a-days getting some attention on initiation of space life science research at microgravity. In biological micro-world, mass has dual role â€“ as measure of gravitational force and as measure of metabolic energy. In astrophysical world- mass works also as gravitational measure and a measure of radiant energy or internal pressure. Fluids constitute 50-90 % of the total biomass. Its buoyant property works as astrophysical distance. Under buoyant property of extra-ordinary quantity of fluid, biomass bounded in closed surface, get advantage of apparent reduced â€˜weightâ€™ under same quantity of â€˜massâ€™. In terms of gravitation, distinction between â€˜livingâ€™ and â€˜non-livingâ€™ mass has not yet been framed out. Living mass can keep independent gravitation identity because of spontaneous generation of metabolic energy against binding action of self gravity. A â€˜planet within planetâ€™ situation arises at macromolecular, cellular and multi-cellular levels bringing self gravity into the scenario, where higher the molar mass and density of macromolecules, higher would be gravitational attraction or conversely, lower the molar mass and density, there would be delay in central attraction. So there is enough scope for comparing astrophysical world of gravitation with biological micro-world, as self and mutual gravitation. The paper examines various aspects of comparing astrophysical world with biological micro-world with support of biological evidences and reasoning, as enumerated in new biophysics topic â€˜Self gravitation bioâ€™.

Introduction

The 'Self gravitation bio', a new topic has been annexed in the study of biophysics by the Biophysical Society (USA) in 2008 on being presented by the author [1, 2]. It has also gain momentum after publication of series of articles, latest on â€˜Gravitation induced Mechanical movement in cells [3].Â Self gravitation bio contemplates the concepts of gravity to the microscopic world of life science.Â Gravity as variable in life science was proposed for the first time. But many of its working remains elusive. Gravity is customarily considered as long distance force acting on massive body at macroscopic length scale and limited to astrophysical world.Â Presence of gravity at macroscopic scale at 10^6 to 10^36 m, especially from planet to universe is virtually understood through various astrophysical principles. Similarly presence of gravity at microscopic scale at 10^-12 or so to 10^-36 m is being felt under particle physics mainly through quantum gravity.Â At mesoscopic length scale, interaction phenomena of mutual gravity are now-a-days getting some attention after initiation of space research on life sciences at microgravity. In contrast, biological micro world at mesoscopic scale (10^0 to 10^-12m) is kept outside the purview of gravitation because of historical oversight. The recent detection of gravitational wave in realty might be an eye opener to the biologists. Under equal quantity of gravitational mass, distinction between living and non-living is never projected in proper gravitational perspective. In living biomass, there is extra-large quantity of fluid, buoyant force of which was, however, never given prominence.Â Buoyant force of denser fluid apparently reduces gravitational load, thereby enhances the distance of separation between two gravitating bodies. Biomass mostly remains under neutral buoyant condition. As such under a closed surface within a membranous boundary, it can become an independent gravitating body and can interact with other gravitational bodies, as per general astrophysical principles of gravitation. Under such a state of affairs, if astrophysical principles are allowed to be scaled down or compared to

biological micro world, there would be great break through to understand various intricacies, still present in living organisms. Gravitation has till date no lower or upper limit. Easiest way for such distinction, at least at preliminary level of investigation, is to carry out feasibility of scaling down or comparing larger mass to smaller mass on the principle of equivalence. Â

So in this paper, we would examine various aspects of commonness of some astrophysical principles in few phenomena of biological micro-world with support of evidences and reasoning, as enumerated in new biophysics topic â€˜Self gravitation bioâ€™.

1. Unspecified role of extra-large quantity of fluids in living

Presence of extra-ordinary quantity of fluids in living bodies is one of the most poorly understood aspects in life science. Â On average, the body of an adult human contains 60% water. Most of the water in the human body is contained inside cells.Â For example, a 70-kg man is made up of about 42 litres of total water-Â 28 litres is intracellular water;Â 14 litres is found in extracellular fluid of whichÂ 3 litres is blood plasma,Â 1 litre is the transcellular fluid (cerebrospinal fluid, ocular, pleural, peritoneal and synovial fluids),Â 10 litres is the interstitial fluid (including lymph), which is an aqueous medium surrounding cells. Also, all our vital organs contain different amounts of water: the brain, the lungs, the heart, the liver and the kidneys contain a large quantity of water â€“ between 65 to 85% depending on the organ, while bones contain less water (but still 31%). Most interesting fact is that whatever large quantity of fluid present, their accumulation generally varies according to age, context etc. For instance, the body of a newborn is composed of more water (75%) than that of an elderly person (50%), who has more accretion mass than newborn. The density of water and fat varies under equal volume. At high temperature, fats and oils are less dense than water. In living organisms, there is certain relation. The more muscular a body is, the more water it contains. Conversely, the more fat in the body, the less water the body contains â€“ as body fat has little water. In case of fetus it follows a distinct curve. For instance, atÂ 10 weeks gestation, amniotic fluid is 10 to 20 milliliters of Â volume,Â at 16 weeks gestation ~250 milliliters, Â at 33 weeks gestation ~800 milliliters,Â at 38-39 weeks reaches a plateau of ~1000 milliliters, andÂ finally decreases at 40 weeks to ~800 milliliters. In fact, the total amount of water in human body is found in three main locations: within cells (two-thirds of the water), in the space between cells and in blood (one-third of the water). Importance of such large volume of water in living bodies has not yet suitably defined in life science. Fluids not only play a role for transportation, but its buoyant property bounded in closed surface in living organisms work as astrophysical detachment from external stronger gravitation field making planet within planet situations for living organisms, similar to Moon remains detached from gravitational field of Earth or Sun.Â

2.Physical role of fluid in living bodies

An egg floats on saline water, on working against earth's gravity, due to buoyant force. Buoyancy acts against the force of gravity and so makes objects seem lighter with respect to gravity. At microgravity, everything floats in absence of gravitational attraction. These are phenomena for attraction or lack of attraction for mutual gravity. Similarly an intravenous drip of â€˜isotonicâ€™ saline not only corrects disturbances in water and electrolytic balance, but also provides buoyant force against gravitational weight [4]. In this matter, let us discuss the physical role of water in relation to living bodies in little details.

3. Floating mechanism of aquatic living mass for survival

It is believed that evolution of life started from aquatic medium. Increase or decrease in water temperature; density and dynamic as well as kinematic viscosity of the fluids are usually affected. Higher dynamic viscosity represents the "stickiness" of fluids. Effects of mass towards kinematic viscosity can be eliminated through dividing dynamic viscosity by density.Â It is easier to swim (or move blood) in warm water, but it's harder to float. Temperature driven changes of density of water have profound impacts on aquatic organisms. Most living organisms have bodies that are at least 90% water, which means that at least 90% of their body weight will be offset by the weight of the water around them. It is that last 10% that is critical. Organisms that live on the bottom of a body of water are called benthic organisms. Efficient locomotion for them often entails walking or crawling on the substrate. Just as on land, in order to walk on the bottom, they need traction, and traction is largely determined by weight - or, more accurately, the downward pull on the

body caused by gravitation. However weight of aquatic organisms is largely offset by water inside. Heavy shells, massive bones, etc which constitute 10% of the accreted mass, body density of benthic organisms facilitates bouncing affect.Â Swimming organisms (*nekton*), or floating organisms (*plankton*), have the opposite problem, and their solution is similar. They make the remaining 10% of their bodies as light as possible. Fats and oils are two biological molecules that are less dense than water and allow some organisms to float. Sharks have large, oil-filled livers which help them float.Â Trapped air is also effective as a float. Fish have air-filled swim bladders. Bladderworts are floating carnivorous plants that occur in fresh water as well as wet soil as terrestrial or aquatic species. It has air filled cavities. Its trapping mechanism is purely mechanical, active mechanism of which is involved in the constant pumping out of water through the bladder walls by active transport. Up thrust mediated detachment causes reduction in â€˜weightâ€™ under same quantity of accreted masses.

4. Seclusion on reducing gravitational drag force under neutral buoyancy

Amniotic fluid index (AFI) is a rough estimate of the amount of amniotic fluid (expressed in cm) in pregnant uterus and is an index for the fetal well-being in mothers' wombs. Through ultrasonograph, deepest, unobstructed, vertical length is measured. An AFI between 8-18 is considered normal. An AFI < 5-6 is considered as Oligohydramnios where as > 20-24 is considered as Polyhydramnios. Proper role of AFI remains elusive in health science. It is considered as a part of the undefined biophysical profile.

Similarly, cytoplasm is composed mainly of water and also contains enzymes, salts, organelles, and various organic molecules. Spaargaren [5] coined the term â€˜metabolically inert infrastructureâ€™ (MII) to describe liquids in the cell. Let us redefine the metabolically iner infrastructure as follows. For instance, in unicellular organisms, cellâ€™s environment- viz. a substratum beneath it, a liquid medium around it and neighboring cells beside it; whereas in multicellular organisms, aggregation of cells and tissues with sufficient intra and extra-cellular matrix in totality affect â€˜lifeâ€™ (Illustration 1).

Illustration 1: Metabolically Inert Infrastructure includes gravitational environment.

The mucilaginous jelly surrounding the embryo, or adequate depth of liquid media for multiplication of green algae, cultural media for bacteria, living host for viruses, plasmid or bacteriophage for transfer of gene from one chromosome to other etc are some of the examples of undefined biophysical profile. Without MII support death occurs.Â It is presumed that MII or â€˜mediumâ€™ play the role of â€˜astrophysical distanceâ€™, due to co-moving non-accelerated position of the metabolically inert infrastructure (MII) that are relatively stationary or at constant velocity, or non-aligned or acting in opposite direction of the energized accelerated self gravitating biomass or of the steady state supporting inertial reference frame at the specific point of time.

5. Property of fluids to avert gravity

Water has a high surface tension due to its adhesive and elastic property and tends to aggregate in drops on averting gravity's central pull. Thus under a closed surface, fluid has the capacity to avert gravity's central pull and to provide desired thrust for maintaining distance in terms of astrophysical seclusion.Â Â Â In animal cell, for instance, cytosol (fluids) works against central pull of self and mutual gravity, as shown in the free-body diagrams (Illustration 2).Â In the process, there was scope to understand transmission of fluid pressure with increase in mass conforming Pascalâ€™s Law. Thus with such fluids within an enclosure or â€˜metabolically inert infrastructureâ€™, there would be an apparent seclusion of biomass or detachment from external gravitational force that work as â€œastrophysical detachmentâ€•. Such closed surface would be like â€˜planet within planetâ€™ and would be of Gaussian in nature. Physical events within it can proceed in vitro independently.Â Â
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Â Â Illustration 2. Cytosol (fluid) causes substantial detachment of organelles from external gravitational field.

6. Reduced level of fluid stop metabolism

Studies in the brine shrimp showed that reducing the amount of water in a cell below 80% of the normal level inhibits metabolism, with this decreasing progressively as the cell dries out and all metabolism halting at a water level about 30% of normal. From the

perspectives of gravitation an explanation to this observed phenomenon could be possible. With inadequate depth of supporting fluids, macromolecular mass in the interior lost their gravitational seclusion identity- metabolic kinetic energy gets over-powered by potential gravitational energy (Illustration 3).
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Â Illustration 3: Fluids cause substantial detachment â€" Reducing its level inhibit metabolism.

7. Mass remain same but weight get reduced

A normal weight of a human child at birth is say 3200 gm on earth but at moon its weight would be 531 gm. The actual mass of the human brain is about 1400 grams; however, the net weight of the brain suspended in the cerebrospinal fluid (CSF) is equivalent to a mass of 25 grams. i.e. what is 56 gm in human body will appear to be 1 gram only. Thus under neutral buoyant condition a body experiences a non-zero net force due to gravitational acceleration. Junwu Mu et al [6] made in vivo quantification of embryonic and placental growth during gestation in mice using micro-ultrasound and pair-wise comparisons of in utero and ex utero measurements. They reported that when gestational age of mice reaches 16.5 days, the non-invasive predictive body weight remains to 0.792 gm in average. The crown-rump length (CRL) and abdominal circumference (AC) was reported to be the function of gestation age (Illustration 4).Â The CRL and AC remain to be 16.22 mm and 23.4 mm respectively at that growth stage of mice. The average radius of the foetus can thus be considered to be roughly 9.9 mm.
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Illustration 4: In utero and ex utero measurements of foetus.

8. Magnitude of acceleration due to gravity under partial detached environment

Let us extend theoretically the foetal weight floating over amniotic fluid. Ignoring difference in the value of neutral buoyancy in cerebrospinal and amniotic fluids, due to differential presence of salt and other matters at particular location, the neutral buoyant weight of mice embryo of 0.792 gm would appear to be 0.014gm.Â

The acceleration due to gravity on earth is about 9.8 m/s2, whereas at moon it is 1.62 m/s2. However, if we calculate acceleration due to self gravity in0.792 gram at 16 days of gestational age of mice with radius 9.9 mm, separated by neutral buoyant force, as provided byÂ Junwu Mu et al [6], using standard formula g(s)= GM/R^2, it comes to be about 5x10^-9 m/s^2. That is free fall acceleration to the tune of 5 nanometer per second square in a massive body of the planet may be negligible, but in an isolated living mass at a distance of 9.9 picometer (9.9 x 10^-12 meter), acceleration of 5 nm/s^2 is quite a significant force. Mass would have experienced a force of 7.70^-8 N downwards due to gravity, had it been outside the fluid. But under neutral buoyant condition, mass would experience an upward resistance force/ upward force of the water of 0.14^-8 N. Thus upward force would be greater than downward force of planetary or external gravity (Illustration 5).

Illustration 5. Substantial detachment of mass through weight reduction under fluid.

9. Gravitation induced mechanical movement of macromolecules

External fluid stresses, internal driving moments, and passive elastic resistance are generally considered as the primary cause of rafting of macromolecules over fluids. Pressure exerted anywhere in a confined incompressible fluid is transmitted equally in all directions throughout the fluid such that the pressure variations (initial differences) remain the same, as per Pascal's law or the principle of transmission of fluid-pressure. Gravity is an all-time force â€" slow but steady. Omnipresent but slow moving gravitation works similar to tortoise of the popular story â€˜The Hare and The Tortoiseâ€™. Unless variation in gravitational forces gets accounted, surface tension and hydrodynamic forces would appear to remain prominent. Say, if there is no resistance, equal and opposite bounding force, there would not have been an unbalanced pressure to exert. Our feet move due to action of unbalanced force over the ground out of resistance or friction. Compressive action is needed to create unbalance pressure. Elastic force cannot be a substitution for gravitational force.

10. Assembly and heat production in astronomical

objects

The stages of formation of planet are depicted (Illustration 6) to show how homogenous low density protoplanet after initial accretion become dense and differentiated planet on being exposed to gravitational contraction [7]. Under astrophysical principles, after initial accretion, planets are formed from homogenous low density protoplanet and become dense and differentiated planet on being exposed to gravitational contraction whereby size is reduced, density of accreted materials gets increased.

Illustration 6: Stages in formation in planet- initial accretion, contraction and differentiation.

In the core, gravitational compression produces heat. Gravitational pressure is then balanced by the outward thermal pressure from fusion reactions, temporarily halting gravitational compression. Equilibrium is reached when the compression is balanced by the pressure gradient. This pressure gradient is in the opposite direction due to the strength of the material, at which point gravitational compression ceases. Surface of star or planet gets cool. The cooling causes the pressure to drop and a frost line or ice line is formed. As a result the star or planet further shrinks. This compression, in turn, heats the core of the star/planet. So, alternate heating and cooling down or â€˜rhythmicâ€™ phenomena in growth are natural in all gravitating bodies.Â Â Â Â Â Â Â Â Â Â Â Â
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Illustration 7:Â Formation of heat in core due to gravitational compression. On balanced from thermal pressure, surface gets cooled; frost line forms due to opposite pressure gradient that leads to alternate heating and cooling down or â€˜rhythmicâ€™ phenomena in growth in star.Â

11. What could produce heat in human body?

What could produce heat in human body? Constitution and physical environment of biological micro-world is completely different from planet formation. But the phenomena can be compared with growth, development, differentiation to death in life science. Endothermic (warm-blooded) organisms create most of their heat via metabolic processes, but ectotherms (cold blooded) hires external sources of temperature to regulate their body temperatures. In human, hypothalamus (sensor) in the brain is not the heat producing center but only controls internal thermoregulations through neural feedback mechanisms. Radiation, perspiration, conduction and convection are the heat transfer mechanisms. Interestingly core body temperature lies at central region liver, kidney, heart and parts of brain under circular initial fetus position. Coldest part is at the periphery at toe, foot, hand (Illustration 8). Molecules undergo elastic collisions. Faster the molecules collides, the hotter the surface would be. Thus kinetic energy of molecules and kinetic energy of movement of sliding object causes heating and cooling phenomena.Â Thus it can be said that generation of heat in human body is due to elastic collision of the molecules and kinetic energy of the sliding object, triggered by potential gravitational compression energy (Illustration 8).

Illustration 8: Core body temperature in the central region during fetus stage; with heat transfer mechanisms â€“ coldest parts lie in peripheral region- toe, foot, hand.

12. Homogeneous and heterogeneous accretion in planet formation

In astrophysics, accretion is the accumulation of particles into a massive object by gravitationally attracting more matter, typically gaseous matter, in an accretion disk. Galaxies, stars, and planets are formed by accretion processes. Homogenous accretion [7] is a phenomenon where similar elements stick together, heavier particles sink towards the center of mass and outgassing creates planetâ€™s atmosphere. Heterogeneous accretion means heavier elements collected in nebula (center) and lighter particles adhere to the mass and subsequent stages on formation of atmosphere [8, 9] (Illustration 9). In biological micro-world, though many little understood phenomena can be explained through homogenous and heterogenous accretion, but in absence of proper viewing angle, these are often summed up as â€˜gift of natureâ€™.
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Illustration 9: Homogenous and heterogeneous accretion phenomena in astrophysics where similar elements stick together, heavier particles sink towards the center of mass, lighter particles adhere to the mass.Â

13. Gravitation induced localization based on molar mass, density and temperature

Among the various macromolecules, as available in eukaryotes cells, nucleic acids have highest accretion of molar mass (say, 1000 â€“ 5,000,000 g/mol) as well as density. Naturally, under gravitational (self) environment, nucleic acids would remain in the core position on the principle â€˜higher the mass and density- higher would be the attractive force of self gravityâ€™. Whole genome in the three-dimensional folded structure of DNA, if fully laid out would be around 6 feet long, but these fit into the nuclei of each of cells in human body. Proteins are intermediate in accretion of molar mass (say, 75 â€“ 180 g/ mol) as well as higher density (say, 1.1 -1.4 g/ml), compared to molar mass of water molecule of only 18 g/mol. So it remains traditionally in the cytosol away from dynamic nucleus. Fats and lipids, though of comparable accretion of molar mass (say, 88 â€“ 280 g/ mol) as that of proteins, but their accretions consist of lowest density (say, 0.8 â€“ 0.9 g/ml). Hence as per principle â€˜lesser the density of accreted material, there would be delay in gravitational attraction to the centreâ€™. In â€˜central dogma of molecular biologyâ€™, it is interesting to note that replication of DNA (DNA - > DNA polymerase) and transcription of DNA to RNA (DNA - > RNA polymerase) traditionally occurs in the dynamic nucleus and translation of RNA to Protein (Ribosome) occurs in the cytoplasm away from the dynamic nucleus in the eukaryotic cell. Various exceptions for dynamic change of position with time were deliberately omitted to avoid detraction of attention from focus of the topic. Molar mass of nucleic acid (DNA, RNA) is higher than protein including ribosome. Ribosomes are large complexes of RNA and protein. Ribosomes are composed of two complex subunits, each of which includes rRNA and protein components. Volume of nucleic acid is comparatively less than protein. Therefore potential energy of gravitation could move dynamic nucleic acid to the central position. Thus macromolecules find position according to individual molar mass, density, variation in temperature and characteristic solubility (Illustration 10). Â

Illustration 10. Macromolecules find position according to individual molar mass, density, variation in temperature and characteristic solubility under neutral buoyant conditions.

14. Localization of Endoplasmic reticulum with or without ribosomes

Rough Endoplasmic Reticulum (RER) is coated with Ribosome. Ribosome is of higher molar mass than materials in endoplasmic reticulum. Rough Endoplasmic reticulum (RER) is found to be distributed throughout the cell but its density is higher near the dynamic nucleus or core. On the other hand, Smooth Endoplasmic reticulum (SER), not studded with ribosomes, remains lighter and is found away from the dynamic core towards periphery. SER is associated with comparatively less dense fats. The presence of higher weight ribosome nearer to the dynamic nucleus and association of lesser density fat away from dynamic nucleus within a living cell (Illustration 11), thus, seems to obey the fundamental principle of universal gravitation within a eukaryotic cell.

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Illustration 11: Rough Endoplasmic reticulum (RER) studded with ribosomes is found to be distributed throughout the cell but its density is higher near the dynamic nucleus or core.Â

15. Assembly and localization of fats, oils and lipids on heat and heat loss

Assembly and localization of fats, oils and lipids is primarily dependent on temperature and their physical state. At room temperature, fats are solid where as oils are liquid. Among lipids, triglycerides are found in storage form; phospholipids being polar and non-polar, form cell membrane; lipoprotein work as carriers for fats in blood.Â Both fats and oils are molecules shaped like a capital E with a glycerol spine and arms made of fatty acid chains. In animals, the carbon atoms in the fatty acids are saturated with hydrogen atoms. This allows them to lie straight and the molecules will pack neatly into a solid arrangement. In plants, missing hydrogen atoms cause kinks in the fatty acids. This reduces the amount of intermolecular bonding that can occur and keeps the molecules liquid at room temperature. The reason they have evolved this way is probably due to differences in plant and animal metabolisms. Lipids consisting of three

molecules of fatty acids covalently bonded to one molecule of glycerol are termed triglycerides (or triacylglycerols), but are more commonly known as fats and oils. The division into fats and oils is arbitrary and depends on the physical state of these molecules at room temperature. Those molecules that are usually solid at room temperature (plant or animal) are termed fats, while those that are liquids at room temperature are termed oils. These latter are usually found in plants, but fish also store liquid forms of triglycerides (fish oils).

16. Effect of temperature on accretion process

The effect of temperature on accretion process, as happened in the planetary formation, has not yet studied in life science. Body temperature can increase as a result of exercise. A normal human core body temperature ranges from 36.5 degrees to 37.5 degrees Celsius. Depending upon the duration and intensity of exercise, temperature can easily reach above 40 degrees Celsius.Â During exercise, respiration releases energy in the muscles. When the body temperature is too high, the skin produces sweat, which evaporates from the surface of the skin. As it evaporates, it takes heat energy from the body. Oil is hydrophobic. Water is denser than oil. Since the ice is less dense than water and therefore less dense than oil, it floats at the top. As such distribution of oils and fats in disperse state are mostly temperature dependent phenomena and follow â€˜lower the density, slower will be the central attraction during accretion processesâ€™. Among total cholesterol, there are LDL (low-density lipoprotein cholesterol, also called "bad" cholesterol) and also HDL (high-density lipoprotein cholesterol, also called "good" cholesterol).Â Regular exercise brings down a high LDL count. As exercise raises body temperature, low density lipoprotein can evade the process of accretion (Illustration 12).

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Illustration 12: Low density lipoprotein (fat) can evade process of accretion on exercise with rise in body temperature.Â

17. Localization of carbohydrates

Molar mass of carbohydrates is 180 - 340 g/mol and their density is 1.4 g/ ml. Monomer carbohydrates undergo polymerization and develop into long chained polysaccharides, such as cellulose, cellobioses, starch and glycogen (animal starch). Cellulose is made up of glucose units linked by Î²1>4 linkages and it is an important component of cell wall. Similarly starch is also a polymer of Î±1-4 linked glucose units and it is the main source of energy for all living cells. The most striking feature of monomer carbohydrates is that these posses highest solubility (683 g/ L) gets miscible with protoplasm, due to which, in general, carbohydrates cannot maintain its distinct location in a gravitational field, as do nucleic acid, proteins, fats and lipids. The protoplasm is granular colloidal in nature, because many macromolecules, tiny organelles are suspended in it, also exhibits sol and gel properties. Gutt [10] expressed that granular system exhibit duel properties â€“ in a gravitational field, it may have a self-bounding free surface but also conform to the shape of the bounding wall, obeying continuum theories of fluid mechanics. As compacted granular system, it can support shear stress in absence of a shearing velocity. Application of granular physics is still at nascent stage of study in life science. There is need for in-depth study on application of granular physics in life science to advance further on carbohydrate and other macromolecular movements.

18. Ultracentrifugation as inverse process of central action of gravitation

Under laboratory practices for separation of biological particles, centrifugation is adopted as common routine practice. Swedish chemist Theodor Svedberg [11] in 1925 developed the ultracentrifuge and won 1926 Nobel Prize in chemistry, through which sub cellular materials, cells, large macromolecules like nucleic acids, proteins, ribosomes are now separated from a solution. Depending on rotor speed of centrifugation (in anti-clockwise direction) and viscosity of the medium, various forces like centrifugal, inertial, gravitational, buoyant and frictional forces work between particles and solutions. Centrifugal acceleration is given as rÏ‰^2; where r is the radial distance from the rotation axis and Ï‰ is the angular velocity in radians per second. Sedimentation coefficients, expressed using Svedberg unit (symbol S) depends on mass, density, size, and shape. It is the ratio of the speed of a substance in a centrifuge to its acceleration in comparable units. When area is bigger, say, a folded paper, if allowed to drop would reach its

terminal velocity higher than the velocity of the same unfolded paper, as the area of the former would be larger and the friction force acting on it would be higher. In centrifugation, objects with larger surface area will travel at a slower terminal velocity. Here question lies, why Svedberg choose centrifugation as process of separation of biomaterials and not any chemical or other physical methods to separate in dispersed colloidal systems? In gravitational terms, â€˜centrifugation of any mass is an inverse process of central attractionâ€™. The Svedberg values basically tell us about the comparative molecular weight and shape of biomaterials under ex vivo condition. Let us discuss the whole issue in details for understanding realty behind the process.

19. Rate of sedimentation after centrifugation corresponds to in vitro acceleration towards accretion

Bacteria and eukaryotes have ribosomes that are structurally different. Bacteria have so-called 70S ribosomes and eukaryotes have 80S ribosomes. However, it is admitted fact that the ribosomes and their sub-particles are heterogeneous accretion. They are named according to their sedimentation characteristics during centrifugation. The ribosomes subunits are named 60S and 40S for their "size" in Svedberg units for eukaryotes. In prokaryotes (bacteria), these are 30S and 50S. These subunits are made up of three forms of rRNA: 16S, 23S, and 5S. For bacterial ribosomes, ultracentrifugation yields intact ribosomes (70S) as well as separated ribosomal subunits, the large subunit (50S) and the small subunit (30S). Within cells, ribosomes normally exist as a mixture of joined and separate subunits. The largest particles (whole ribosomes) sediment nears the bottom of the tube, whereas the smaller particles (separate 50S and 30S subunits) appear in upper fractions. Svedberg values are depicted as 1x g. The symbol g is considered as relative centrifugal force; where relative means normalized to the acceleration due to gravity on earth g = 9.81 m/s^2. One Svedberg (S) unit is 10^-13. That is, a 1S particle travels a distance of at the rate of 10^-13 m s^-1 or 0.1 picometer per second. Particles with higher values of S will travel proportionately faster, and increasing g force will also increase sedimentation rate. The two eukaryotic ribosomal subunits have sedimentation coefficients of 40 x 10^-13 and 60 x 10^-13, are referred to as the 40S and the 60S ribosomal subunits. The molecular mass of the 40S and 60S particles are 1.5 and 3.0 million g/mol, respectively. Thus, the complete heterogeneous ribosome has a mass of approximately 4.5 million g/mol.

Under the influence of an acceleration of a million gravities (10^7 m/s^2), a substance with a sedimentation coefficient of 80S (80Ã—10^âˆ’13 s) would travel at 80 micrometers per second (80Ã—10^âˆ’6 m/s). Now, say, an 80S ribosome at 100 000 g centrifugation over the sucrose cushion buffer; the rate of sedimentation is equal to 10^-13 x 10^5 x 80 m per sec or 80 x 10^-8 m s^-1. In order to travel, say, 10 cm (10^-2 m), it would take 10^-2/ (80 x 10^-8) s i.e. approximately 8.5 hour. It means that 80â‹…10^âˆ’13 sec is the time that ribosome would take to reach the terminal velocity in the fluid under ex vivo condition. Earlier, under in vitro situation, we have demonstrated that free fall acceleration to the tune of nanometer per Second Square in an isolated living mass of the picometer distance.

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Â Illustration 13. Theodor Svedberg developed ultracentrifugation as process of separation of bio-particles - inverse process of central action of gravitation. Â

Under ex vivo situation, for moving 10 cm distance at a speed of 80 micrometers per second, 80S ribosome is taking approximately 8 hours 30 minutes. It may be considered as approximate matching between in vitro and ex vivo observations, thereby indicating that both the process have their origin from same sources, first one is on â€˜natural settingâ€™ and second one is on â€˜inverse or reverse of natural settingâ€™. Pre-centrifugation materials under in vitro situation are arranged as per density gradient influenced by the complex gravitation field â€˜within the cellâ€™. Post-centrifugation order of succession depicts ex vivo sedimentation or setting as per external gravitational or mutual fields (Illustration 13). Centrifugation facilitates reversing the process for separation of organelles on losing its compression memory under ex vivo condition.

Gravitation is slow but steady in its action, compared to electro-magnetic or electrostatic forces. Due to its slow rate of action, gravity could generally evade oneâ€™s attention, especially amid electrostatic field. Detection or undertaking quantitative measures for gravity is still a matter of challenge before physicists at the level of millimeter scale. So at this state of affairs, only way to establish is to apply abductive reasoning on comparing various circumstantial evidences. Centrifugation operation for separation of bio-particles is one of such prime evidence.

20. Input and output of metabolic energy in living organism

Although planets and stars are neither in thermal equilibrium with their surroundings nor perfect black bodies, black-body radiation is used as a first approximation for the energy they emit. In living organism, range of temperature seems little different, but major outline remains same (Illustration 14). Schematic diagram shows input and output of metabolic energy in living organism. Rate of basal metabolic energy, resting metabolic energy, physical activity level and generation of heat and radiation are the primary mode of distribution of energy in living organism.
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Illustration 14. In living organism, range of temperature seems little different from astrophysical body, but major outline for black-body radiation remains same. Â

Anabolism (build-up) and catabolism (break-down) through various process including photosynthesis and respiration respectively result a â€˜change in masses per unit volumeâ€™ continuously, resulting contraction and relaxation alternately in living body. The living body converts energy stored in food into prominent three mode viz. work, thermal energy, and/or chemical energy (including that is stored in fatty tissue). The rate at which the body uses food energy to sustain life and to do different activities is called the metabolic rate, and the corresponding rate when at rest is called the basal metabolic rate (BMR). About 75% of food calories are used to sustain basic body functions included in the basal metabolic rate. The energy consumption of living organisms during various activities can be determined by measuring their oxygen use, because the digestive process is basically one of oxidizing food. For instance, total power consumed at rest (Watt) and total Oxygen consumption (mL/min) for an adult human is 85 and 250 respectively. In different organs, there are liver & spleen 23 and 67, brain 16 and 47, skeletal muscle 15 and 45, kidney 9 and 26, heart 6 and 17, other 16 and 45 respectively.

21. Basal metabolic rate is proportional to the 3/4 power of an animal

Biological growth means increase in mass. Every biological organism has mass. When mass is there, gravitation would be there. This is a universal phenomenon. Body Mass Index (BMI) or Quetelet index (individual's body weight/ mass divided by the square of personâ€™s height) when less than 18.5 is underweight and may indicate malnutrition, or other health problems, while greater than 25 is considered overweight and above 30 is considered obese. BMI determine risk of developing heart disease and other health problems such as diabetes. But most interesting fact is that basal metabolic rate (R) is proportional to the Â¾ power of an animal's mass (M). This relationship, known as Kleiber Law, holds from simple organisms to most complex ones, from microbes to giant blue whales across 18 orders of magnitude in body mass. Part of mass (say 2/3 to Â¾ or 66 to75%) is expended towards maintaining metabolic rate. On other hand, 100 percent of the same mass works towards generating self gravitational potential energy. There is thus a huge difference (a tug-of-war) between kinetic (metabolic) and potential (gravitational) energies. Metabolic energy works against gravitational energy in the ratio of about 3:4. When force of gravity and inertia are balanced there will be no change of motion, object remains stationary i.e. net force is zero. When metabolic energy is put at the rate of 10^-12 to 10^-6 kcal/hr, it can move unicellular organisms. Similarly cold blooded animals can be in motion when metabolic rate is 10^-8 to about 10^0 kcal/hr. Warm blooded animals do the same work with metabolic rate having less than 10^0 to 103 kcal/hr. Thus presence of metabolic energy can be felt taking into account both intrinsic and extrinsic â€˜gravitational forceâ€™ with resting metabolic rate (RMR) for meeting most of the demands on working against self gravity where as physical activity level (PAL) could be mostly to meet demands for working against extrinsic gravitational force. This will be clear from the under mentioned discussions.

22. Broad division in metabolic energy for working against intrinsic and extrinsic gravity

Take an example on movement of dome shape arc structure of human thoracic diaphragm. Here potential energy of self gravity contracts its dome shape structure. The inertia attempts to bring back contracting surface to original position. Kinetic energy

of metabolism works against it, thereby, allowing the dome shape structure to relax. Unbalanced forces causes change in motion in a curved surface in speeding up and slowing down (Illustration 15). Thus we can say that resting metabolic rate (RMR) is therefore primarily involved in such internal activity against self gravity. During movement of human thoracic diaphragm, potential energy of self gravity contracts the dome shape structure. The inertia attempts to bring back contracting surface to its original position. Kinetic energy of metabolism works against it, thereby, allowing dome shape structure to relax. Resting metabolic rate (RMR) is involved in such internal activity against self gravity.

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Illustration 15:Â Dome shape arc structure of human thoracic diaphragm developed at fetus stage which induces alternate in and out movement through energy originate from and to the center during respiration.Â

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Â On the other hand, raising a ball through a height above earthâ€™s surface by hand involves metabolic kinetic energy against potential energy of earthâ€™s gravity and invites spending metabolic energy as per physical activity level (PAL) on contracting and relaxing muscles (Illustration 5).

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Â Illustration 16: Physical activity level on contracting and relaxing muscle.

23. Gravitational anchor is a criterion for manifestation as living

To understand gravitational anchor, we are to look into the concept of entropy leading to Gibbs free energy change (Î”G) that is related to reaction spontaneity and equilibrium. The biological systems do not violate the second law of thermodynamics (Illustration 17). In biological systems, energy inputs from other energy sources (including the Sun and exothermic chemical reactions) are "coupled" with reactions that are not entropically favored (i.e. have a Gibbs free energy above zero). The system is held at constant temperature and pressure, and is closed (no matter can come in or out). Taking into account the coupled reactions, the total entropy in the system gets increase. This coupling allows endergonic reactions, such as photosynthesis and DNA synthesis, to proceed without decreasing the total entropy of the surroundings.

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Illustration 17: Gravitational anchor â€“ The system is held through reaction and equilibrium in conformity with second law of thermodynamics.

After accretion of critical mass, say, a single cell cannot survive in isolated way, unless it is thermodynamically active and anchored by inertia. A minimal inertial mass is required for survival.Â In plant tissue culture, unless a callus (â€œexplantsâ€•) of say above 500 mg or suspension of cultures of say, 3-4 cubic centimeter (in terms of PCV - packed cell volume) is used, it is difficult to maintain continuity of life and growth from individual cells. Similarly in the final volume for cell culture, maintaining cell density as low as 3 x 105 to high of more than 10â€“15x 10^6 cells/ml of inoculums are required. Why a minimum mass is required for cell culture under multi-assembled single cell condition. Is it for anchorage? There is a literary proverb that â€œA Rolling stone gathers no mossâ€•. This is not only a literary proverb but based on scientific observation and fact of the commoners. In formation of stars, relatively dense concentrations of interstellar gas and dust (molecular clouds) are required.

24.Regeneration happens from Inner cell mass of stem cell

Mass based gravitational anchorage and metabolic energy decides potency for regeneration or differentiation in stem cells. Stem cells are undifferentiated biological cells that can differentiate into specialized cells and can divide (through mitosis) to produce more stem cells. They are found in multicellular organisms. In mammals, there are two broad types of stem cells: embryonic stem cells, which are isolated from the inner cell mass (ICM) of blastocysts, and adult stem cells, which are found in various tissues. In a developing embryo, stem cells can differentiate into all the specialized cellsâ€”ectoderm, endoderm and mesoderm, but also maintain the normal turnover of regenerative organs, such as blood, skin, or intestinal tissues. Stem cell potency specifies the differentiation potential (the potential to differentiate into different cell types) of the stem cell. It can be totipotent, pluripotent, Multipotent, Oligopotent, Unipotent etc. as per their characteristics for regeneration or differentiation. Most interesting fact is that inner cell mass (ICM) influences potency in stem cells. For instance, pluripotent, embryonic stem

cells originate in inner cell mass (ICM) cells within a blastocyst.

Why inner cell mass or central position is an important location as non-potency stage for regeneration or differentiation in stem cells? Compared to periphery, attractive gravitational pull/ force towards core or central position are higher. Therefore potency for regeneration/ differentiation might begin when bio materials are displaced from the central position. In central position (at core), potential energy of self gravity is strongest. Metabolic or kinetic energy working against it fails to act in required differential function against the self gravity while locating itself as inner cell mass. Once it goes out of the inner cell mass, kinetic energy can set into motion leading to regeneration or differential of stem cell. This is similar to an example below. Kinetic energy of a frog for escape can be put to rest on pressing it at central position. On removal of pressure from central position, frog can go out to exhibit its full potency (Illustration 18). Same is the case for plasma cells which are large lymphocytes with a considerable nucleus-to-cytoplasm ratio. After the process of affinity maturation in germinal centers, plasma cells have an indeterminate lifespan, ranging from days to months. Recently they have been shown to reside for much longer periods in the bone marrow as long lived plasma cells (LLPC). Thus movement and lifespan of plasma cells depend on location and local characteristics within self gravitating environment.

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Â Illustration 18: Magnitude of gravitational force is highest at central point. The potentiality of expression under same physics of development is thus high at inner or central mass.

25. Energy producing organelles are little away from central position

Gravitational attraction is highest at the core. To continue as living, metabolic energy is needed to counteract gravitational attraction. Mitochondria are the energy producing organelles that work against gravitational energy in the ratio of about 3:4. Mitochondria in prokaryotic (bacteria) and eukaryotic organisms of both plant and animal remain away from gravitating core (Illustration 19).

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Â Illustration 19: Energy producing organelles are away from core. Outward energy must remain at a distance from core where inward gravitational force is of highest magnitude.Â Â

A fluorescent image of an endothelial cell are reproduced here (Illustration 20). Nuclei (stained blue) are almost in central position with some eccentricity. Energy producing organelles like mitochondria (stained red) are little away from centre. Microfilaments (stained green) act as anchor in the cell.

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Illustration 20: Fluorescent image of endothelial cell showing mitochondria (energy producing organelles) away from nuclei or core.

26. Understanding planet within planet situation in biological micro world

Gravitation in microscopic biological world can only be imagined under planet within planet situation. There may be gravity anomalies out of local variations of the gravity field involving the effect of immediate local accretion of masses in the vicinity. Also in chronological event driven phenomena, hydrostatic pressure increases with depth inside the surrounding matrix on being bounded by the peripheral structure. Nucleus region then gets drifted outward from central region with increase in size, reflecting an eccentricity of the core in a dynamic orienting system of coordinates, what we call an â€œeccentric nucleusâ€• after passing of phase. Chalko [12] pointed out that under gravity-buoyancy equilibrium of a solid core in a spherically symmetric pressure gradient â€“ it has to be eccentric. In planet within planet situation, eccentricity of the core is one of the distinguishing features. In Illustration 21, eccentric nucleus in case multiple myeloma in bone marrow are shown. It is interesting to note that the nucleus both translates and rotates in the cytoplasm in a variety of experimental situations.[13, 14, 15] Recently the concept of Mechanotransduction has come up that take into account various mechanisms by which cells convert mechanical stimulus into electrochemical activity. Unfortunately it is yet to take into cognizance into the gravitation induced phenomena.

Illustration 21: Eccentric nucleus in blood plasma in cases multiple myeloma in bone marrow.

27. Gravitational compression and metabolic energy in

biological mass

Biological growth means either an increase in number of cells (hyperplasia) or increase in cell size (hypertrophy). Irrespective of expression, growth means increase in mass. However, growth does not occur in uniform arithmetic progression - there is retardation in the percentage increase.

Illustration 22: Increase in weight of chick from day 1 to till hatching (day 21).

The per cent rate of growth is afterwards slowed down in spite of best nutrient supplementation. Say, a day one chick in embryo weighs 0.002 grams, on 7th day, it attains 0.57 gram and at day 14 and 20, it attains 9.74 and 30.21 grams respectively. Subsequently at 8 weeks it weighs about 1200 grams.Â It can be seen from chart above that weight of chick got increased. But if we see meticulously, we can observe that percentage increase in weight got decreased linearly. Why percent increase in weight gets reduced?

Illustration 23: Percent increase in weight decreases with age.

It is still considered a puzzling feature in developmental genetics [16], â€˜how does genome appreciate that its activities need to be slowed down after the phenotypic task is overâ€™. To bridge the gap in scientific understanding it is postulated that phenomena is due to building up of critical level of growth limiting substance at particular period of growth. What could be the critical growth limiting factors (and not substance)?

Such slowing down in the rate of growth by an unknown factor could be explained with the astrophysical principles of gravitation. Gravitation force increases with increase in Newtonâ€™s mass. The gravitational mass is a â€˜chargeâ€™: an object feels a gravitational force in proportion to its gravitational mass, just as it would feel an electromagnetic force in proportion to its electric charge. There would be an increase in gravitational force with increase in accretion of mass which put the limiting factor towards decrease in percent weight.

Interestingly, retardation in percent increase in growth is common to all gravitating stellar bodies of the universe. Similarly retardation in percent increase in growth is common to all biological organisms. Miniature size of the biological bodies seems do not show hindrance to mimic gravitation phenomena. In biological micro-world metabolic energy is the source of energy that works based on the quantity of mass in the ratio of 3:4 i.e. 3 metabolic energy: 4 mass. Mass, on the other hand, is a measure of gravitational force. So there is enough scope to compare astrophysical principles of growth in stellar bodies with that of growth in biological micro-world.

llustration 24: Astrophysical world vis-Ã -vis biological micro-world.

Research indicates that physical parameters like â€˜membrane surface areaâ€™, â€˜pathwaysâ€™ and â€˜cell sizeâ€™ determine cellular growth rate. The increase in growth rate in fast-growing yeast Kluyveromyces marxianus can be explained by a dominant (80%) limitation of growth by the group of membrane processes including membrane surface area. Simultaneous activation of membrane processes may be what is required to accelerate growth of the fastest-growing form of eukaryotic life and may be of potential interest for single-cell protein production [17]. Similarly it was shown that nutrient-dependent pathway and cell size controls growth rate in the Gram-negative bacterium Salmonella typhimurium or Gram-positive model organism Bacillus subtilis[18]. From both the findings, it is clear that â€˜membrane surface areaâ€™, â€˜pathwaysâ€™ and â€˜cell sizeâ€™, that all are physical parameters, can be manipulated on controlling volume by a compressive gravitation force.Â From the aforesaid findings, it can be said that invisible force of gravitation on living organism plays the dominant role in controlling the rate of increase in weight. Â

Cell growth comprises changes in both mass and volume. Using buoyant mass, growth of single cells has been measured.Â With the suspended microchannel resonator (SMR), particles are weighed in real-time as they flow through a hollow cantilever. The microchannel resonant frequency is determined by the difference in mass of the particle with respect to that of the displaced fluid. Thus, the particle's density is determined by measuring its mass in two fluids of different densities [19]. Michel Godin et al [20] found that for individual cells of Bacillus subtilis, Escherichia coli, Saccharomyces cerevisiae and mouse lymphoblasts, heavier cells grew faster than lighter cells. Andrea K. Bryan et al [21] found that cell density increases prior to bud formation of the yeast Saccharomyces cerevisiae. To investigate the origin of this density increase, they monitor relative density changes of growing yeast cells. They focus on basic cell cycle questions in yeast, but they remain oblivious on gravitation. They found that the density increase requires energy, function of the protein synthesis. But they have not defined the required source of energy in

appropriate dimensions.

It is worthy to note that cells adjust their mass-to-volume ratio during important processes such as cell cycle progression, apoptosis, differentiation, disease state, and malignant transformation. In biology and medical diagnostics, correlations of mass and density with disease and other physiological states have been established, e.g. in the various stages of malaria [22]. But these cellular-level parameters remain poorly investigated, especially as a system in relation to their self-gravitating environment.

William H. Grovera et al [23] had developed technique to measure single-cell mass, volume, and density. They had attempted to demonstrate this technique with four examples: identifying Plasmodium falciparum malaria infected erythrocytes in a culture, distinguishing transfused blood cells from a patientâ€™s own blood, identifying irreversibly sickled cells in a sickle cell patient, and identifying leukemia cells in the early stages of responding to a drug treatment. From all these examples, all the paradoxes would be clear once gravitation is brought into the scenario.

28. Accretion mass and quantity of fluid in various stages of growth

In astrophysics, accretion is the accumulation of particles by gravitationally attracting more matter in an accretion disk. Most astronomical objects, such as galaxies, stars, and planets, are formed by accretion processes. The body of a newborn is composed of more water (75%) than that of an elderly person (50%). The accretion mass is therefore 25% and 50% respectively. Higher the accretion mass, higher would be gravitational pressure, as common in any astrophysical body (Illustration 25). The role of water towards buoyant mechanism has already been explained. The accretion of mass is also explained. The accretion of mass in child is about 25 %, where as in case of old, it is 75% compared to their body fluid as 75 % and 50% respectively.

Illustration 25: Difference in accretion mass and body fluids in child and old.

29. Retardation in percent increase in growth due to disproportionate accretion of mass

So we can say that higher the accretion mass, higher would be gravitational pressure. Accretion mass for new born is 25% whereas in case elderly person it is 50%. At infant stage, there would be higher metabolic energy but lesser accretion mass or lesser gravitational energy. At adult stage, there would be equilibrium between metabolic and gravitational energy. At old age, there would be lesser metabolic energy and high gravitational energy due to higher accretion mass. Percentage increase in growth thus diminishes with age.

Illustration 26: Accretion mass is highest in old age than at child stage. This leads increase in gravitation pressure on old than at child and adult stages. At adult stage, there is equilibrium between accretion mass (synonym gravitational energy) and metabolic energy.

30. Growth due to isostatic balance between lighter and heavier mass

Isostatic balance (Illustration 27) is balances between lighter and heavier mass in relation to centre of mass or gravity is a common phenomenon in all gravitating bodies including earth [24]. Subduction in an area is compensated by formation of mountain on other side due to action of self gravity of the earth.

Illustration 27: Isostatic or seesaw balance is the equilibrium between lighter and heavier mass.

In biological growth, isostatic balance happens around self-gravity (ignoring minor circumstantial exceptions). Head (consists of solid mass of brain, muscle, and bone) is much heavier (greater specific gravity) than water on equal volume basis or than of bone and muscle or fatty and air-containing body tissues. During and after embryonic growth, brainâ€™s higher weight is compensated by continued growth towards human leg- an isostatic balancing act of self gravity around central position (Illustration 28).Â Â Â
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Illustration 28:Â Isostatic balance in human â€“ Growth occurs towards leg to compensate higher specific gravity of head.
Similarly plant growth occurs through balance between

roots and shoots alternately, though root growth dominates during early period. Roots are comparatively denser than shoot on equal volume basis (Illustration 29).
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Illustration 29: Isostatic balance - plant growth occurs through balance between roots and shoots alternately, though root (higher specific gravity) growth dominates during early period.

31. Balance is the Law of Life

From giant universe to tiny microscopic bacteria, though materials for constitution differ, there is one phenomenon common to all - "Balance is the law of life". In giant star, internal pressure opposes self gravity. Radiant energy generates due to balance between outward internal pressure and inward gravitational pressure- keeps sun shining. In living organism outward metabolic energy opposes inward invisible force of self gravity (Illustration 9). Life continues so long balance is maintained. So "keep balance"- that is the universal rule to survive and living organism cannot remain exception (Illustration 30).

Illustration 30: â€˜Keep Balanceâ€™ is the law of life from universe to biological micro-world.

32. Rhythmic pattern of growth due to alternate heating and cooling down phenomena

If we look on the principles enumerated in the science of astrophysics, we find that a kind of inflation followed by recession (or a rhythmic pattern) in the process of growth of stellar bodies is a universal phenomenon. The famous Kelvin-Helmholz contraction hypothesis under astrophysical principle is an indication wherein it is stated that continued contraction of the Sun under its own gravity generates energy for radiation. Similarly overall biological growth is not a steady increase in mass or weight. There is log or exponential growth phase, followed by lag phase, stationary phase and then finally death or logarithmic decline phase (Illustration 31).

Illustration 31: Lag, log, stationary, logarithmic decline growth phases.

Growth period in human includes five stages viz. prenatal, infantile, early childhood, juvenile and adolescent plus post-adolescent. There is rapid growth in prenatal and puberty period. There is retarded growth in juvenile and post-adolescent periods followed by little or no growth afterÂ Â Â Â the post-adolescent period (Illustration 32).

Illustration 32: Rhythmic prenatal infantile to Adult growth pattern.

stage after which rate slows down again. After another period of slow growth coinciding vegetative lag-phase, Similarly in annual plants, after rapid sprouting stage, there is retardation. Growth increases slowly till mature seedling stage. After slow growth, there is another period of rapid growth up to most active tillering the rate increases and then finally decelerates-ceasing when generative growth phase is reached (Illustration 33).

Illustration 33: Rhythmic sprouting to generative growth phases in plants.
In plant, growth occurs in three steps or phases viz. formative, enlargement and differentiation. There is contraction-expansion phase in embryonic growth sequence viz. zygote and morula as contraction phase and cleavage and blastula as expansion phase in the order: zygote (shrinking phase) - cleavage (rapid rates of division) - morula (antagonism phase between periods of rapid cell division and cell movement) - blastula (cells in centre begin to lose contact with one another and a central fluid-filled cavity, the blastocel forms (Illustration 34).
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Illustration 34: Rhythmic embryonic growth sequence from zygote to morula.

33. Logarithmic spiral formation due to non-equilibrium kinetic energy

Logarithmic spiral is known as growth spiral, equiangular spiral or spira mirabilis. Length of radius goes on increasing with shell. Logarithmic spiral has unique geometrical property of maintaining a constant angle between radius and tangent at any point on the curve from the core or centre with only length of radius goes on increasing with the growth of shell (Illustration`35). In biological world, such spiral is abundant, say, in Fibonacci numbers, golden ratio, or

golden spiral in snails, snakes and others. Mechanism of potential energy of self gravity versus kinetic energy of metabolism is responsible for formation of logarithmic spirals in nature.

Illustration 35: Logarithmic spiral where length of radius increases from center.

Similarly there is constant angle between radius from common centre and tangents over intercepted arcs, if supposed to be drawn from heart. Heart is considered at central position at its formative stage, though with further growth it loses its central position in subsequent fetus stages. The heart has balloon like bulging and the skeletal muscles are shaped in alternate half-bulging shape. The sketches (Illustration 36) show that at fetus stage, self gravitating features seem prominent in the formation of muscle tone.
Â Illustration 36: Constant angle supposed from heart to muscle with increase in length from center.

34. Symmetry in morphological structure in plant and animal

My present investigation began with the quest - why all living species are in spherical symmetry?Â Why round? Why not square? The human body- head, hand, leg etc. are all in spherical pattern, starting journey from spherical shaped eggs/ embryo. Tips of fingers, flowers or inflorescences are all in spherical symmetries. Notion of surface tension had to be quashed. Transplanting in agricultural field two to three rice seedlings in a bunch, keeping 15-25 cm isolation between bunches, one can notice that the canopy of three seedlings coalesce and form a single top-round canopy at the end of vegetative phase or at the end of reproductive phase (Illustration 37). Why the middle one gets taller than the neighboring two on synchronization? All rice plants are of same age and same genetic constitution. Nutrient availability is also same for all plants, since they are in the same spatial zone of the soil. Bending of plants towards source of light under indoor condition or the effective spectral region triggering phototropism in between 350-500 nm i.e. the blue region of the spectrum is also not found to be beyond the threshold limit under such open field condition. Unconnected plants having homogeneous accretion, similar elements attract each other, as if they are situated within the sphere of individualâ€™s gravity barrier. The angle between tangent and radius from common centre of gravity remains equal. Roots are denser than shoot on equal volume basis. Next phase of growth is towards root on maintaining isostatic balance (extreme right).

Illustration 37: Plants of homogenous accretion attract each other with convergence of attractive forces towards imaginary common center.

35. Bilateral or mirror symmetry in animals due to convection flow

Developmental geneticists [16] consider cause of bilateral symmetry in animals as â€˜necessityâ€™ to cope up with environment. Similarly, if I wish to have a third eye in back, to extend my visibility in rear portion, I cannot have such extra eye or hand. Instead of wishful necessity, there should be a physical cause for every eventuality.Â In small mass, there is no â€˜fountain effectâ€™- only â€˜central tendencyâ€™ in internal structure of living organisms (Illustration 38). Convection is the dominant mode of energy transport in stars when the temperature gradient is steep within the star.Â Similarly thermal convection active in the embryo can be the driving mechanism for development of bilateral symmetry and morphogenic development in animals. During gastrulation phase of embryonic development in animals, there are ectoderm externally, the mesoderm next to this and the endoderm on the inside. Bilateral symmetry and convectional morphogenic development in animals is evident from the â€˜fountain effectâ€™ in frontal region.
Illustration 38: Convection flow causes mirror symmetry in animals.

36. Internal structural sophistication varies with mass and volume of biological object

In solar mass stars (0.3â€“1.5 solar masses) have radiative cores with convective envelopes in the outer portion of the star. In massive stars (greater than about 1.5 solar masses), have a radiative envelope. The lowest mass main sequence stars have no radiation zone; the dominant energy transport mechanism throughout the star is convection. Giants are also fully convective [25]. Therefore, it can be seen that various transport mechanisms in a star is dependent on the quantity of mass as per gradation as

low mass, intermediate mass and high mass stars.
To understand thermal convection as internal energy transport mechanism in living world based on mass, we have tried to project through pictorial means. Convective transport mechanism from high density to low density leads variation in internal structure and morphological symmetry. For instance frog has high mass, butterfly intermediate and bacteria or amoeba have low mass. In organism having small mass, there is no â€˜fountain effectâ€™- only â€˜central tendencyâ€™ in overall structure, but in organism with intermediate mass there is fountain effect as well as central tendency (Illustration 39).
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Illustration 39. Quantity of accreted mass determines internal energy transport system from warmer to cooler region which influences morphological features in animals and stars.

In bacteria and blue-green algae, the nuclear material is not separated from the cytoplasm by a discrete membrane whereas it is so in majority of multicellular organisms. The entire virus consists primarily of viral genetic material enclosed in a proteinaceous envelope. Viroids, very small particles, appear to consist of genetic material alone and lack enclosing membranes. The prion which is about 100 times smaller than the smallest viruses, contain a spherical shell of protein only. Prion can reproduce in the living cell, yet no DNA or RNA has been found in them.

37. Mechanical load bearing structure in cell

Mechanical living cell deformation studies have demonstrated that mechanical loads are borne by microtubules, which are balanced by tensile forces in contractile elements of the cytoskeleton [26]. Moreover, the disruption of microtubules yields a transfer of forces to the extracellular matrix, a decrease in cell stiffness and altered cell shape. Evidence also suggests that similar forces that are active on micro-tubules are integral to the maintenance of nuclear shape and also proposes that the transfer of mechanical stress across the cytoskeleton may link the alterations in cell and nuclear shape that occur during cell spreading and retraction [27, 28]. It is interesting to note that in animal cells, the major microtubule-organizing center for bearing mechanical load is the centrosome, which is located adjacent to the nucleus near the center of interphase (non-dividing) cells. In Illustration 40, Pictures show centralized arrangement of microtubules structure bearing mechanical loads in cell. Photo taken on using green fluorescent protein (GFP) tagged proteins (photos with permission [29]).

Illustration 40. Centralized microtubular load bearing structure in a cell.Â

38. Gravitational Interaction Phenomena

The interaction between intrinsic and extrinsic gravity would become spectacular in the space research. In one such space (microgravity) experiment it had been shown that the net work of blood vessels get relaxed from stretched condition on entry into space. This is reflected from the cross section of the blood vessel of rat [30] under earth-normal and space-normal (microgravity) where feed artery, first-order arterioles and basilar artery from brain are shown to be relaxed under sole influence of intrinsic gravity in space-normal (microgravity) condition (Illustration 41). Under earth-normal condition, there is balanced, isometric contraction in the artery where as in space-normal; arteries are in relaxed, imbalanced contraction.Â This is due to the fact that side vectors are pulled out from base vector of isosceles triangular vectors on withdrawal from earth.

Illustration 41: Relaxed and imbalanced contraction in blood vessel of rat under space normal condition in contrast to balanced isometric contraction under earth-normal condition.

39. Transformation of singular cell to multicellularity in evolutionary process

Ratcliff et al. [31, 32, 33] carried out a novel experiment to create an environment on the lab that favored strains to evolve to form clusters of cells, as the first step in the transition to multicellularity, starting with single-celled microbes, by subjecting Bakerâ€™s yeast (Saccharomyces cerevisiae) to daily selection for fast settling through liquid medium. Within just a few weeks, yeast, that formed snowflake-shaped clusters of cells, evolved and displaced their single-celled ancestors. â€œSnowflakeâ€• yeast display several hallmarks of multicellularity, including juvenile and adult life stages, determinate growth, and a rudimentary cellular division of labor utilizing programmed cell death. The findings confirm our observation that biomass is initially to be anchored

through inertia of the critical amount of callus/ explants, suspension of cultures, or cell density for a three dimensional cell to be pivoted on the central axis of the self gravity. Daily selection for fast settling through liquid medium and then formation of clusters of cells are thus the natural consequence of gravitation. In a personal communication to the researcher it has been conveyed that in selection of genotype, the researcher would have got better insight had they worked out additionally the molar mass and the density of the clusters, as to them "clusters have greater fitness only with gravitational selection". Also had the aforesaid worker observed meticulously, they would have noticed that there would be a central position, which as per theory of gravitation, as if entire mass in the sphere of influence of such gravitating system would have been concentrated at the center (Illustration 42). This is a distinguishable features of gravitational force compared to other basic forces viz. electromagnetic forces or any other local forces like surface tension, elastic forces etc.

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Illustration 42: Transformation of singular cells to multi-cellular â€“ only gravitation based clusters of cells could transit to multicellularity in evolutionary process.

Conclusions:

On completion of few decades of in-house as well as outdoor investigations, we have come out with the opinion that various little understood phenomena in life science could be compared and explained through gravitation based astrophysical principles. From the aforesaid extensive discussions, we therefore, conclude the following:

(1). Fluids constitute 50-90 % of the total accreted biomass. Buoyant property of fluids bounded in closed surface in living organisms work as astrophysical detachment from external stronger gravitation field making planet within planet situations for living organisms, similar to Moonâ€™s internal processes remain detached from gravitational field of Earth or Sun.Â Detachment is reflected on reduction of â€˜Weightâ€™ under same quantity of â€˜massâ€™. Gravitational free fall acceleration, as estimated, to the tune of nanometer per second square in a massive body of the planet may be negligible, but in an isolated living mass at picometer distance, such acceleration is quite a significant force.

(2). Biological growth means increase in mass. Every biological organism has mass. When mass is there, gravitation would be there. This is a universal phenomenon. Body Mass Index (BMI) or Quetelet index (individual's body weight/ mass divided by the square of personâ€™s height) when less than 18.5 is underweight and may indicate malnutrition, or other health problems, while greater than 25 is considered overweight and above 30 is considered obese. BMI determine risk of developing heart disease and other health problems such as diabetes. In biological micro-world, mass has dual role â€“ as measure of gravitational force and as measure of metabolic energy in the ratio of 4:3 to 3:2, as per Kleiber Law, that holds from simple organisms to most complex ones, from microbes to giant blue whales. It has however been partitioned between Resting metabolic rate (RMR) for meeting most of the demands on working against self gravity where as physical activity level (PAL) could be mostly to meet demands for working against extrinsic gravitational force.Â In astrophysical world- mass works also as gravitational measure and a measure of radiant energy or internal pressure.

(3). Homogenous accretion is a phenomenon in astrophysics where similar elements stick together, heavier particles sink towards the center of mass and outgassing creates planetâ€™s atmosphere. Heterogeneous accretion means heavier elements collected in nebula (center) and lighter particles adhere to the mass and subsequent stages on formation of atmosphere.

(4). Molecules undergo elastic collisions. Faster the molecules collides, the hotter the surface would be. Thus kinetic energy of molecules and kinetic energy of movement of sliding object causes heating and cooling phenomena and rhythmic pattern of growth in biological and astrophysical world. Â

(5). Under astrophysical principles, after initial accretion, planets are formed from homogenous low density protoplanet and become dense and differentiated planet on being exposed to gravitational contraction whereby size is reduced, density of accreted materials gets increased. In the core, gravitational compression produces heat. Gravitational pressure is then balanced by the outward thermal pressure from fusion reactions, temporarily halting gravitational compression. Equilibrium is reached when the compression is balanced by a pressure gradient. This pressure gradient is in the opposite direction due to the strength of the material, at which point gravitational compression ceases. Surface of star or planet gets cool. The cooling causes the pressure to drop and a frost line or ice line is formed. As a result the star or planet further shrinks. This compression, in turn, heats the core of the star/planet. So, alternate heating and cooling down or

â€˜rhythmicâ€™ phenomena are natural in all gravitating bodies. Endothermic (warm-blooded) organisms create most of their heat via metabolic processes, but ectotherms (cold blooded) hires external sources of temperature to regulate their body temperatures. In human, hypothalamus (sensor) in the brain is not the heat producing center but only controls internal thermoregulations through neural feedback mechanisms. Radiation, perspiration, conduction and convection are the heat transfer mechanisms. Interestingly core body temperature lies at central region liver, kidney, heart and parts of brain under circular initial fetus position. Coldest part is at the periphery at toe, foot, hand.

(6). Metabolic energy expressed as basal metabolic rate range from 2:3 to 3.4 ratios of mass or gravitational energy. It causes generation of heat, as per rhythmic pattern of sliding accretion mass. Logically biological mass has thus two sides â€“ one act as gravitation and other to main metabolic energy against mass to continue life processes. Thus â€˜higher the mass and density- higher would be the attractive force of self gravityâ€™ and in reverse way, â€˜lesser the density of accreted material, there would be delay in gravitational attraction to the centreâ€™. Nucleic acid having higher molar mass and density gets accreted in the centre of the cell. Proteins which have immediate lower molar mass and density than nucleic acid (as being derived from it) gets distributed surrounding the core.Â This is reflected in accretion of nucleic acid in centre of the cell, which is having higher molar mass and density. Distribution of fats and lipids however is a temperature dependent phenomenon, as solid and liquid phase are interchangeable in graded temperature.Â For distribution of carbohydrates, advancement of granular physics has been advocated.

(7). Centrifugation of any mass as bio-protocol to separate is an inverse process of central attraction. Sedimentation coefficients, expressed using Svedberg unit depends on mass, density, size, and shape. The Svedberg values basically tell us about the comparative molecular weight or gravitational mass and shape of biomaterials under ex vivo condition. Rate of sedimentation after centrifugation corresponds to in vitro acceleration towards accretion

(8)Â Growth, development, differentiation till death in living bodies obeys astrophysical principles of gravitation.

(9) Researches on microgravity and transformation of singular cells to multicellularity in evolutionary process suggest upholding gravitation theory.

Acknowledgement

The author is grateful to all his reviewers, friends, well wishers and group members in various scientific and social forums for their encouragement and thoughtful discussions.

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