

## THE MATRYOSHKA RUSSIAN DOLL UNIVERSE

“HAMLET: A man may fish with a worm that hath eat of a king, and eat of the fish that hath fed of that worm.

CLAUDIUS: What dost thou mean by this?

HAMLET: Nothing but to show you how a king may progress through the guts of a beggar.”

Within our vast trillion cell network churns a universe of miniscule microbial passengers, manipulating how we think, act, and feel. Microscopy provides a window at various scales ranging from atoms and molecules to proteins, and organs.

Eldercollege participants who wish to pursue these ideas, may consider searching Google at *“Cell Animation Youtube”* and/or *The Cell , a book, by Jack Challoner,* or *“I Contain Multitudes “ by Ed Yong* or *“Life’s Engines” by Paul G. Falkowski .*

### Your Inner World Where Relative Size and Shape Matter

Appreciating the surprising layers of the microscopic spatial and mass differences among animal cells, bacterial cells, and virus particles requires knowing several facts.

*#1) One millimeter can be subdivided into 1000 microns and each single micron can be subdivided into 1000 nanometers and so on down smaller and smaller to pico meters of atoms at the one trillionth meter level, and the femtometre world of protons and neutrons.*

#2) Simple naked numbers on a diagram such as the 30 *micron* human cell diameter, 2 *micron* bacterial cell diameter, or 30 *nanometer* virus are simply linear (one dimensional). But cells exist in 3D space where events happen in unimaginably tiny fractions of a second.

#3) By idealizing each as a cube and a sphere based on diameter and by using an extension of AMADEUS AVOGADRO'S LAW one can roughly calculate the probable number of water molecules which mostly make up each living cell.

Refer to the diagram "Anatomy of Cells"

***A three dimensional 30 micron cube*** has a volume of  $30 \times 30 \times 30$  or 27000 cubic microns which can accommodate 903 trillion water molecules. A 30 micron sphere holds 473 trillion.

***A 2 micron cube*** has a volume of  $2 \times 2 \times 2$  or 8 cubic microns which can fit 267 billion water molecules. A 2 micron diameter sphere of water has 140 billion.

A much smaller ***30 nanometer spherical virus*** houses about one million water molecules.

#4) Simply by using a diagram, showing one dimensional diameters or lengths, who might ever guess that a human cell could be over 3000 times as massive as a bacteria or 900 million times as large as a virus?

## USEFUL IMAGES

*To grasp the relative sizes of human cell, bacteria, and virus, imagine yourself on a sailboat with a one cubic meter box on deck looking up at a 3000 meter mountain. The mountain is relatively equivalent to a human cell while the box represents a single bacteria. The equivalent virus relative size would be a bacteria sitting on the box.*

### 1) Power Generators, 2) Power transformers, 3) Protein Factories

-Cells are analogous to television sets receiving signals from an environment which swarms with microbes. By translating DNA information within its circuits, cells use chemical energy to make proteins, transmit and or receive signals, and reproduce.

-**Eukaryotes** including plant, fungal, and animal cells (Greek for "true nut or kernel") have a large bacteria sized 5 micron nucleus containing DNA. Prokaryotes such as bacteria do not. Bacterial DNA is loose inside the cell.

-For all cells, water has the **viscosity of molasses**. Movement of anything either inside or out is energy intensive.

-The cell has a **waterproof double-hulled fatty membrane** with tiny virus-sized portals which selectively admit some atoms and molecules and act as exits for others. The membrane also has docking receptors for incoming molecular signals. Fossil fuels are geologic stored remnants of long dead cell membranes from millions of years ago.

-Cyanobacteria, green sulphur bacteria, and plant membranes have embedded power reaction centers called #1) **chloroplasts *which harvest light energy*** to split water and carbon dioxide molecules. These are recombined in coupling centers to be stored as sugars and starches and oxygen to be released into the atmosphere. Eventually the starches and sugars are converted into ATP (adenosine tri-phosphate), the universal energy currency of life

=At some point in the past, plants ***enslaved photosynthetic bacteria*** within their cells. Hence all chloroplasts today contain their own DNA.

-Similarly, cells have smaller #2) ***bacteria-sized engines called mitochondria***, all with their own DNA. They also were once independent ***bacteria enslaved to transform glucose into ATP adenosine tri-phosphate, the universal energy currency of life.***

- Cells also contain thousands of tiny virus sized #3) **ribosomes**, the **protein factories** which ***read, record and translate coded DNA directions to build proteins.***

## Information, as a Physical Reality

**Space, time, energy, matter and information** are related facets of measurable physical reality. Physicists, astronomers, and micro biologists know that the Universe is awash with a spectrum of both visible and invisible electro-magnetic radiation (light, radio waves, x-rays that can be **recorded, read, and translated using these facets.**

**Cells can decipher signals and convert coded information to construct complex proteins with a physical shape that make life possible.**

The length of nanometre light waves limits what an optical microscope can make visible.

Sub-nanometre atoms, molecules and complex molecular proteins become visible using new computing technologies

## The Hydrogen Ion Bond, an Electronic Glue Gun

From the lightest, the neutrally charged hydrogen atom with a single proton and electron to the heaviest, all atoms have nearly the same diameter, varying just 2 or 3 times in size.

**The 0.1 nanometre Hydrogen atom is mostly empty space** with a single proton that can exist alone as a positively charged ion 100 000 times smaller.

Atoms can be bonded together by hydrogen ions to form ever larger molecules in complex configurations that record, read, translate information, and create physical structures such as proteins, cells and multi-cellular creatures.

The water (H<sub>2</sub>O) molecule at .278 nanometers is the source of life because it is a source of Hydrogen ions which each consist of a single positively charged proton, a hundred thousand times smaller than the hydrogen atom.

The miniscule proton (positive Hydrogen ion) is an electronic glue-gun that can be turned on and off by separating single electrons by membranes as chemical reactions unfold in a sequence at unimaginable femto-second speeds. ((0. 000 000 000 000 001 seconds)