A definition of a cell?

A living cell is a ......

self contained
self assembling
self adjusting
self perpetuating
isothermal mix of biomolecules

held in a 3-D conformation by weak
non-covalent forces
which can extract raw materials (precursors)
& free energy from its surroundings
that can catalyze reactions with specific
biocatalysts (enzymes), which it makes
that shows great efficiency & economy of
metabolic regulation
that maintains a dynamic steady state far
from equilibrium
that can self-replicate using the linear
information of a molecule of DNA.
How Cells are ORGANIZED:

3 Basic Parts of a Cell
1. membrane (selectively permeable - in/out)
2. a DNA region (nucleoid or nucleus)
3. the cytoplasm & its parts organelles

within the three Biological Domains
Eubacteria - true bacteria
Archaea - ancient prokaryotes
Eucarya - modern multi-cellular systems

2 successful Cellular Plans of Organization

1. PROKARYOTE - "before nucleus"
   includes... Unicellular forms  blue green algae & bacteria
   primitive, simple, versatile, common unicellular forms
   most successful life form -
   80% to 90% of total biomass of planet
   2500 different species known

   characteristics:
   lack membrane bound organelles
   genes "naked DNA" - no "chromosomes"
   little to no internal compartmentation
   size 0.1 to 10 µm diameter
Two major forms of prokaryotes exist today:

Archaebacteria and Eubacteria [ancient & true]

**ARCHAEBACTERIA** ...

- **living archaebacteria include:**
  - the **extremophiles** – those living in extreme environments
    - METHANOGENS $CO_2 + H_2 \rightarrow CH_4$
    - HALOPHILES live in Dead Sea & Great Salt Lake
    - THERMOPHILES in acid hot springs, deep ocean geysers
    - ACIDOPHILES & ALKALIPHILES acid & base loving

**EUBACTERIA** (all other living bacteria modern form + flagella)

- many cause diseases - Bacillus anthracis = anthrax
  - Clostridium botulinum = botulism
  - Staphylococcus aureus = food poisoning
  - Salmonella = food poisoning & typhoid
- many make antibiotics - Streptomyces = streptomycin
  - Penicillius = penicillin

**CYANOBACTERIA** - are photosynthetic eubacteria

Archaebacteria/eubacteria ...

- are highly conserved - living fossil forms and solve many environmental challenges (problems)
  - by their chemistry and by evolving new metabolic solutions.

**procaryotic bacteria are found in 3 common shapes:**

- **cocci**
- **bacillus**
- **spirochetes**
current paradigm...
eukaryotes evolved from simpler prokaryotes

2. **EUKARYOTIC** eu - true karyon - nucleus
   plan of **multicellular** organisms...
   many internal membrane bounded organelles
   organelle = a subcell part that has a distinct metabolic function

7 **common major characteristics of eucaryotes:**
   nucleus - single greatest step in evolution of animals
   genes in "chromosomes" [colored bodies + protein]
   contains more DNA (1,000 x more)
   presence of **organelles**- internal compartmentation
   presence of flexible cell walls (allows **phagocytosis**)
   presence of **cytoskeleton**
   reproduce **sexually**
   usually larger - cell volume 10X greater than bacteria)
   - size 5.0 to 20 µm diameter

**extensive internal membranes**

2 **basic types of eukaryotic cells:**
   animal - metazoan - heterotrophic feeder
   plant - metaphytian - autotrophic producer
   chloroplasts, large vacuoles, cellulosic cell wall
Where do the VIRUSES fit?

- obligatory intracellular parasites:
  - pathogens of made of a protein capsid (capsule) & genetic material (ss or ds RNA or DNA)

VIRION - virus outside of host
VIROID - RNA pathogen (virus w/o capsid) 240-600 n's

Extreme viruses:
Viruses (like extremophiles) can live in Earth's most extreme environments.

Origin of Viri(?)... small pieces of cell chromosomes, that maintained an autonomous existence within cells. Overtime these genetic elements acquired protein coats & ability to transfer to other hosts (and became infective) ???

What are PRIONS – protein infectious pathogens

- biological activity without RNA or DNA ? How ???
- cause diseases as: encephalopathies...
  - scrapie, Creutzfeldt-Jacob, mad-cow disease.
- all are due to --> misfolded proteins

Nanobes?? are tiny filamental structures found in some rocks and sediments;
- smallest are just 20nm long. May be crystal growth, but they're purported to hold DNA;
- look similar to life-like structures found in ALH84001
How do we identify subcell parts?

Light Microscopy
resolution = distance by which distinguish 2 dots = 0.2 um
killing/fixing samples: formaldehyde & glutaraldehyde
sectioning: microtome (1 to 10 um thick)
selective staining:
types: bright field, phase-contrast, Nomarski, dark-field

Electron Microscopy
resolution = 0.2 nm
TEM - Transmission
SEM - Scanning
FfEM - Freeze fracture

3D = Orange Bowl cross section
see figure examples

Size relationships of parts -
Cell Isolation & Culture ..... HeLa cells
Homogenization - Fractionation & Centrifugation
Major Eukaryotic sub cell ORGANELLES

NUCLEUS: envelope, chromatin, nucleolus, nucleoplasm
MITOCHONDRIA: peri-mitochondrial space, cristae, matrix
CHLOROPLAST: peri-chloroplast space, thylakoids, stroma
RIBOSOME: small unit, large unit, polysome
ENDOPLASMIC RETICULUM: smooth & rough
GOLGI BODY: sided - cis & trans; endomembrane pathway
LYSOSOME: hydrolytic enzymes
MICROBODIES: peroxisome & glyoxysome
CYTOSKELETON:
  microfilaments, microtubules, intermediate filaments
CENTROSOME: centriole, basal body, flagella, cilia
INTRACELLULAR JUNCTIONS:
  tight junctions, desmosomes, gap junctions, plasmodesmata
PLANT CELL VACUOLE:
  surrounded by membrane; stores waste, balance osmosis
CELL MEMBRANE:
  surrounds cell & regulates what gets in/out

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