



Introduction to biology

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Biology - Life Science

- the most diversified science
- a huge range of biological disciplines
- from macromolecular complexes ranging from nanometers to ecology on a global scale

Branches of biology

(structural – physiological – evolutionary – environmental -

Structural

Molecular biology

Cytology, or cell biology

Genetics

Developmental biology

Physiological

Physiology
Anatomy

Evolutionary

Paleontology
Population genetics
Theory of evolution

Environmental Ecology

General Ecology

Global ecology

Ecology of microorganisms

Ecology of the forest and the sea

Ecology of an individual (autecology),
populations (demekology),
communities (synecology), E. of biomes

Ethology

Definition

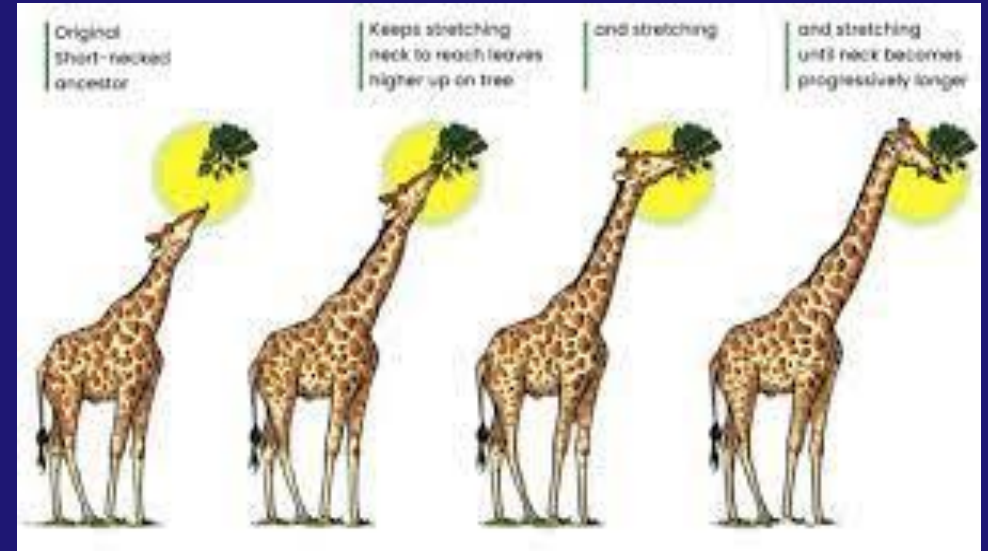
- Biology (from Greek bio meaning life and suffix logic - science - life science)
- In the broadest sense, science is concerned with organisms, and everything related to them - from chemical processes at the level of atoms and molecules to the whole ecosystems
- Biology follows up relations between organisms and relationships with their life environment

History

- **Michael Christoph Hanov** - Philosophiae naturalis sive physicae dogmaticae: Geology, biology, phytology generalis et dendrologia (1766) - first use of the word „biology“.

Jean-Baptista Lamarck (1744-1829)

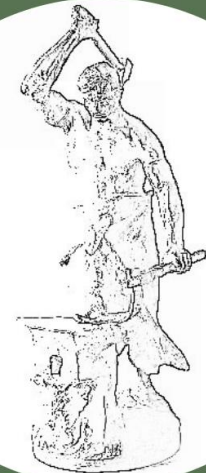
- a theory of evolution based on the principle that **physical changes in organisms during their lifetime**—such as greater development of an organ or a part through increased use—could be transmitted to their offspring
- blacksmith's arm
- the giraffe, seeking to browse higher and higher on the leaves of trees on which it feeds, stretches its neck



Lamarck argued that...



... a blacksmith gets strong muscles from his work ...

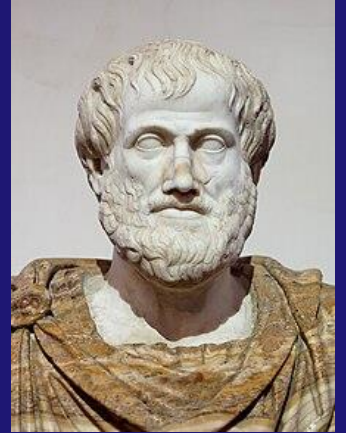


... and his sons inherit those strong muscles.

The era of ancient Greece and Rome

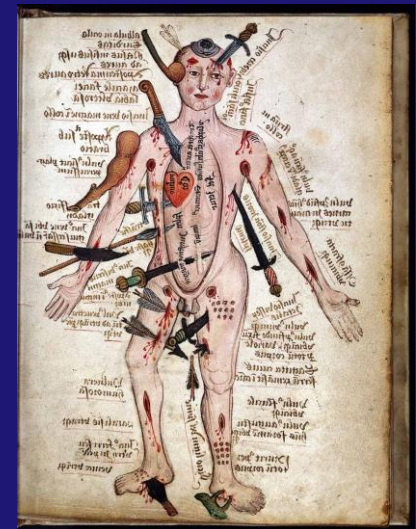
Aristotle

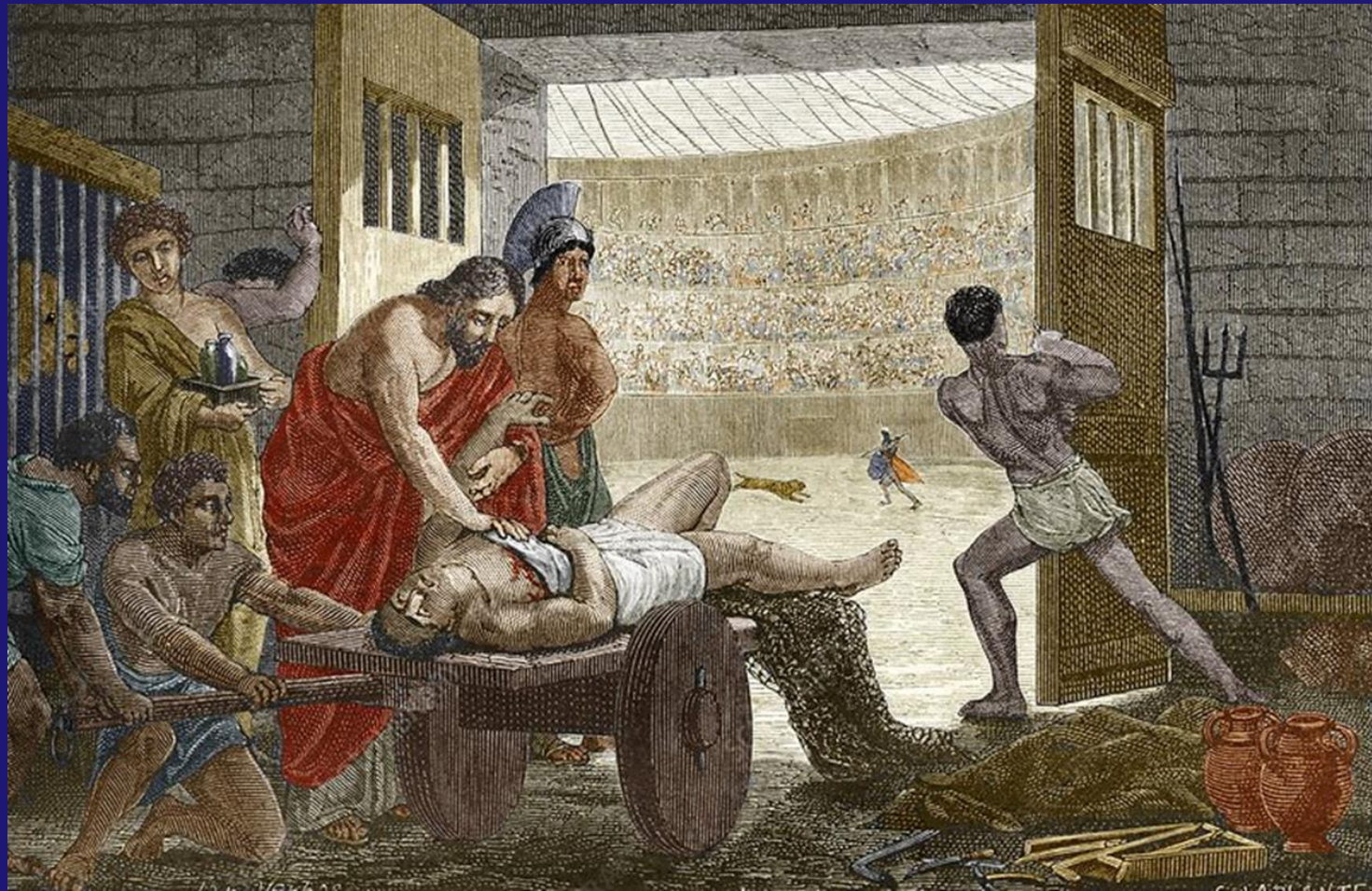
- described about 500 species
- created the foundations of **comparative anatomy and embryology**
- developed an elementary classification of animals.



Claudius Galen

- the first physician to use **the pulse as a sign of illness**.
- Some representative study areas included embryology, neurology, myology, respiration, reproductive medicine, and urology
- improved the science and use of drugs in therapeutics
 - doctor of gladiators, emperors Marcus Aurelius, Commodus,
 - learning about the four bodily juices (blood, phlegm, bile, black bile) corresponding to the four elements (water, air, earth, fire) and their properties (moisture, dryness, heat, cold)





the Middle Ages (6th - 15th/16th centuries)

- **Avicenna - Ibn Síná**

Muslim physician, the most famous and influential of the philosopher-scientists of the medieval Islamic world. He composed the Kitāb al-shifā' (**Book of the Cure**), a vast philosophical and scientific encyclopaedia, and Al-Qānūn fī al-ṭibb (**The Canon of Medicine**), which is among the most famous books in the history of medicine.



The Renaissance and the Beginning of Modern Times

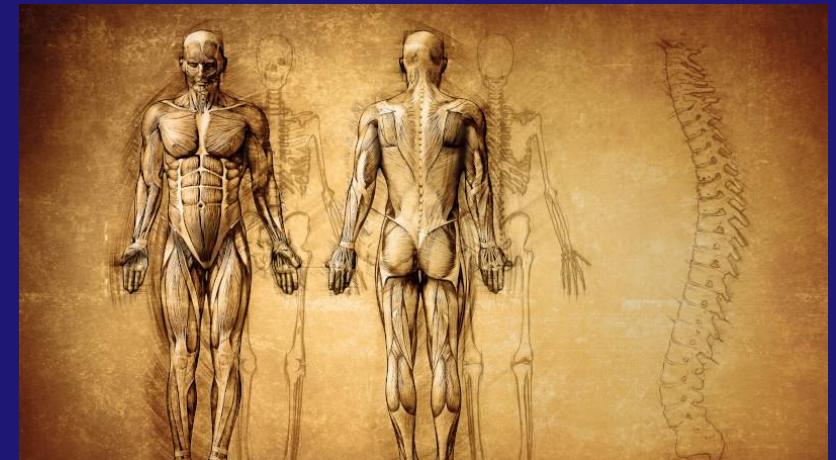
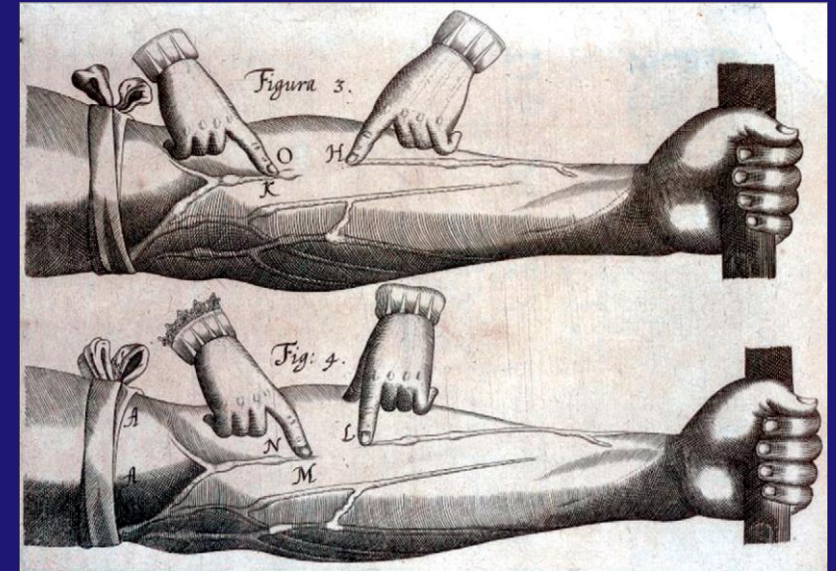
Biology as a science was brought into Europe

William Harvey

- the function of the heart and the circulation of blood

Andreas Vesalius

- illustrate human anatomy based on his findings from autopsies and dissections



18. Century

Discovery of the microscope was a major revolution in biology!



Robert Hook

<https://www.scienceinschool.org/article/2012/microscope/>



Anton van Leeuwenhoek

invented the first practical microscopes and used them to become the first person to see and describe bacteria, among other microscopic discoveries.

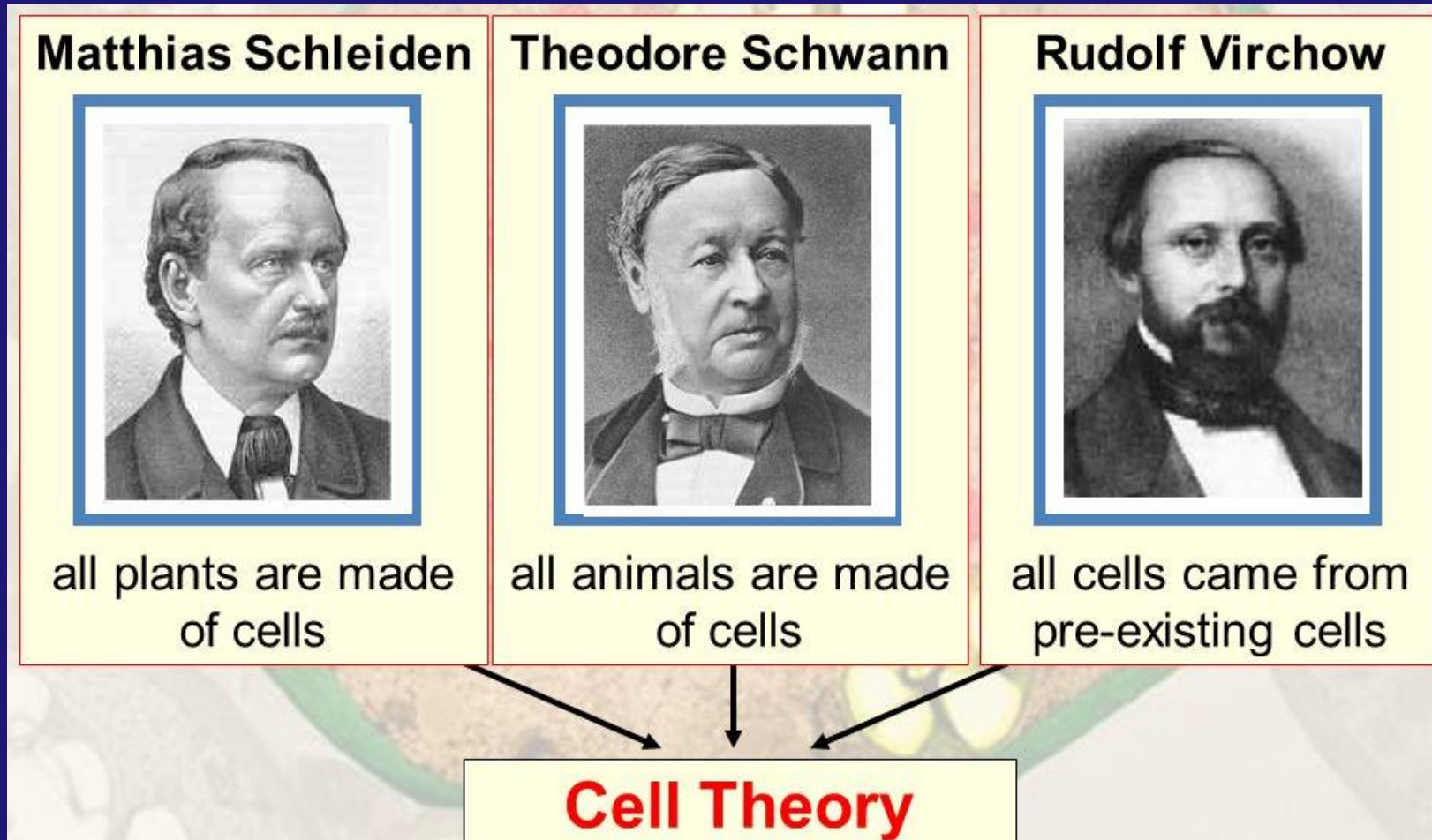


Carl von Linne

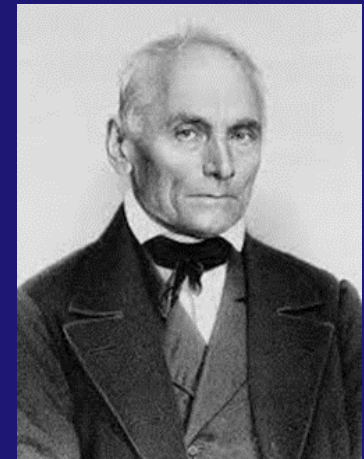
- Carl Linnaeus (1707 - 1778)
- was a Swedish botanist who devised the binomial classification system, a two-part naming system to identify, classify and name organisms from bacteria to elephant.
- is often called the **Father of Taxonomy**



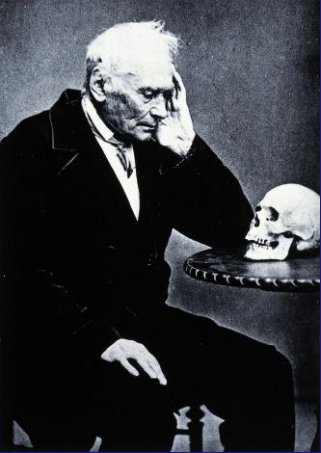
19th century



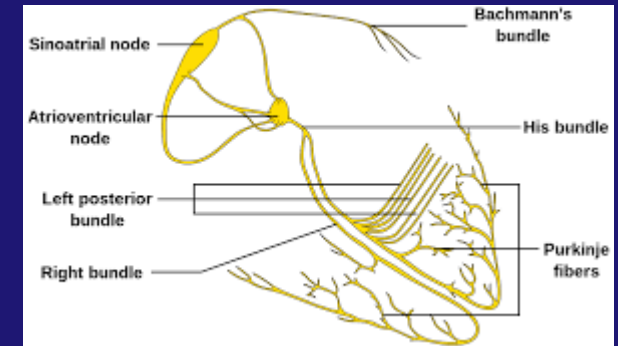
J.E.Purkyně



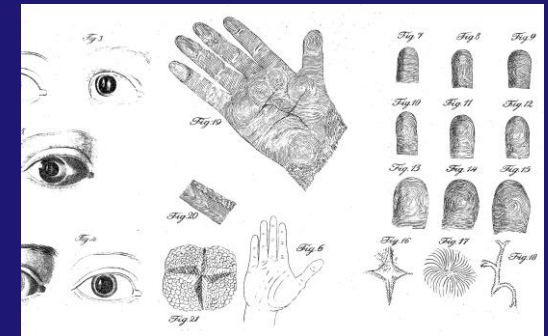
Jan Evangelista Purkyně (1787 – 1869)



- pioneer Czech experimental physiologist whose investigations in the fields of histology, embryology, and pharmacology helped create a modern understanding of the eye and vision, brain and heart function, mammalian reproduction, and the composition of cells.

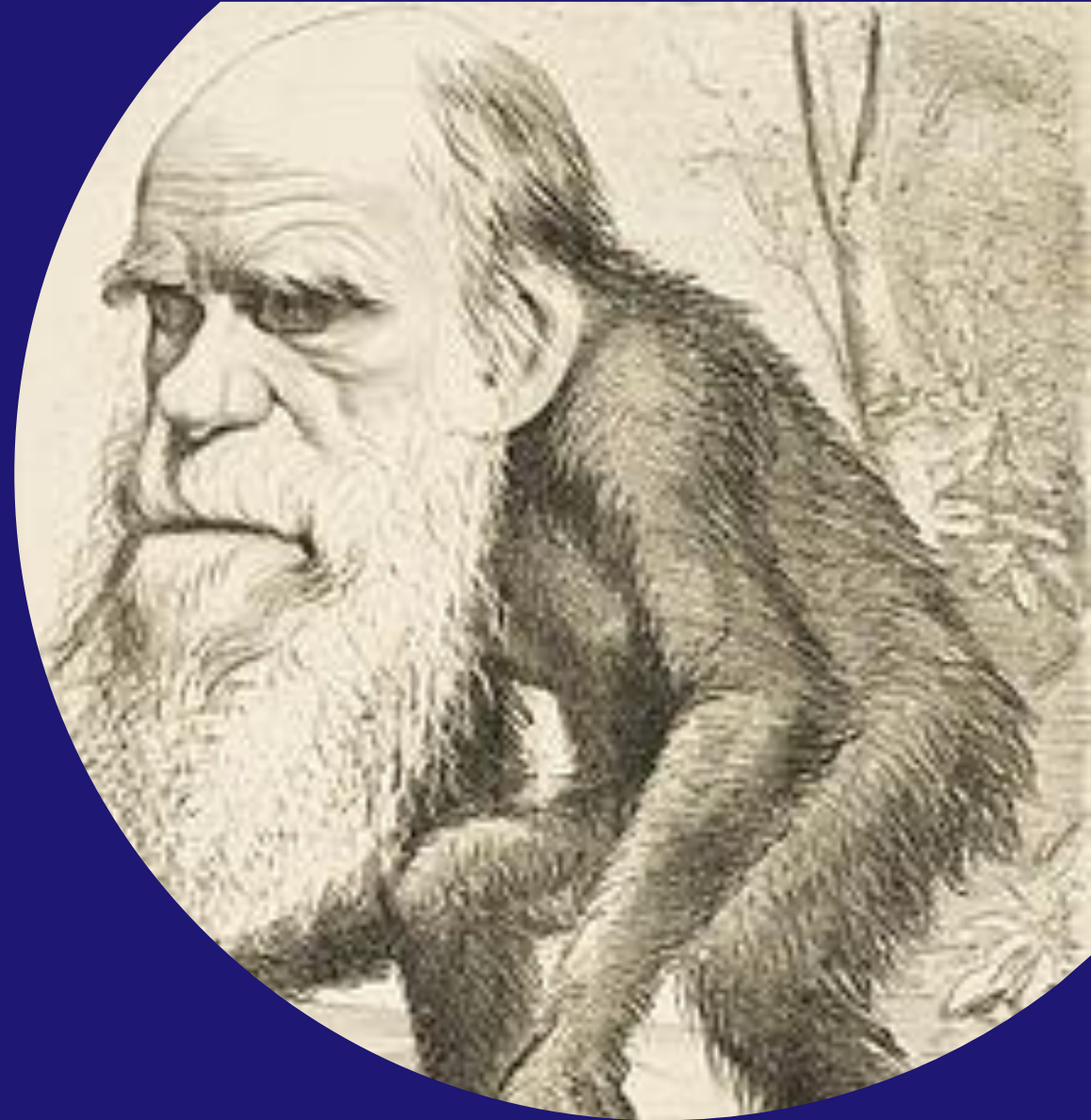


- Purkinje fibers. These fibers were discovered by their namesake scientist in 1839. These fibers conduct the electrical impulses
- Have you ever seen yourself reflecting in someone else's eyes? Those reflections are called Purkinje images.
- first to use a microtome in his lab. This handy tool cuts very thin slices of frozen tissue

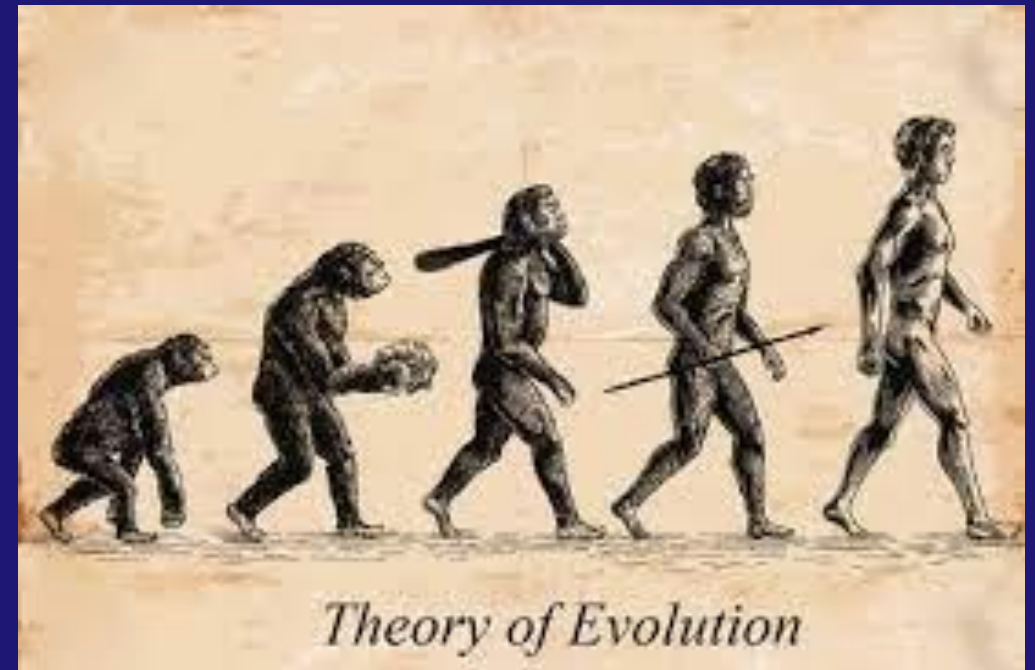
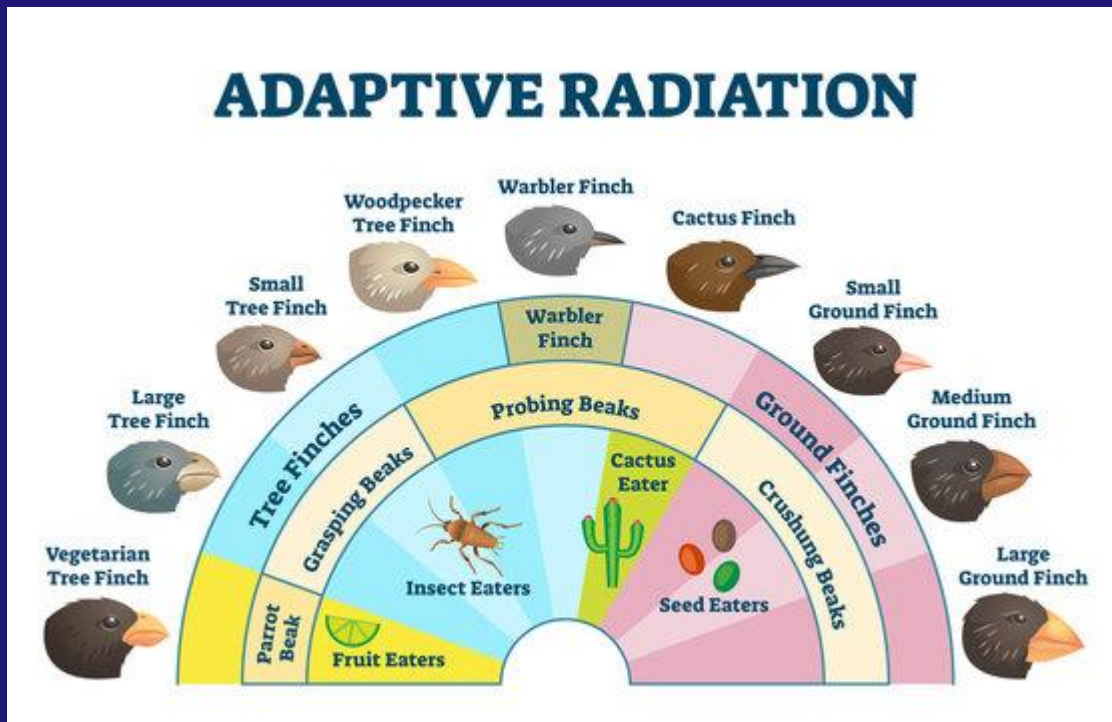


Charles Darwin

- The most important biologist of the 19th century is Charles Darwin with his **theory of evolution** based on natural selection.
- Society's opposition - contrary to Christianity, later recognized as true
- Darwin's theory was misappropriated – racism, and eugenics

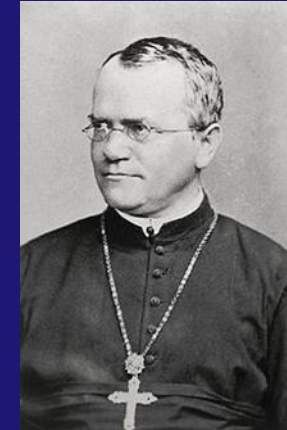


- Darwin's finches are a good example of adaptive radiation. It is an evolutionary process starting from a point in a geographical area, giving rise to new species depending upon habitat.



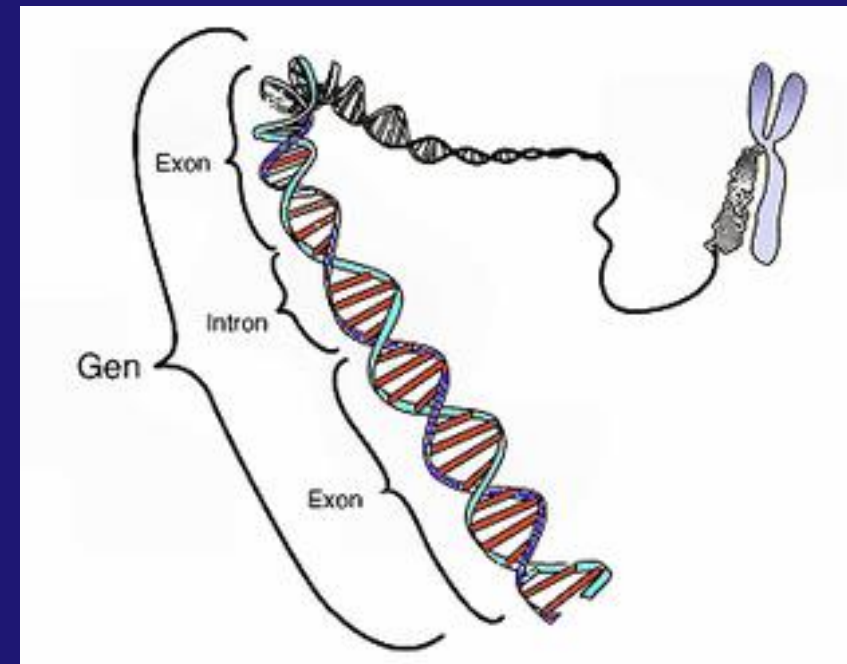
Gregor Mendel

- father of genetic
- He was a Czech teacher, monk, priest, and later abbot of the Augustinian monastery in Staré Brno.
- A rapid increase in genetics research
- careful breeding of garden peas
- discovered the **basic principles of heredity** and laid the mathematical foundation of the science of genetics.
- discovered the **basic laws of heredity**



Thomas Morgan

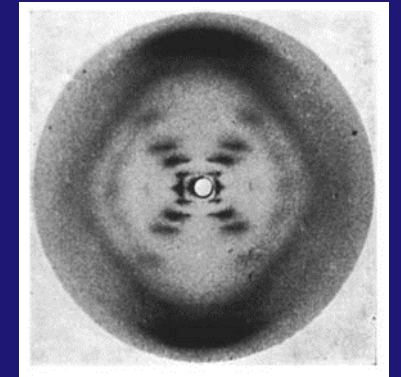
- American evolutionary biologist, geneticist, embryologist
- His work confirmed that **genes are stored in chromosomes** inside cell nuclei
- (fierce opponent of this theory)
- 1933 Nobel Prize awarded
- Experiments with fruit flies



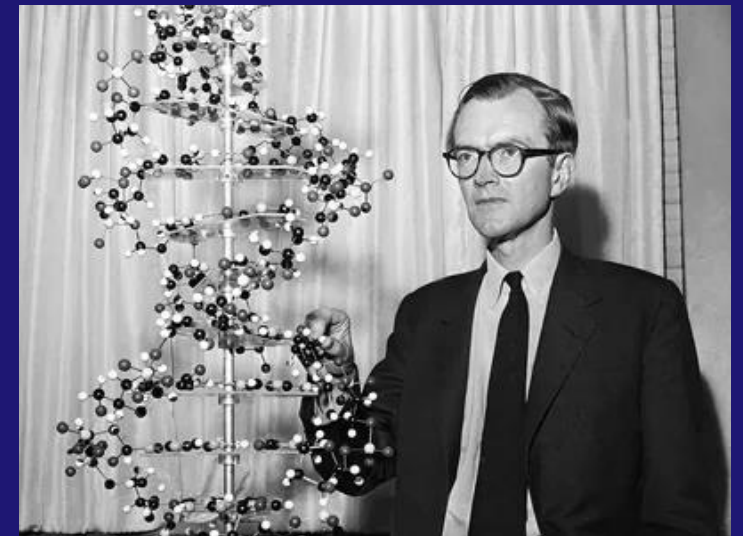
DNA discovery

Rosalind Franklin (1920-1953)

- Using X-ray techniques took pictures of DNA and discovered the double helix shape of DNA.
- Died of cancer due to unknown harmful affects of X-ray



Maurice Wilkins



James Watson and Francis Crick

- First scientists to create a **model of DNA**
- It is still the model used today
- Sides are made of sugar and phosphate molecules
- Rungs of the ladder are made of nitrogen bases
- Made of 5 elements: carbon, hydrogen, oxygen, nitrogen, and phosphorus



- In 1966, American biochemists **Har Gobin Khorana and Marshall Warren Nirenberg** deciphered the **genetic code**.
- In the 1960s, the **structure of RNA** was elucidated.
- In 1989, American chemists **Thomas Cech and Sidney Altman** received the Nobel Prize for the discovery of autocatalytic **RNA**, which significantly advanced knowledge in the field of the origin and development of life on Earth
- ◎ **mapping the genomes** of various organisms, continuing in the 21st century.

The main theme of 21st-century biology

genetics and genomics, leading to a deeper understanding of how organisms function at the molecular level. Key areas include:

1. **Genomics and personalized medicine** – Genome sequencing enables better understanding of diseases, individualized treatments, and the development of precision medicine.
2. **Biotechnology** – Genetic modification is used in agriculture, medicine (e.g., CRISPR), and industrial production.
3. **Epigenetics** – Study of how environmental factors influence gene expression without changing the DNA sequence.
4. **Synthetic biology** – Creating artificial biological systems or organisms.
5. **Evolutionary biology and biodiversity** – Understanding human impact on ecosystems and finding ways to preserve them.
6. **Neuroscience** – Advancing knowledge of brain structure and function, including research on consciousness and artificial intelligence.
7. **Ecology and climate change** – Studying the effects of human activities on the planet and seeking sustainable solutions for the future.

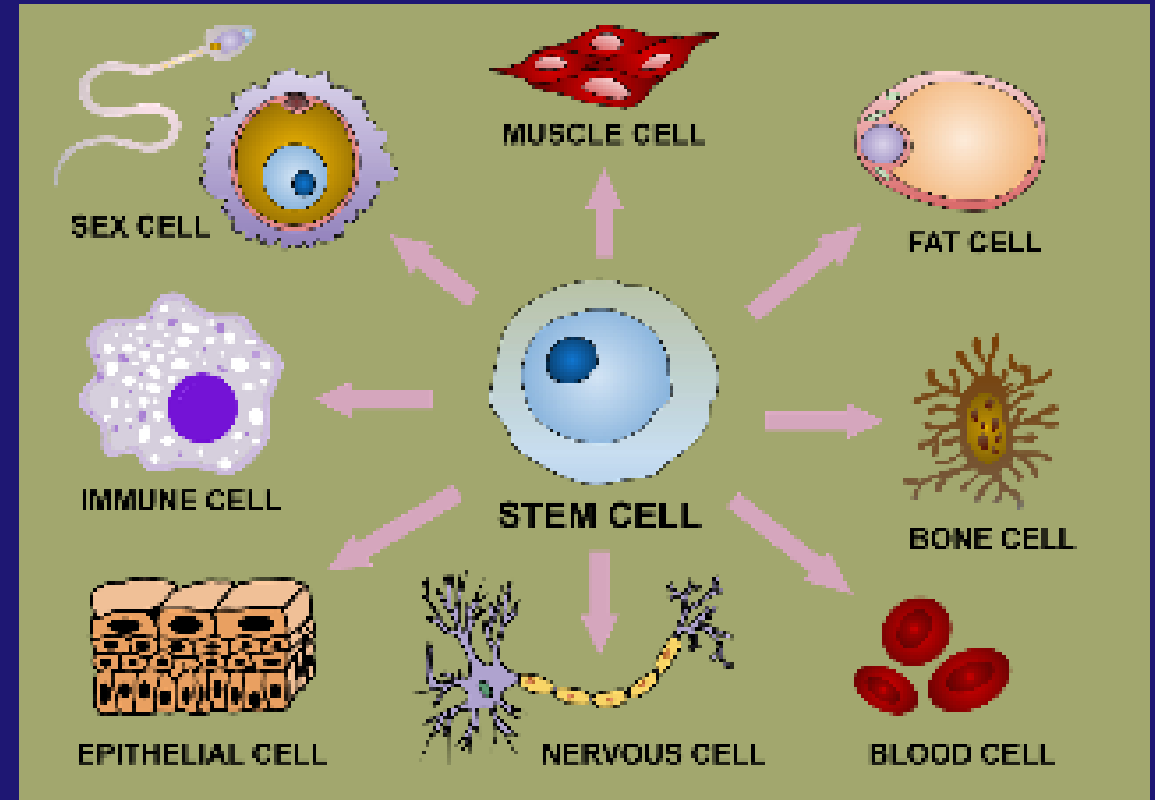
Five principles of biology

1. Cell theory

-living organisms are made up of cells, they are the basic structural/organizational unit of all organisms.

Cell - the basic unit of reproduction.

2. Evolution - in biology, it is an indication of the gradual change in the genetic properties of organisms and the process of natural selection.



3. Gene theory

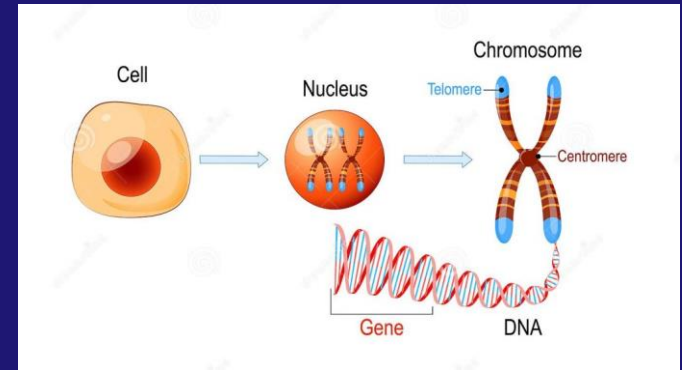
- the properties of all living organisms are encoded in genes.

4. Homeostasis

- physiological processes that maintain stable internal conditions in the body, regardless of external conditions

5. Energy

- the essential feature of every living organism is the use of energy.
- The survival of every animal and plant depends on its constant supply



What's living?

Where is the border and does the bother exist?

Maynard-Smith and Szathmary (1995) - two options for the definition of "living,"

phenotype vs. genotype.

- **Phenotypic approach** - the entity is alive if it has parts or "organs" that perform a function.
- **Genotypic approach** - living entities have properties such as proliferation, variability, and inheritance.

Characteristics of life

Chemical
construction

Cellular nature

Metabolism

Growth

Reproduction

Heredity

Variation

Movement

Evolution

Irritability

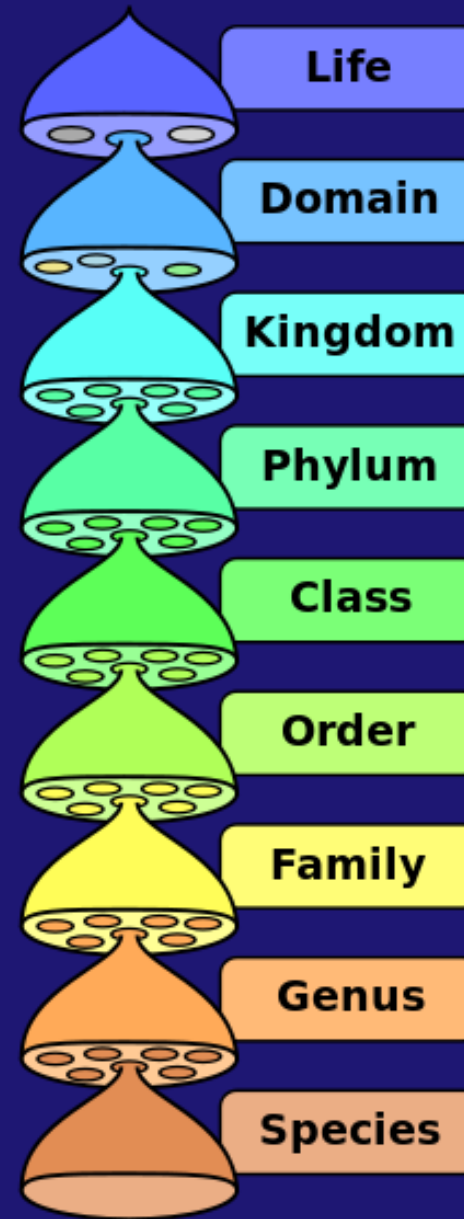
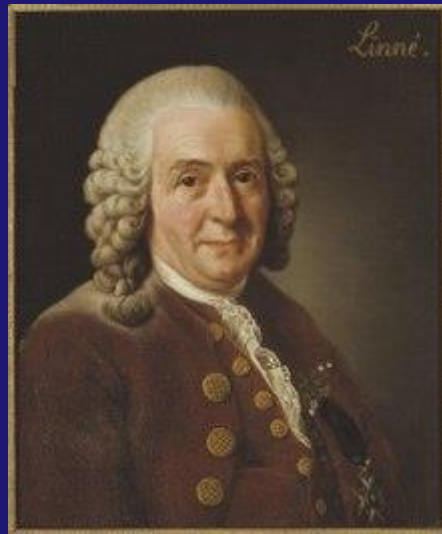
Differentiation

Regeneration

Adaptation

Taxonomy

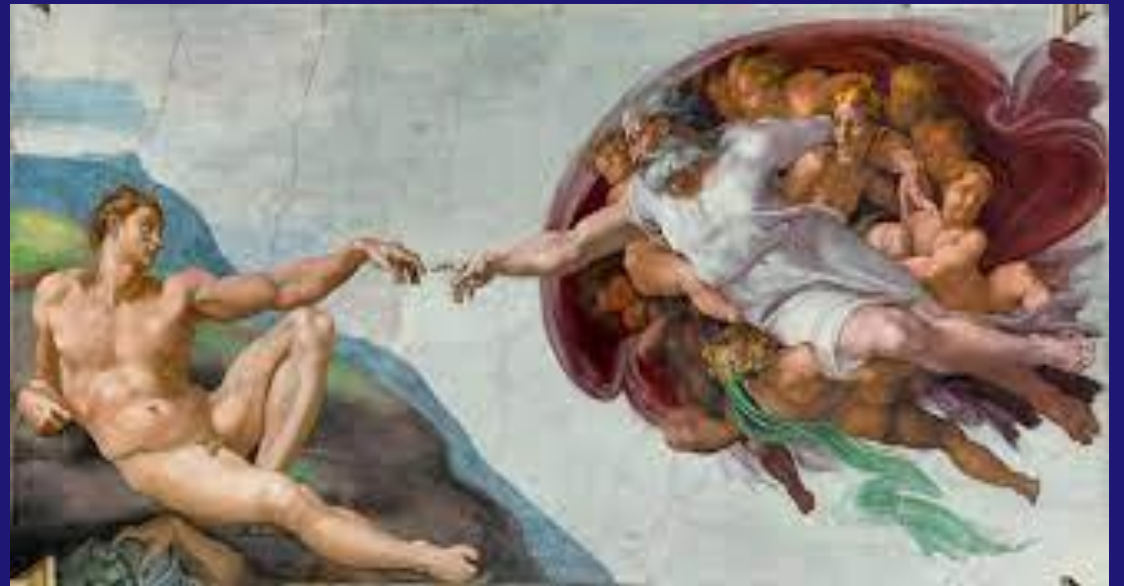
Carl Linné



Theories of life origin

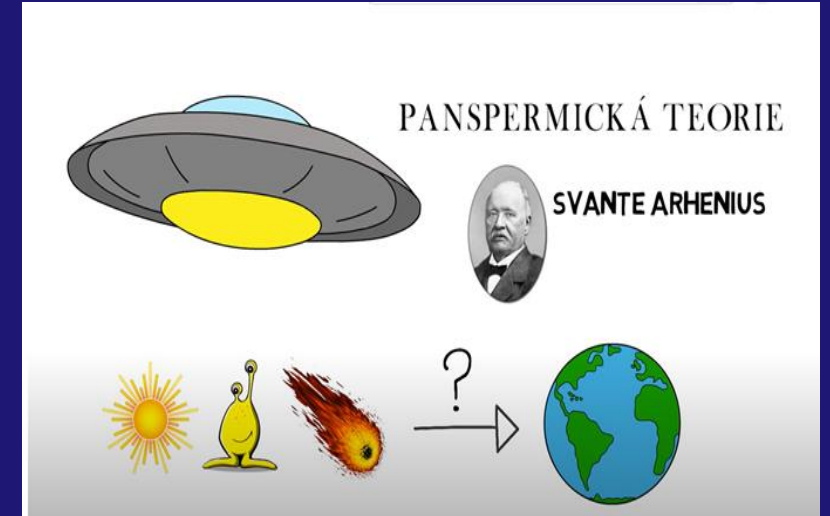
1. Creationism

- Creation theory assumes the intervention of a supernatural power, i.e. God
- C. Linné, R. Hooke or J.B. Lamarck



2. Extraterrestrial origin (Panspermia)

- the hypothesis that life exists throughout the Universe, distributed by space dust, meteoroids, asteroids, comets, and planetoids, as well as by spacecraft carrying unintended contamination by microorganisms
- Panspermia is a fringe theory with little support among mainstream scientists (Crick).



3. Spontaneous generation theory

- The theory of **self-breeding organisms** can arise directly from inanimate matter (Aristotle)
- a theory already stated by ancient philosophers but disproved in the middle of the 19th century - in **2000 years!**
- the creation of organisms directly from inanimate matter (e.g. frogs from mud, mice from grain, etc.)
- was disproved by the French chemist Louis Pasteur

4. Evolutionary theory

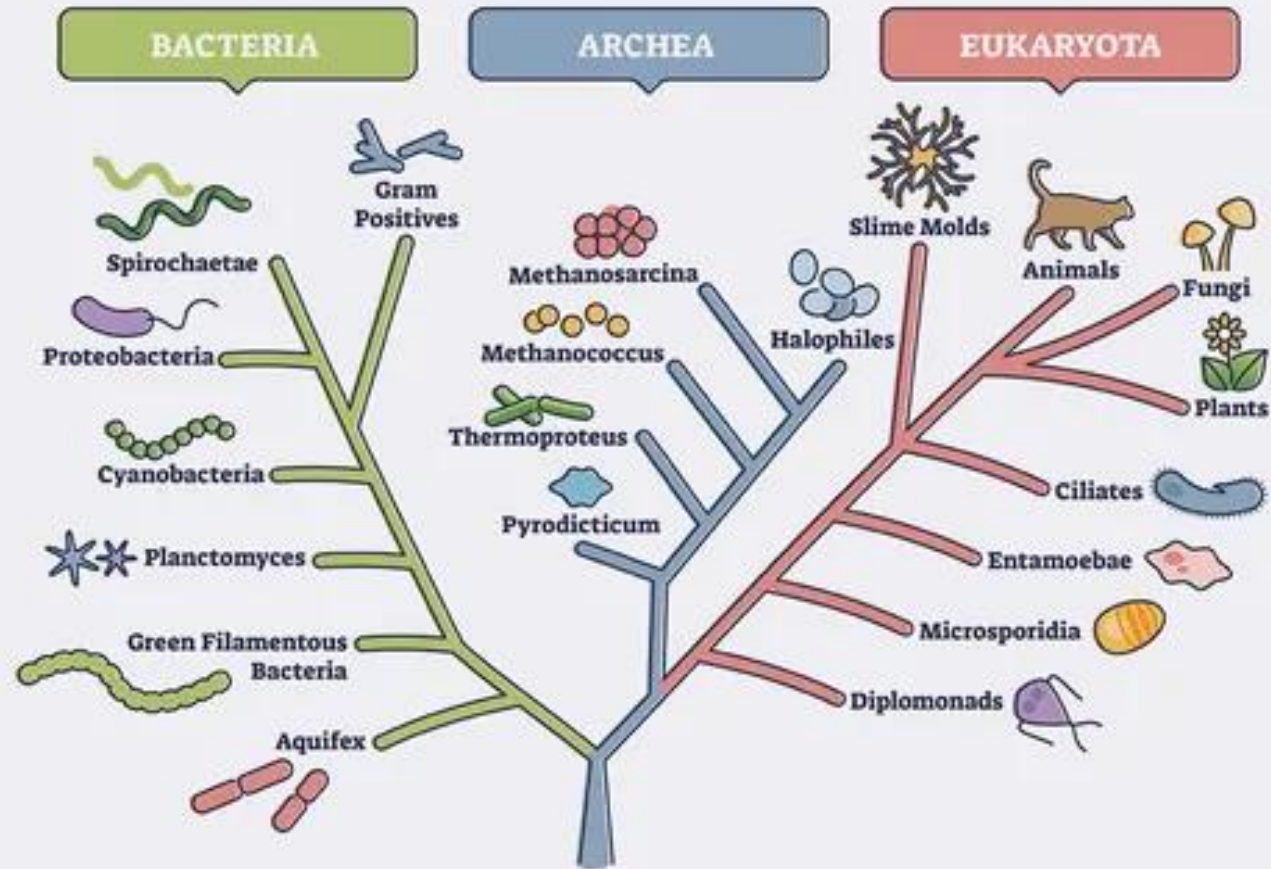
- the emergence of life through gradual development on Earth
the sequence first includes the formation of basic building materials of organisms (amino acids, lipids, sugars) and informative macromolecules (nucleic acids) with subsequent replication and evolution

Domains

- **archaea** (Archaea, Archaeobacteria)
- **bacteria** (Bacteria, Eubacteria)
- **eukaryota** (Eukaryota)

- ? NCLDV (nucleocytoplasmic large DNA viruses) group of large DNA nuclear-cytoplasmic viruses (? 2010)

PHYLOGENETIC TREE

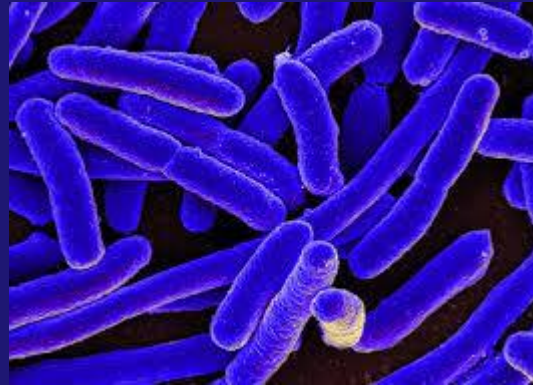


<u>Linnaeus</u> 1735	<u>Haeckel</u> 1866	<u>Chatton</u> 1925	<u>Copeland</u> 1938	<u>Whittaker</u> [60]	<u>Woese</u> 1990	<u>Cavalier-Smith</u> 1998	<u>Cavalier-Smith</u> 2015
		<u>2 empires</u>	<u>4 kingdoms</u>	<u>5 kingdoms</u>	<u>3 domains</u>	<u>kingdoms</u> ⁶	<u>kingdoms</u> ⁷
	<u>Protista</u>	<u>Prokaryota</u>	<u>Monera</u>	<u>Monera</u>	<u>Bacteria</u> <u>Archaea</u>	<u>Bacteria</u>	<u>Bacteria</u> <u>Archaea</u>
			<u>Protoctista</u>	<u>Protista</u>		<u>Protozoa</u>	<u>Protozoa</u>
						<u>Chromista</u>	<u>Chromista</u>
<u>Vegetabilia</u>	<u>Plantae</u>	<u>Eukaryota</u>	<u>Plantae</u>	<u>Plantae</u>	<u>Eucarya</u>	<u>Plantae</u>	<u>Plantae</u>
				<u>Fungi</u>		<u>Fungi</u>	<u>Fungi</u>
<u>Animalia</u>	<u>Animalia</u>		<u>Animalia</u>	<u>Animalia</u>		<u>Animalia</u>	<u>Animalia</u>

Cell types

PROKARYOTIC CELL

- ◉ Archea
- ◉ Bacteria



EUCARYOTIC CELL

- ◉ Plants
- ◉ Animals
- ◉ Fungi



The following table compares some major characteristics of the three domains, to illustrate their similarities and differences.

Property	Archaea	Bacteria	Eukaryota
Cell membrane	Ether-linked lipids	Ester-linked lipids	Ester-linked lipids
Cell wall	Pseudopeptidoglycan, glycoprotein, or S-layer	Peptidoglycan, S-layer, or no cell wall	Various structures
Gene structure	Circular chromosomes, similar translation and transcription to Eukaryota	Circular chromosomes, unique translation and transcription	Multiple, linear chromosomes, but translation and transcription similar to Archaea
Internal cell structure	No membrane-bound organelles (? ^[66]) or nucleus	No membrane-bound organelles or nucleus	<u>Membrane-bound organelles and nucleus</u>
Metabolism ^[67]	Various, including diazotrophy, with methanogenesis unique to Archaea	Various, including photosynthesis, aerobic and anaerobic respiration, fermentation, diazotrophy, and autotrophy	Photosynthesis, cellular respiration, and fermentation; no diazotrophy
Reproduction	Asexual reproduction, horizontal gene transfer	Asexual reproduction, horizontal gene transfer	Sexual and asexual reproduction
Protein synthesis initiation	Methionine	Formylmethionine	Methionine
RNA polymerase	One	One	Many
EF-2/EF-G	Sensitive to diphtheria toxin	Resistant to diphtheria toxin	Sensitive to diphtheria toxin

Prokaryotic cell – bacteria and archea

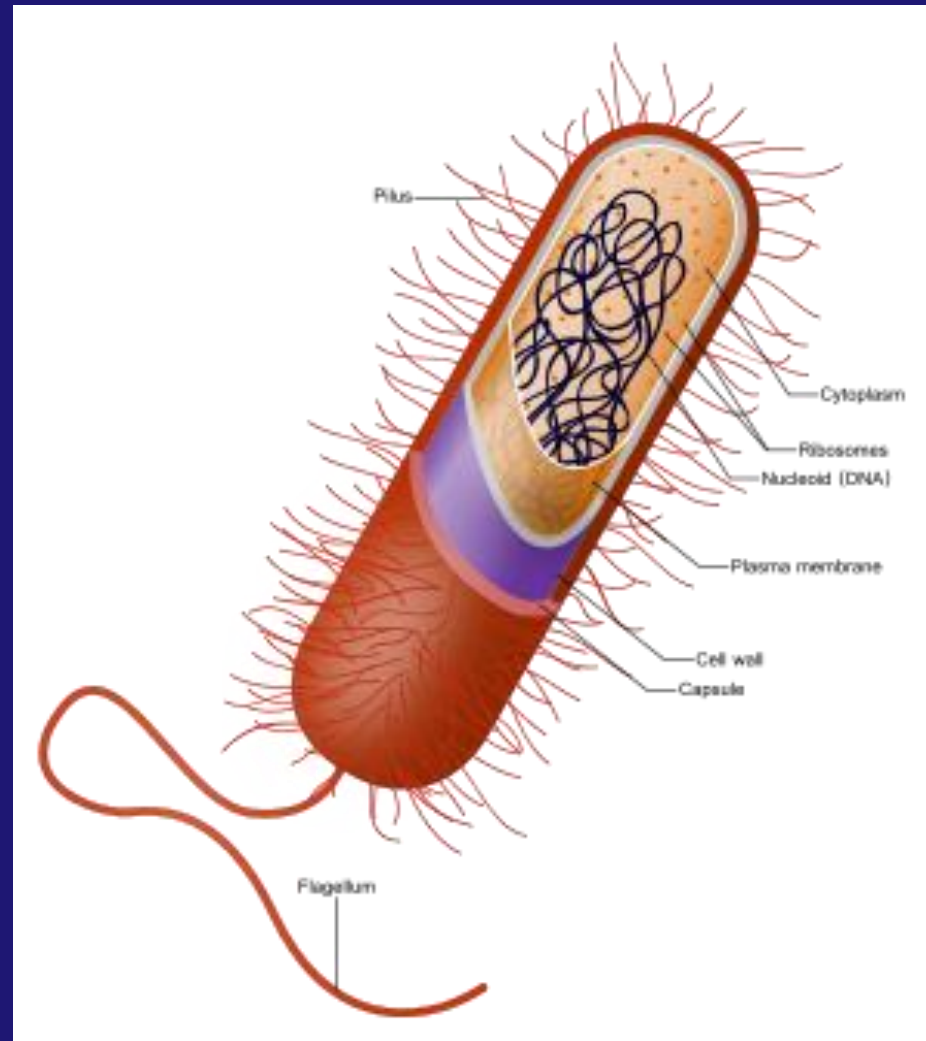
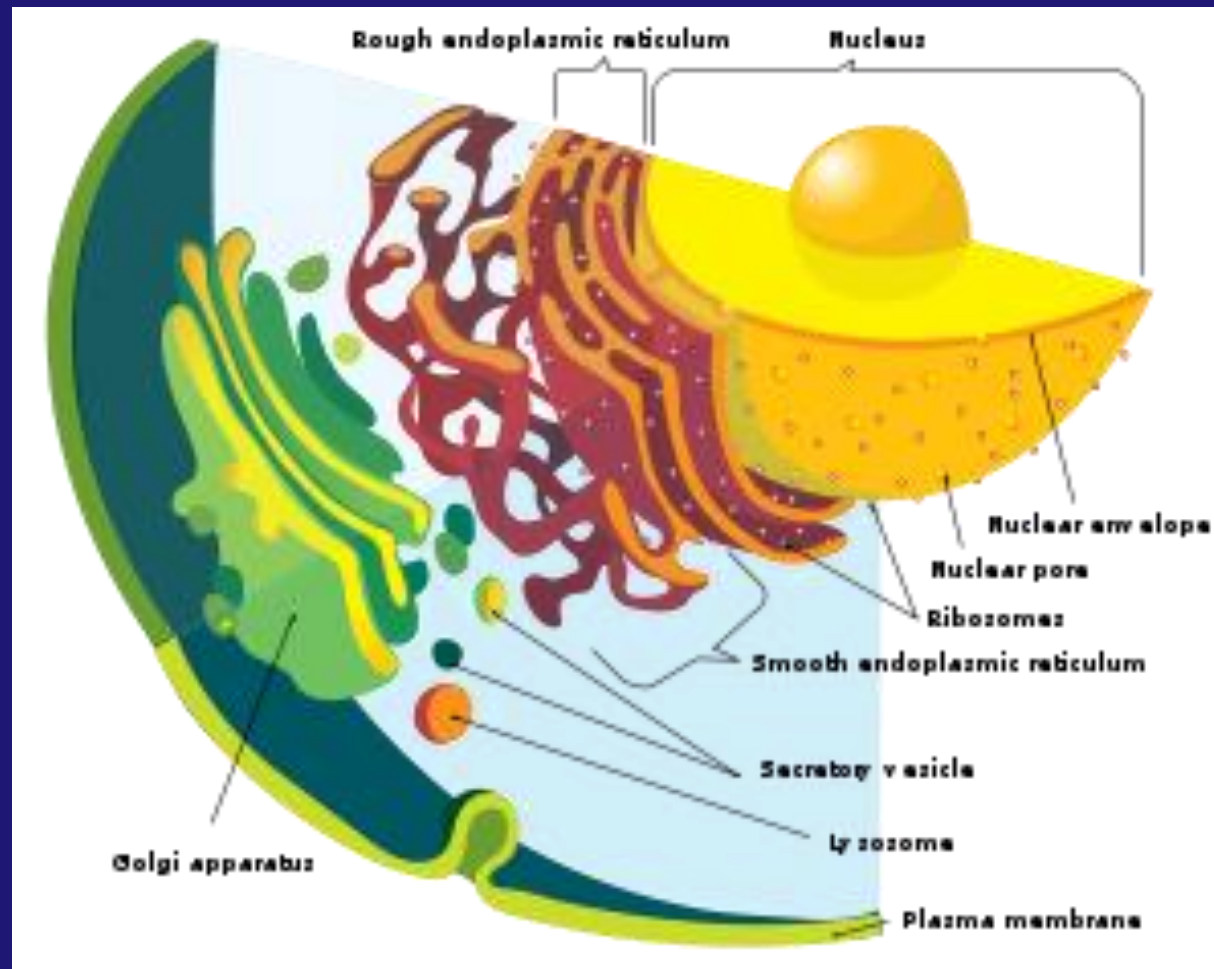


Image credit: modified from "Prokaryotic cells: Figure 1" by OpenStax College, Biology, CC BY 3.0

Eukaryotic cell – plants and animals



Differences between Prokaryotic and Eucaryotic Cells

PROKARYOTIC CELL

- ◉ No nucleus
- ◉ No membrane – enclosed organelles
- ◉ Usually single circular chromosome
- ◉ No cytoskeleton
- ◉ No streaming in the cytoplasm
- ◉ Cell division without mitosis
- ◉ Simple flagella
- ◉ Small ribosomes
- ◉ No cellulose in the walls
- ◉ No histone protein in chromosome

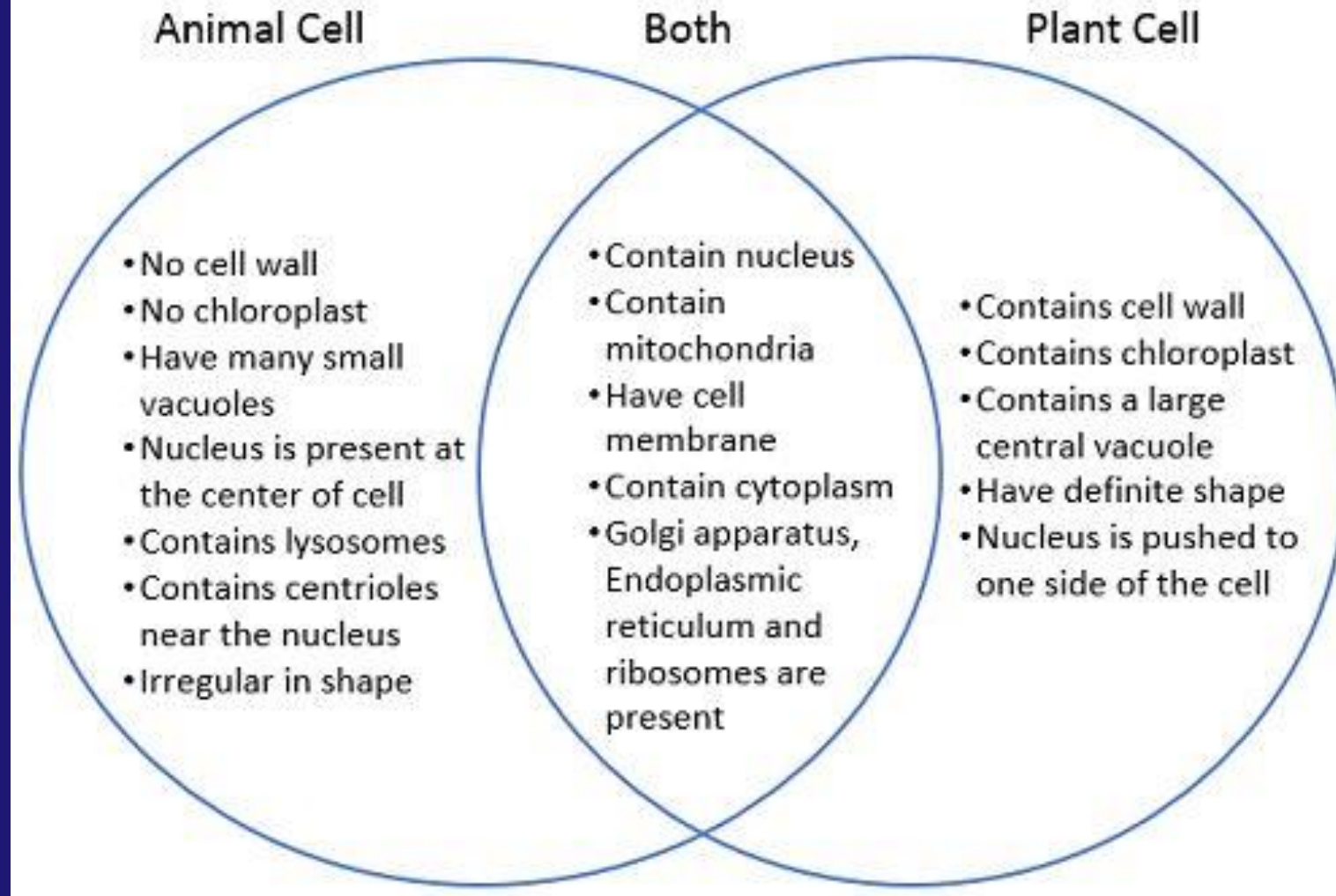
EUCARYOTIC CELL

- ◉ A nucleus
- ◉ Membrane – enclosed organelles
- ◉ Linear chromosomes in pair
- ◉ Cytoskeleton
- ◉ streaming in the cytoplasm
- ◉ Cell division with mitosis
- ◉ Complex flagella with mikrotubules
- ◉ Larger ribosomes
- ◉ cellulose in the walls
- ◉ DNA bound to histones

https://commons.wikimedia.org/wiki/File:Cytoplasmic_streaming.webm

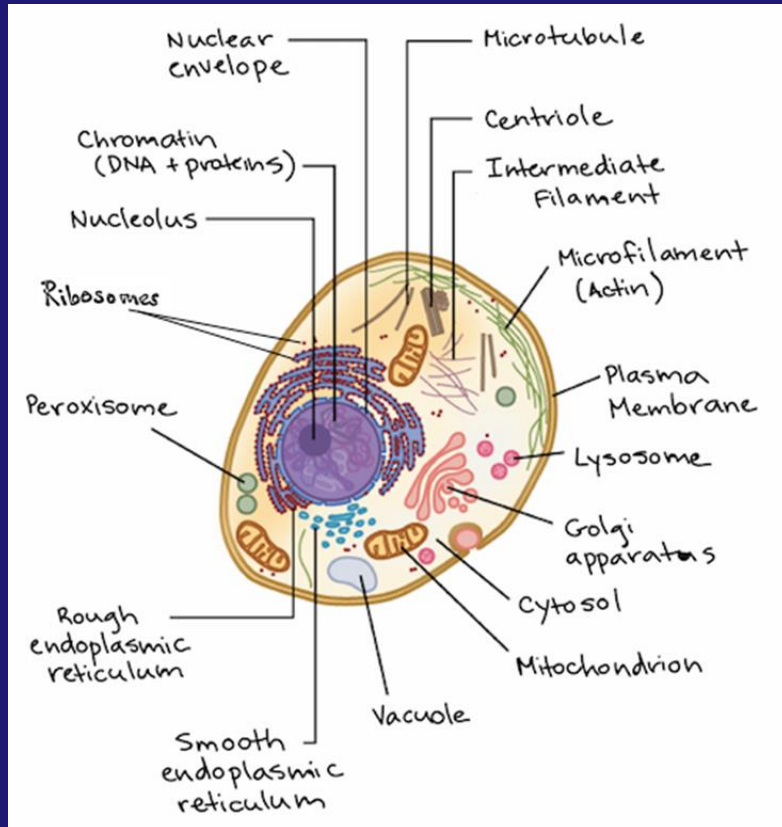
Eukaryotic cell

Venn Diagram of Animal and Plant Cells

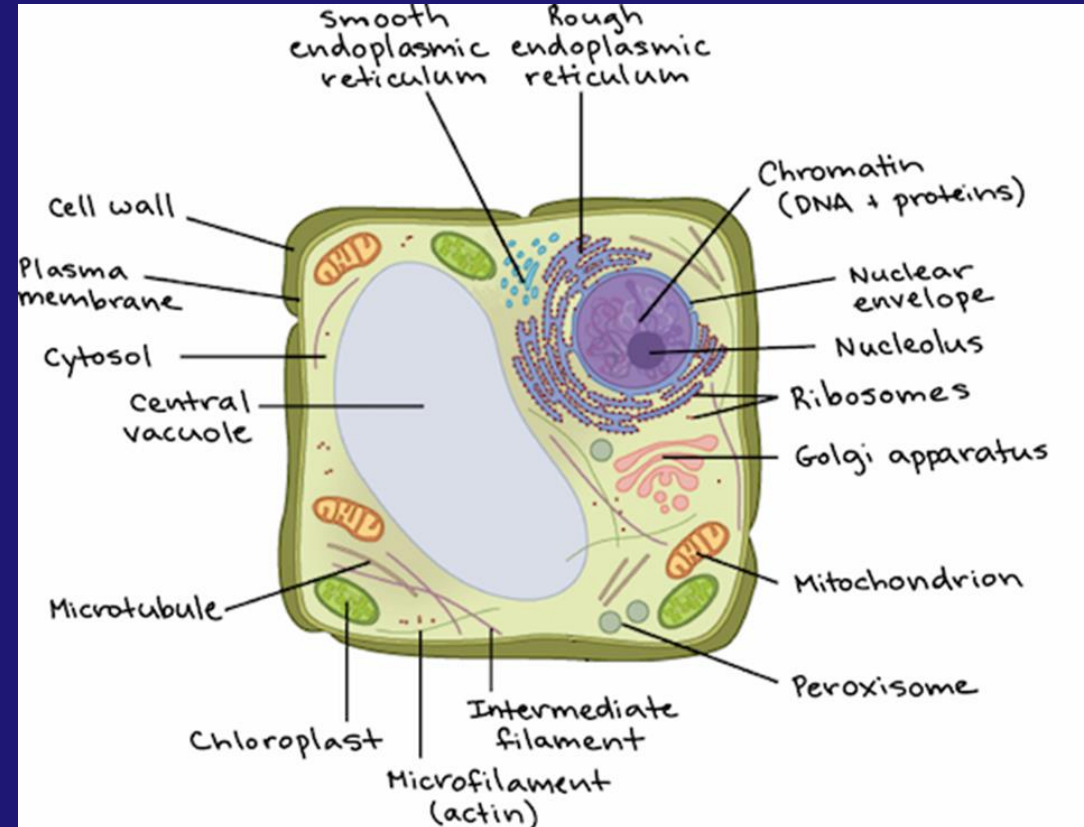


Eucaryotic cell

ANIMAL CELL



PLANT CELL



Plant cell

<https://www.youtube.com/watch?v=TvQNRyWIKws>

<https://www.youtube.com/watch?v=2H3-yBjwkPc>

Animal Cell

<https://www.youtube.com/watch?v=-iGlryqAhSs&t=195s>

Intoduction to the cell (youtube.com)

Specialized cells

<https://www.youtube.com/watch?v=wNe6RuK0FfA>

Types Of Human Body Cells



Red Blood Cells



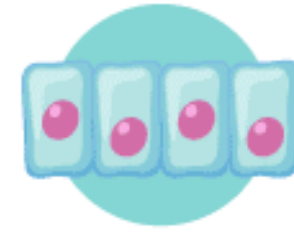
White Blood Cells



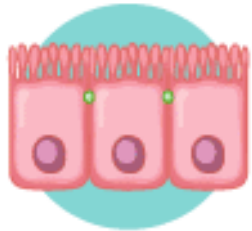
Nerve Cells



Stem Cells



Epithelial Cells



Intestinal Cells



Bone Cells



Sperm Cells



Ovum



Enterocytes



Fat Cells



Chondrocyte



Cardiac Cells



Smooth cells



Skeletal Muscles

Thank you for your attention 😊