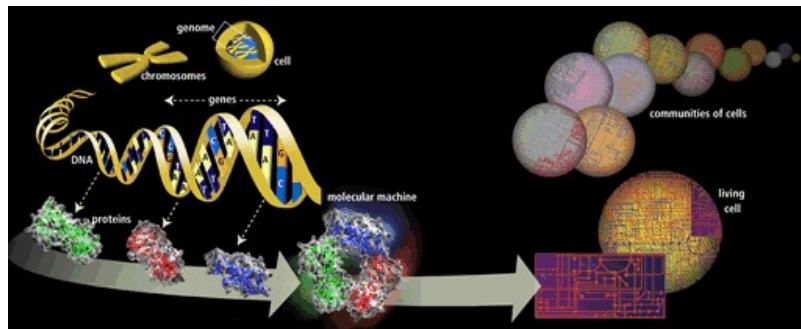
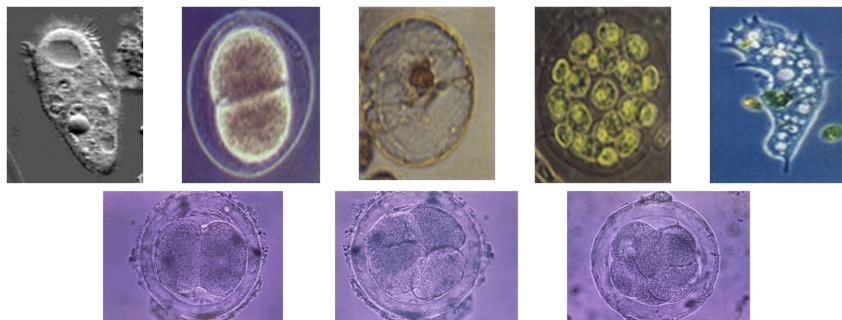


Molecular Biology Primer



What is Life made of?



Part 1 (11min)

Part 2 (10min)

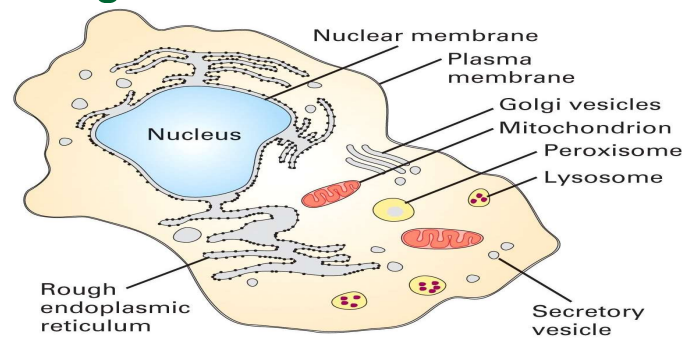
Cells

- **Fundamental working units** of every living system.
- Every organism is composed of one of two radically different types of cells:
prokaryotic cells or **eukaryotic** cells.
- **Prokaryotes** and **Eukaryotes** are descended from the same primitive cell.
 - All extant prokaryotic and eukaryotic cells are the result of a total of 3.5 billion years of evolution.

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Life begins with Cell

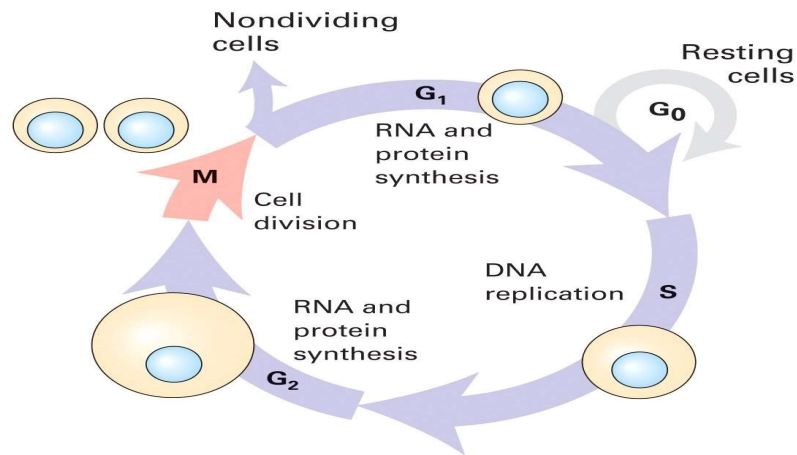


- A cell is a smallest structural unit of an organism that is capable of independent functioning
- All cells have some common features

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All Cells have common Cycles

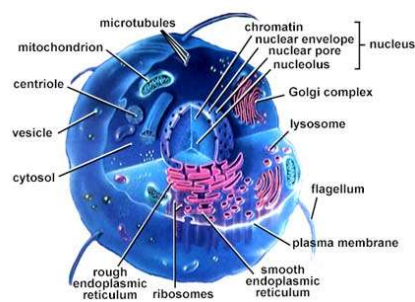
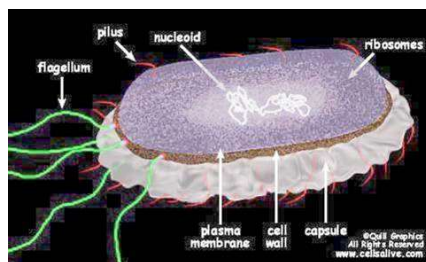


- Born, eat, replicate, and die

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Two types of cells: Prokaryotes and Eukaryotes



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Prokaryotes and Eukaryotes (cont'd)

Prokaryotes	Eukaryotes
Single cell	Single or multi cell
No nucleus	Nucleus
No organelles	Organelles
One piece of circular DNA	Chromosomes
No mRNA post transcriptional modification	Exons/Introns splicing

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Prokaryotes v.s. Eukaryotes Structural differences

Prokaryotes

- Eubacterial (blue green algae) and archaeobacteria
- only one type of membrane-- plasma membrane forms
 - the **boundary** of the cell proper
- The smallest cells known are bacteria
 - Ecoli cell
 - 3×10^6 protein molecules
 - 1000-2000 polypeptide species.

Eukaryotes

- plants, animals, Protista, and fungi
- complex systems of internal membranes forms
 - **organelle** and **compartments**
- The volume of the cell is several hundred times larger
 - Hela cell
 - 5×10^9 protein molecules
 - 5000-10,000 polypeptide species

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Prokaryotic and Eukaryotic Cells

Chromosomal differences

Prokaryotes

- The genome of E.coli contains amount of 4×10^6 base pairs
- > 90% of DNA encode protein
- Lacks a membrane-bound nucleus.
 - Circular DNA and supercoiled domain
- Histones are unknown

Eukaryotes

- The genome of yeast cells contains 1.35×10^7 base pairs
- A small fraction of the total DNA encodes protein.
 - Many repeats of non-coding sequences
- All chromosomes are contained in a membrane bound nucleus
 - DNA is divided between two or more chromosomes
- A set of five histones
 - DNA packaging and gene expression regulation

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Signaling Pathways: Control Gene Activity

- Instead of having brains, cells make decision through complex networks of chemical reactions, called pathways
 - Synthesize new materials
 - Break other materials down for spare parts
 - Signal to eat or die

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Cells Information and Machinery

- Cells store all information to replicate itself
 - Human genome is around 3 billions base pair long
 - Almost every cell in human body contains same set of genes
 - But not all genes are used or expressed by those cells
- Machinery:
 - Collect and manufacture components
 - Carry out replication
 - Kick-start its new offspring
 (A cell is like a car factory)

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Overview of organizations of life

- **Nucleus = library**
- **Chromosomes = bookshelves**
- **Genes = books**
- Almost every cell in an organism contains the same libraries and the same sets of books.
- Books represent all the information (DNA) that every cell in the body needs so it can grow and carry out its various functions.

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Some Terminology

- **Genome**: an organism's genetic material
- **Gene**: a discrete units of hereditary information located on the chromosomes and consisting of DNA.
- **Genotype**: The genetic makeup of an organism
- **Phenotype**: the physical expressed traits of an organism
- **Nucleic acid**: Biological molecules(RNA and DNA) that allow organisms to reproduce;

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More Terminology

- The **genome** is an organism's complete set of DNA.
 - a bacteria contains about 600,000 DNA base pairs
 - human and mouse genomes have some 3 billion.
- human genome has 24 distinct chromosomes.
 - Each chromosome contains many **genes**.
- **Gene**
 - basic physical and functional units of heredity.
 - specific sequences of DNA bases that encode instructions on how to make **proteins**.
- **Proteins**
 - Make up the cellular structure
 - large, complex molecules made up of smaller subunits called **amino acids**.

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All Life depends on 3 critical molecules

- DNAs
 - Hold information on how cell works
- RNAs
 - Act to transfer short pieces of information to different parts of cell
 - Provide templates to synthesize into protein
- Proteins
 - Form enzymes that send signals to other cells and regulate gene activity
 - Form body's major components (e.g. hair, skin, etc.)

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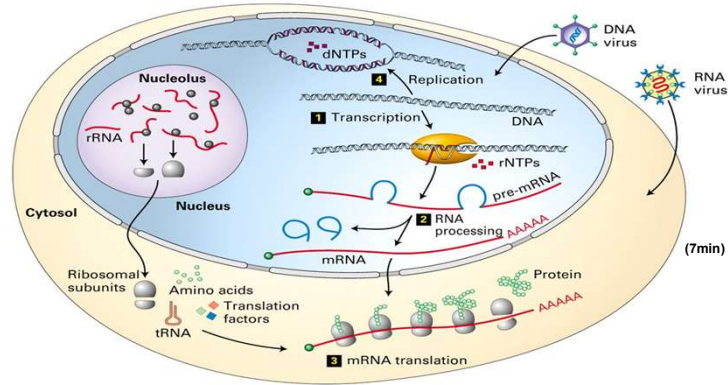
DNA & Protein Production

- Structure of DNA: **double-stranded helix** held by **complementary base pairs**.
- DNA carries the genetic information for making proteins. The **four bases A, T, C and G** make up the genetic code. The base sequence determines **amino acid** sequence in protein.
- **Messenger RNA** (mRNA) is a molecule which carries a copy of the code from the DNA, in the nucleus, to a **ribosome**, where the protein is assembled from amino acids.

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DNA → RNA → Protein



- Brief Introduction to DNA & RNA
- Brief Introduction to Protein