Nucleus

• Information Central

• It houses most of the cell's DNA

• It contains most of the genes in the eukaryotic cell

• Most conspicuous (noticeable) structure in eukaryotic cells (5 µm)

Nucleolus (Nucleoli)

Non-membranous structure involved in production of ribosomes

Nucleus has one or more nucleoli

Nuclear envelope

Encloses the nucleus

Separates its contents from the cytoplasm

Double membrane

Perforated by pores	**Pore complex lines** regulates entry and exit of proteins, RNAs, and large complexes of macromolecules

Continuous with ER

Chromatin

Consist of DNA and proteins

Makes up chromosomes

Visible in a dividing cell as individual condensed chromosomes

Endomembrane system

Includes: **nuclear envelope, ER, Golgi apparatus, lysosomes, various kinds of vesicles and vacuoles, plasma membrane**

ENDOPLASMIC RETICULUM (ER)

Biosynthetic Factory	**endoplasmic** - within the cytoplasm
It is continuous with the nuclear envelope	**reticulum** - little net
Rough ER	**Smooth ER**
Ribosomes on the outer surface	Lacks ribosomes on outer surface
Synthesis of lipids, metabolism of carbohydrates	Synthesis of secretory and other proteins on bound ribosomes
Ca^{2+} storage	adds carbohydrates to proteins to make glycoproteins
Detoxification of drugs and poisons	<3

Golgi apparatus

Shipping and Receiving Center

Active in synthesis, modification, sorting, and secretion of cell products	Warehouse for receiving, sorting, shipping, and even some manufacturing
Cis face	**Trans face**
receiving face, in which the vesicles empty their content	through which the vesicles leave the Golgi apparatus

Lysosome

Digestive organelle where macromolecules are hydrolyzed

hydrolytic enzymes that an animal cell uses to digest (hydrolyze) macromolecules.

Peroxisome

Oxidation

Contain enzymes that remove hydrogen atoms from various substrates and transfer them to oxygen

Produces hydrogen peroxide as a by-product, then converts it to water

Ribosomes

Protein Factories

Made of ribosomal RNA and protein	**Free ribosomes** (Cytosol)
Carry out protein synthesis	**Bound ribosomes** (ER and Nuclear Envelope)

Not membrane bounded and thus are not considered organelles

Ribosomes in the cytoplasm translate the genetic message, carried from the DNA in the nucleus by mRNA, into a polypeptide chain.

Centrosome

Contains a pair of centrioles

Where the cell's microtubules are initiated

Chromosome

A structure within the nucleus containing one long DNA molecule

By **Lady's Notenook** (Lady_Notenook)
cheatography.com/lady-notenook/

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Mitochondrion

Chemical Energy Conversion	common to plant and animal cells
Organelle where cellular respiration occurs	**Cellular respiration** - uses oxygen to generate ATP by extracting energy from sugars, fats, and other fuels

Nuclear Lamina

Maintains the shape of the nucleus

Supports nuclear envelope

Plasma membrane

Membrane enclosing the cell

Microvilli

Projections that increase the cell's surface area

Cytoskeleton

Reinforces cell's shape

Functions in cell movement

Components are made of protein

It is a network of fibers that organizes structures and activities in the cell

Includes: **Microfilaments, Intermediate filaments, Microtubules**

Microfilaments

Thin rods functioning in muscle contraction

Intermediate filaments

Support cell shape and fix organelles in place

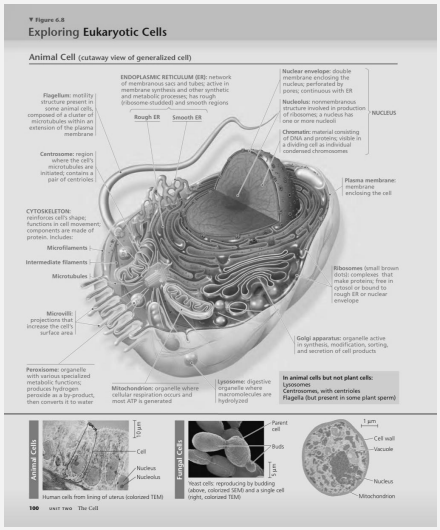
In animal cells but not plant cells

Lysosomes

Centrosomes w/ centrioles

Flagella (present in some plant sperm)

Eukaryotic Cell (Animal Cell)



In plant cells but not animal cells

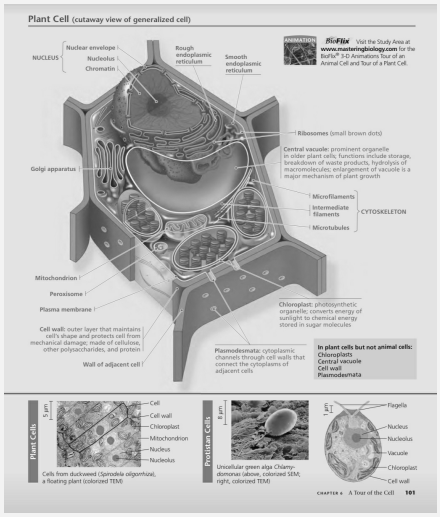
Chloroplasts

Central vacuole

Cell wall

Plasmodesmata

Plant Cell



Chloroplast

site of photosynthesis

Converts energy of sunlight to chemical energy	**thylakoids** - stacked like poker chips
Capture of Light Energy	**granum** - each stack of thylakoids
Contains chloro-phyll	**stroma** - contains the chloroplast DNA and ribosomes

Central vacuole

Include storage, breakdown of waste products, hydrolysis of macromolecules

Enlargement of vacuole is a major mechanism of plant growth

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Cell wall

Outer layer that maintains cell's shape and protects cell from mechanical damage; made of cellulose, other polysaccharides, and protein

Plasmodesmata

Cytoplasmic channels through cell walls that connect the cytoplasms of adjacent cells

Chromosomes

chroma - color	soma - body

Where DNA molecules are packaged into

Each eukaryotic chromosome: One long, linear DNA molecule associated with many proteins

Made of protein and a single molecule of deoxyribonucleic acid (DNA)

Human somatic cells have **46** chromosomes, two sets of **23** inherited from each parent	**Maternal set** (from your mother) **Paternal set (from your father)**

Gametes (sperm and eggs): Have half as many chromosomes as somatic cells, one set of *23* in humans

Sex Chromosomes

Determine individual's sex (X and Y chromosomes in humans)

Females have a homologous pair of X chromosomes (XX)

Males have one X and one Y chromosome (XY).

Autosomes Chromosomes

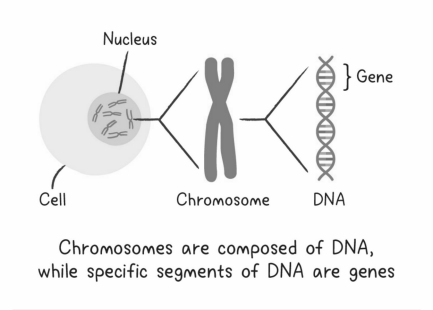
Carry genetic information unrelated to sex determination

The other 22 pairs of chromosomes

Number of chromosomes

n	number of chromosomes in a single set
Diploid cell	Two sets of chromosomes; diploid number of chromosomes (2n)
Haploid cell	Single chromosome set; haploid number of chromosomes (n)
Humans: haploid number is 23 (n = 23)	Humans: diploid number is 46 (2n = 46)

Chromosome



Chromosomes are composed of DNA, while specific segments of DNA are genes

Condensation of chromosomes

When the cell is not dividing	Each chromosome exists as a long, thin chromatin fiber
DNA replication occurs in preparation for cell division	Chromosomes condense, becoming densely coiled and folded

Condensation of chromosomes (cont)

Makes them shorter and thicker, visible under a light microscope

Genome

The complete set of DNA

A cell's endowment of DNA, its genetic information

Prokaryotic genome	Single DNA molecule
Eukaryotic genomes	Multiple DNA molecules

Prokaryotes

Single-celled organisms lacking a nucleus and other membrane-bound organelles

Eukaryotes

Organisms with cells that contain a nucleus and other membrane-bound organelles

Gametes

Reproductive cells (eggs or sperm) containing half the chromosome number of somatic cells

Gametes

Reproductive cells in plants and animals that carry genes to the next generation

Rudolf Virchow

German physician **1855**

"Where a cell exists, there must have been a preexisting cell, just as the animal arises only from an animal and the plant only from a plant."

Latin axiom **"Omnis cellula e cellula,"** meaning **"Every cell from a cell."**

Cell Division

The process by which a parent cell divides into two or more genetically identical daughter cells

Involves distribution of DNA to ensure each daughter cell receives a complete set of genetic material

Roles of Cell Division

Reproduction

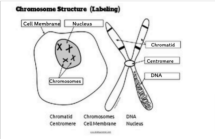
Growth and development

Renewal and repair

Daughter cells

The cells resulting from cell division, each containing a complete set of genetic information inherited from the parent cell

Chromosome Structure



Sister chromatids

Joined copies of the original chromosome

Each duplicated chromosome has two sister chromatids

Attachment known as sister chromatid cohesion

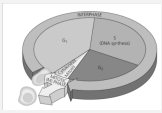
Arms of chromatid

The portions of a chromatid on either side of the centromere

Centromere

A region of DNA sequences where sister chromatids are closely attached.

Cell Cycle



Mitotic (M) phase

Shortest phase

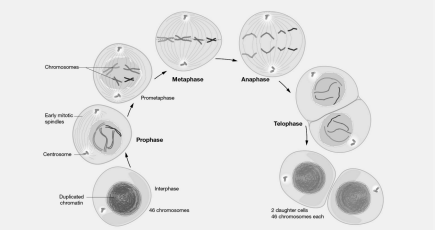
Includes mitosis and cytokinesis

Mitosis

The division of genetic material in the nucleus of a cell

The nucleus divides into two daughter nuclei, each with the same number of chromosomes as the parent nucleus

Mitosis



five stages of mitosis (Animal)

Prophase	Chromatin fibers - become more tightly coiled
	Nucleoli - disappear
	Each duplicated chromosome appears as two identical sister chromatids
	Mitotic spindle - Begins to form
	Centrosomes move away from each other
Prometaphase	Nuclear envelope - fragments (Breaks)
	Chromosomes - more condensed
	Microtubules - invade the nuclear area
	Kinetochore on microtubules
Metaphase	Centrosomes - opposite poles of the cell
	Chromosomes convene at the metaphase plate
Anaphase	Shortest stage of mitosis
Telophase	Nucleoli - reappear
	Nuclear envelopes- arise
	chromosomes - less condensed

Cytokinesis

The division of the cytoplasm, resulting in the formation of two daughter cells

involves the formation of a cleavage furrow, which pinches the cell in two

Interphase

Longer Phase (90% of the cycle)

Cell growth, DNA replication, and preparation for cell division

three stages: **G1 phase, S phase, G2 phase**

Interphase

G1 phase	cell growth and production of proteins and organelles
S phase	where DNA synthesis occurs, resulting in the duplication of chromosomes
G2 phase	cell continues to grow and prepares for cell division

Meiosis

A type of cell division that reduces the chromosome number by half, occurring in reproductive cells to produce gametes

From diploid to haploid

Ttwo consecutive cell divisions:	**meiosis I and meiosis II**

Meiosis I

Separates homologous chromosomes

Prophase I	Synapsis and crossing over
	synapsis - Replicated homologs pair up and become physically connected along their length, by synaptonemal complex,
	Crossing over - genetic rearrangement between nonsister chromatids

Meiosis I (cont)

	After synapsis, two homologs pull apart slightly but remain connected by at least one Xshaped region called a chiasma (plural, chiasmata)
metaphase I	Alignment of homologs on the metaphase plate
	pairs of homologous chromosomes line up on the metaphase plate
anaphase I	Separation of homologs
	replicated chromosomes of each homologous pair move toward opposite poles, while the sister chromatids of each replicated chromosome remain attached
	sister chromatids separate
Note:	**anaphase I** - cohesins are cleaved along the arms, allowing homologs to separate
	anaphase II - cohesins are cleaved at the centromeres, allowing chromatids to separate.

Mitosis II

Prophase II	Spindle apparatus forms; Chromosomes, each still with two chromatids, move toward the metaphase II plate via microtubules

Mitosis II (cont)

Metaphase II	Chromosomes align at the metaphase plate, similar to mitosis; Due to crossing over in meiosis I, sister chromatids are not genetically identical. - Kinetochores of sister chromatids attach to microtubules from opposite poles.
Anaphase II	Proteins holding sister chromatids together at the centromere break down. - Chromatids separate and move toward opposite poles as individual chromosomes.
Telophase II and Cytokinesis	Nuclei form, chromosomes start decondensing, and cytokinesis happens. - One parent cell's meiotic division yields four daughter cells, each with a haploid set of unduplicated chromosomes. - The four daughter cells are genetically distinct from each other and from the parent cell.

mitosis vs meiosis

Meiosis	Mitosis
Halves the total number of chromosomes, reducing the number of sets of chromosomes from two (diploid) to one (haploid), with each daughter cell receiving one set	Conserves the number of chromosome sets
Produces cells that differ genetically from the parent cell and from each other	Produces daughter cells that are genetically identical to the parent cell and to each other

Binary fission

A type of asexual reproduction in prokaryotes where a cell grows and then divides into two daughter cells

Genetics

It is the scientific study of heredity and hereditary variation

Genes

Coded information passed from parents to offspring in the form of DNA

Genome

Complete set of genes inherited from both parents

Heredity

It is the transmission of traits from one generation to the next

Gregor Mendel

He deduced the fundamental principles of genetics by breeding garden peas

hybridization or a genetic cross

Offspring from different varieties are hybrids

P generation

initial parent plants

F1 generation

Hybrid offspring

F stands for "filial," which means "son" in Latin

Locus (plural, loci)

refers to a specific spot on a chromosome where a gene is located

Genetics

- Genes have different forms called alleles.
- Alleles and genes can be used interchangeably.
- A gene pair refers to a set of alleles for the same gene.
- Each allele determines a specific characteristic or trait.
- Genotype refers to the combination of alleles (genetic makeup).

Genetics (cont)

- Phenotype refers to observable traits, like behavior or physical appearance, resulting from the genotype.
- Homozygote for a particular allele means having two identical alleles (e.g., PP or pp).
- Heterozygote means having two different alleles for the same gene (e.g., Pp).

Mendelian and Non-Mendelian

Mendelian:

1. **Incomplete Dominance**:
- Results in intermediate phenotypes.
- Example: In flowers, RR is red, rr is white, and Rr is pink.

2. **Law of Independent Segregation**:
- Alleles of a gene pair separate during meiosis.
- Example: In seed shape, Rr alleles segregate independently.

3. **Law of Independent Assortment**:
- Alleles of different gene pairs segregate independently during meiosis.
- Example: Alleles for seed color and seed shape assort independently.

Non-Mendelian:

4. **Multiple Alleles**:
- Many genes have more than two alleles.
- Example: ABO blood groups in humans with three alleles (IA, IB, i).

5. **Codominance**:
- Both alleles in a heterozygote are fully expressed.

Mendelian and Non-Mendelian (cont)

- Example: ABO blood type where IA and IB are codominant.

6. **Pleiotropy**:
- One gene influences multiple traits.
- Example: A gene affecting coat color also influences eye color.

7. **Polygenic Inheritance**:
- Many genes contribute to one phenotype.
- Example: Skin color influenced by multiple genes.

8. **Epistasis**:
- One gene's expression depends on another gene's presence.
- Example: The expression of one gene (like fur color) depends on the presence of another gene (like pigment production).

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