MARCO LEARNING

AP Biology Insta-Review

Big Idea 3: Information Storage & Transmission

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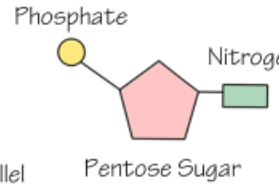
Structure

- Composed of C, H, O, N, & P
- Monomer: Nucleotide
- Bond: Phosphodiester linkage (between phosphate and hydroxyl)
- Directionality: 5' → 3'; antiparallel



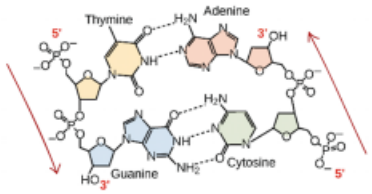
Nitrogenous Bases

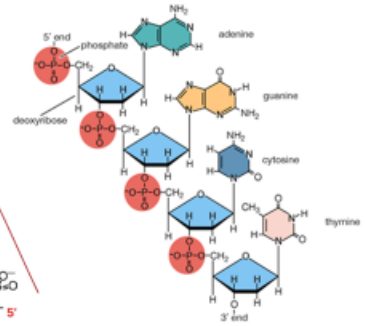
Purine:
- Double Ring
- A & G

Pyrimidine:
- Single Ring
- C, U, T

1.6: Nucleic Acids

Base Pairing	H bonds
A & T	2
C & G	3





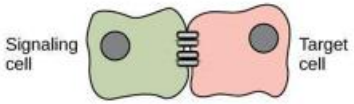
DNA vs. RNA

	DNA	RNA
Nitrogenous Bases	A, T, C, G	A, U, C, G
Sugar	Deoxyribose	Ribose
Strandedness	"double"	"single"

4.1 Cell Communication

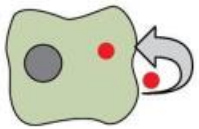
Cell-to-Cell Contact

- Cell communication where two cells are in direct contact with one another
- Example: Helper T cell binds to antigen presenting cell

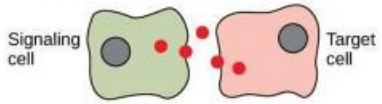


Autocrine Signaling

- Signaling to the same cell
- Example: Apoptosis



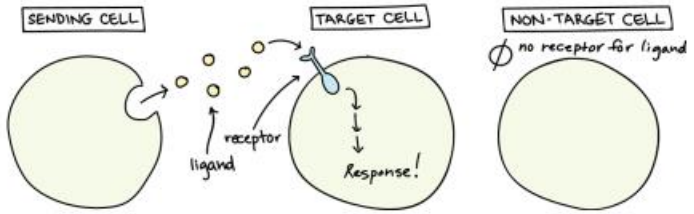
Paracrine Signaling



- Signaling molecule released into extracellular fluid and binds to nearby cell
- Example: Growth Factor

Endocrine Signaling

- Long distance signaling through bloodstream
- Example: Insulin released by pancreas and binds to body cells for glucose uptake



4.2/4.3 Signal Transduction

Reception

Ligand (signaling molecule) binds to receptor
Causes confirmational shape change
Ex: G protein coupled receptor

Steroid Hormone

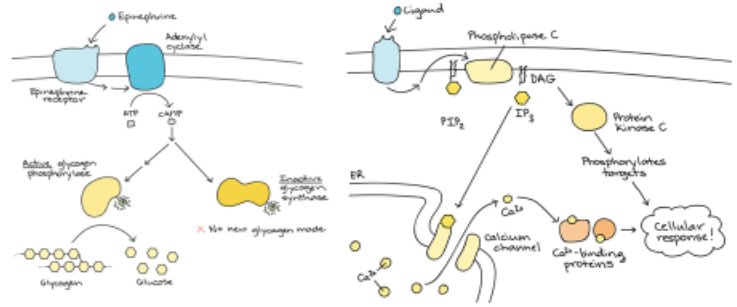
Release: Simple Diffusion
Receptor: Intracellular
Example: Testosterone, Estrogen

Protein Hormone

Release: Exocytosis
Receptor: Extracellular
Example: Insulin

Response

cell growth
secretion of molecules
gene expression
apoptosis



Transduction

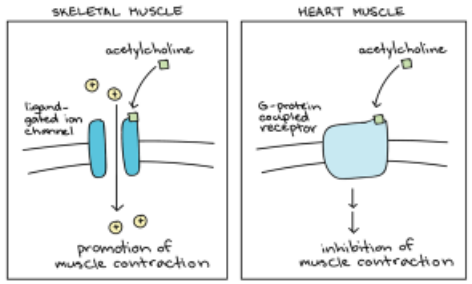
Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals

Phosphorylation Cascade

Protein Kinase
Phosphorylate relay molecules

Secondary Messengers

Ca^{2+}
cAMP



4.4 Changes in Signal Trans. Pathway

Mutations in any domain of the receptor protein or in any component of the signaling pathway may affect the downstream components by altering the subsequent transduction of the signal.

Chemicals that interfere with any component of the signaling pathway may activate or inhibit the pathway.

Interphase

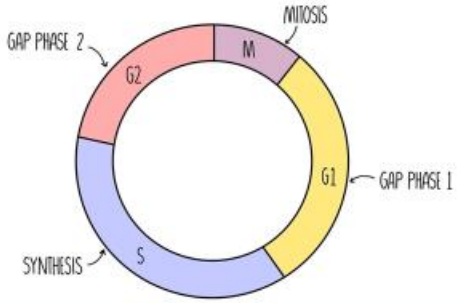
G_1 S G_2

The cell grows through all the different phases of interphase

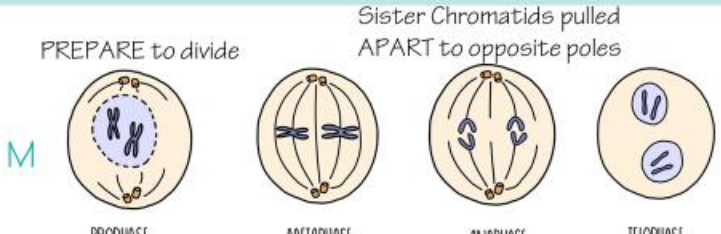
Duplication of cell organelles
Synthesis of proteins, RNA, and building blocks

Replication of genetic material and centrosomes

Synthesis of proteins and RNA
Makes organelles
Reorganizes cellular contents



4.6 Cell Cycle



Division of the cytoplasm

Cytokinesis

4.7 Regulation of Cell Cycle

Checkpoints

G_1

During G_1, determines whether to complete the cell cycle

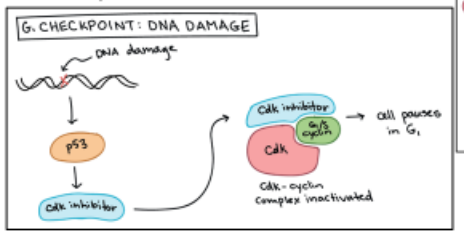
- Growth factor
- Adequate reserves
- Check for DNA damage

If do not pass, enter G_0 (nondividing state)

G_2 Checkpoints

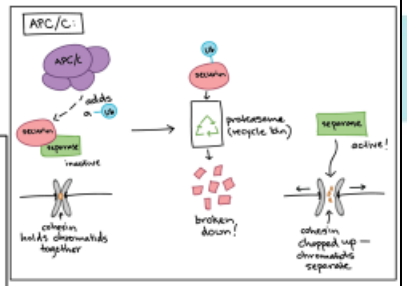
Check all DNA replicated and not damaged.

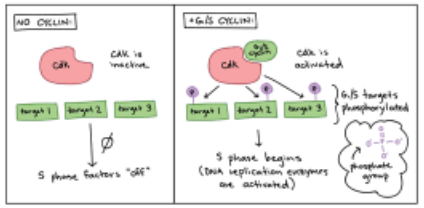
If detect problems with DNA, the cell cycle is halted, to complete DNA replication or repair the damaged DNA.



M Checkpoints

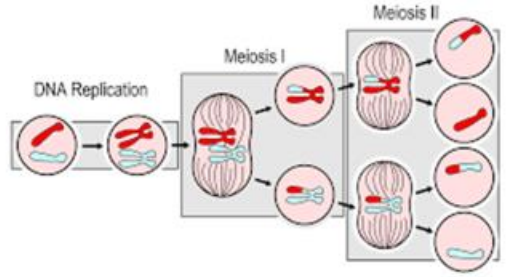
Check sister chromatids attached to the spindle microtubules





Function

Formation of HAPLOID gamete cells in sexually reproducing organisms



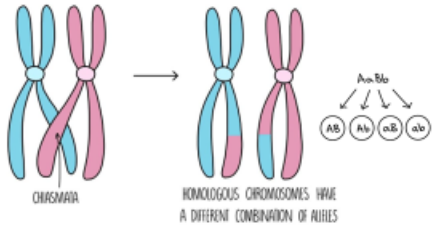
Result

Daughter cells with half the number of chromosomes as parent cell

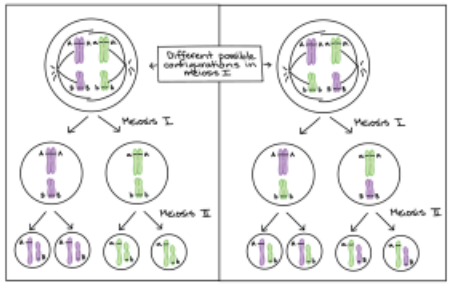
5.1 Meiosis

	Parent Cell Ploidy	Rounds of DNA Replication	Rounds of Nuclear Division	Daughter Cell Ploidy	Number of Daughter Cells
Mitosis	Diploid	1	1	Diploid	2
Meiosis	Diploid	1	2	Haploid	4

Prophase I
Chromatin condenses
Sister chromatids/ homologous chromosomes align
CROSSING OVER



Metaphase I
HOMOLOGOUS CHROMOSOMES align on the metaphase plate
INDEPENDENT ASSORTMENT



Anaphase I
HOMOLOGOUS CHROMOSOMES separate to opposite poles

Telophase I
Nuclear envelope forms around the HAPLOID daughter cells

Meiosis I	Homologous Chromosomes
Meiosis II	Sister Chromatids

5.2 Meiosis & Genetic Diversity

Chromatin condenses
Sister chromatids align
Prophase II

SISTER CHROMATIDS align on the metaphase plate
Metaphase II

SISTER CHROMATIDS separate to opposite poles
Anaphase II

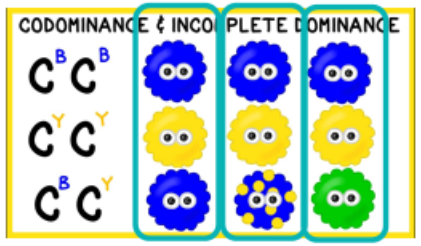
Nuclear envelope forms around the HAPLOID daughter cells
Telophase I

5.3 Mendelian Genetics

Complete Dominance
Homozygous dominant and heterozygous look the same

Codominance
Heterozygous is both dominant traits in organism

Incomplete Dominance
Heterozygous is a blend between the two dominant traits



Mendel's laws of segregation and independent assortment can be applied to genes on different chromosomes

	Y	y
Y	YY	Yy
y	Yy	yy

Yellow: ¾
Green: ¼

	R	r
R	RR	Rr
r	Rr	rr

Round: ¾
Wrinkled: ¼

Yellow & Round: ¾ x ¾ = 9/16
Yellow & Wrinkled: ¾ x ¼ = 3/16
Green & Round: ¼ x ¾ = 3/16
Green & Wrinkled: ¼ x ¼ = 1/16

RELEVANT EQUATION
Laws of Probability—
If A and B are mutually exclusive, then:
$P(A \text{ or } B) = P(A) + P(B)$
If A and B are independent, then:
$P(A \text{ and } B) = P(A) \times P(B)$

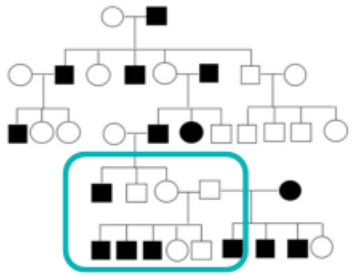
Monohybrid
Heterozygous for ONE trait
Complete Dominance:
3:1 ratio
Incomplete or Codominance:
1:2:1

Dihybrid
Heterozygous for TWO traits
Complete Dominance:
9:3:3:1 ratio
Incomplete or Codominance:
6:3:3:2:1:1

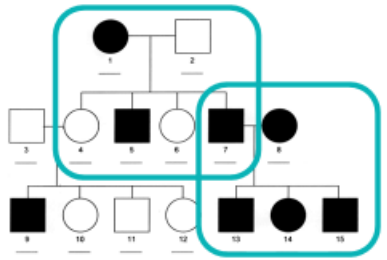
5.4/5.3 Non-/Mendelian Genetics

Autosomal Inheritance
Allele is located on an autosome (non-sex chromosome)

Sex-Linked
Allele is located on a sex chromosome

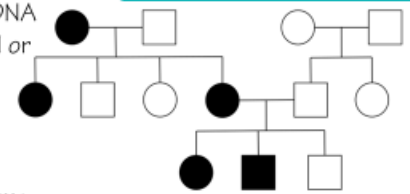


Autosomal Recessive

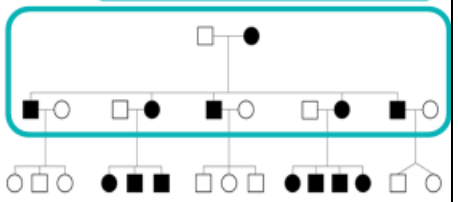


Sex-Linked Recessive

Maternal Inheritance
Allele is located on the DNA found in a mitochondrial or chloroplast



Autosomal Dominant



Maternal Inheritance

Linked Genes
Genes located on the same chromosome closely together

Prokaryote
- Single DNA molecule
- Circular DNA molecule
- No introns

Genetic information (DNA/RNA) is passed to subsequent generations

BOTH has plasmids (small extra-chromosomal, double stranded, circular DNA)

Eukaryote
- Multiple DNA molecules
- Linear DNA molecules
- Introns

6.1: DNA & RNA Structure

Base Pairing	H bonds
A & T/U	2
C & G	3

DNA vs. RNA

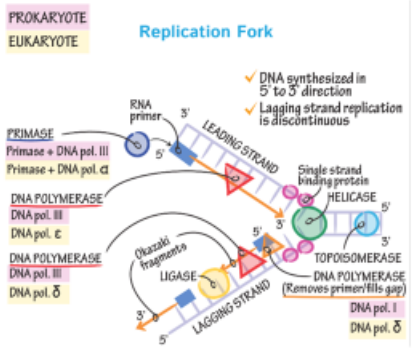
	DNA	RNA
Nitrogenous Bases	A, T, C, G	A, U, C, G
Sugar	Deoxyribose	Ribose
Strandedness	"double"	"single"

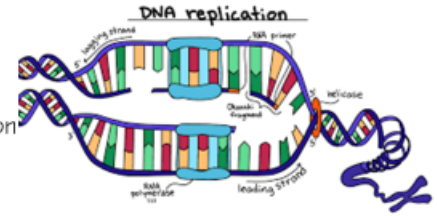
6.2 Replication

Location
- Eukaryotes: nucleus
- Prokaryotes: nucleoid

Structure
- Eukaryotes: multiple linear
- Prokaryotes: single circular

Important Enzymes
- Helicase unwinds the DNA strands
- Topoisomerase relaxes supercoiling in front of the replication fork.
- Primase synthesizes the RNA primer (DNA polymerase requires RNA primers to initiate DNA synthesis).
- DNA polymerase synthesizes new strands of DNA continuously on the leading strand and discontinuously on the lagging strand.
- Ligase joins the fragments on the lagging strand.





Reminders about DNA:
- DNA made up of:
  - nitrogenous base (A, T, C, G)
  - pentose sugar (deoxyribose)
  - phosphate group
- Purine (A/G) have a double ring structure
- Pyrimidine (C/T) have a single ring structure
- Base Pair Rules
  - A & T with 2 H bonds
  - C & G with 3 H bonds
- Sidedness
  - 5' end: phosphate
  - 3' end: hydroxyl group
- Directionality
  - Read 3' to 5'
  - Synthesize 5' to 3'

(Remember ANTIPARALLEL)

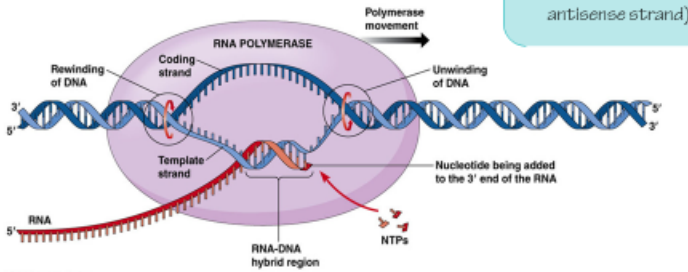
6.3 Transcription and RNA Processing

Location
- Eukaryotes: nucleus
- Prokaryotes: nucleoid (cytosol)

Reminders about RNA:
- DNA made up of:
  - nitrogenous base (A, U, C, G)
  - pentose sugar (ribose)
  - phosphate group
- Purine (A/G) have a double ring structure
- Pyrimidine (C/U) have a single ring structure
- Base Pair Rules
  - A & T(DNA)/U(RNA) with 2 H bonds
  - C & G with 3 H bonds
- Sidedness
  - 5' end: phosphate
  - 3' end: hydroxyl group
- Directionality
  - Read 3' to 5'
  - Synthesize 5' to 3'

Important Enzyme & Components
- RNA polymerase synthesizes mRNA molecules in the 5' to 3' direction by reading the template DNA strand in the 3' to 5' direction.
- Promoter: site where RNA polymerase binds to start transcription
- Transcription Factors: activators/inhibitors to turn on/off gene expression

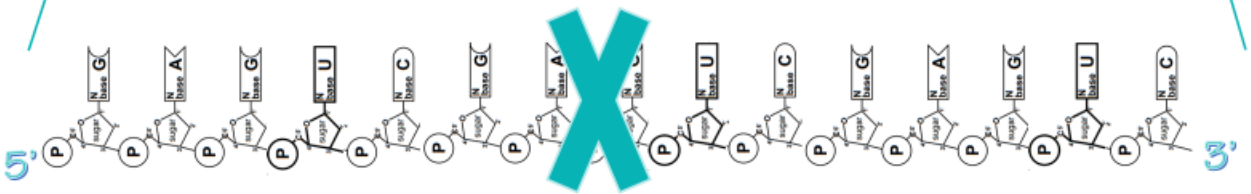
Template Strand (noncoding strand, minus strand, or antisense strand)



6.3 Transcription and RNA Processing

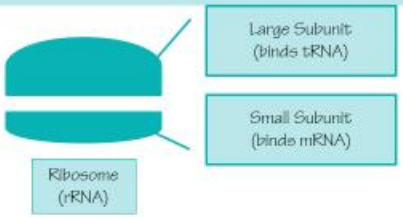
5' Guanine Cap
- Signals the "start" of the mRNA transcript for ribosome to bind
- Facilitates export from nucleus

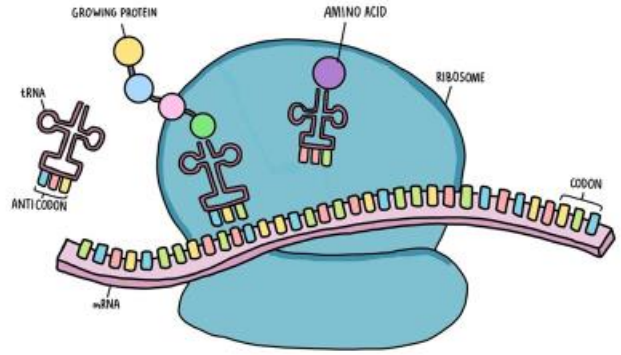
Poly-A Tail
- Inhibits degradation from hydrolytic enzymes in cytosol



Splicing
- Removal of introns from pre-mRNA transcript

6.4 Translation





Location
- Eukaryotes: cytosol/rough ER
- Prokaryotes: cytosol

Steps of Translation
- Initiation: start codon (AUG)
- Elongation: base pair between tRNA/mRNA with amino acid added
- Termination: stop codon (UAG, UAA, UGA)

6.5 Regulation of Gene Expression

Regulatory sequences are stretches of DNA that interact with regulatory proteins to control transcription

Epigenetic changes can affect gene expression through reversible modifications of DNA or histones
- Methylation (DNA): inhibit
- Acetylation (histone): activate

The phenotype is determined by combination of genes expressed and the levels of expression—
- cell differentiation
- induction of transcription factors during development

Operon

Gene Regulation found in prokaryotes

Promoter
Site when RNA polymerase binds

Operator
Site when repressor binds

Genes
DNA

Repressible Operon

Example: Trp Operon synthesizes tryptophan

Starts: ON
Repressor: INACTIVE

If trp is present…
Trp binds to repressor to ACTIVATE
Repressor binds to operator to turn the operon OFF

Inducible Operon

Example: Lac Operon synthesizes enzymes to break down lactose

Starts: OFF
Repressor: ACTIVE

If lactose is present…
lactose binds to repressor to INACTIVATE
Repressor no longer binds to operator to turn the operon ON

6.7 Mutations

Point Mutations

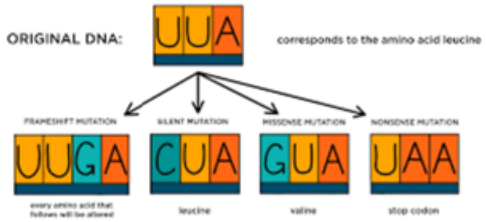
Mutation at one nucleotide base pair

Silent
no change in amino acid (AA)

Missense
change from one AA to another AA

Nonsense
change from AA to STOP codon

Frameshift
insertion/deletion of 1 or 2 nucleotide base pairs
shifts the reading frame for codons



Chromosomal Mutations

Rearrangement of chromosome parts or changes in chromosome numbers

Rearrangement
Insertion
Deletion
Duplication
Inversion
Translocation

Changes in Chromosome Number
Nondisjunction
Polyploidy

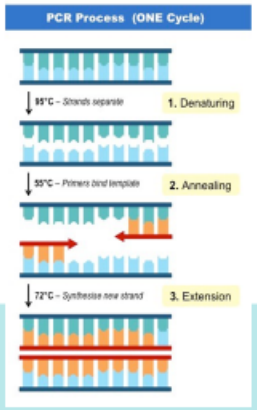
Gel Electrophoresis

Separate molecules based on size and charge

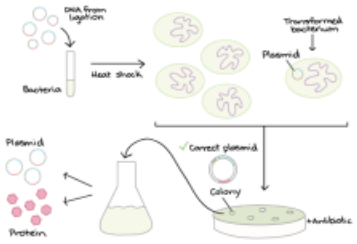
Polymerase Chain Reaction (PCR)

Makes multiple copies of DNA fragments

Steps
1. Heating
2. Cooling
3. Annealing



6.8 BioTechnology

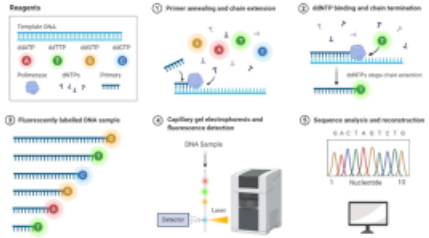


Bacterial Transformation

Introduce genetic material (plasmid) to bacteria

DNA Sequencing

Use radioactive nucleotides to determine the sequence of a DNA strand



8.1 Responses to Environment

Communication

Signaling allows for changes in behaviors of organisms to allow for differential reproductive success

Types of Communication:
- Visual
- Auditory
- Electrical
- Chemical

Function:
- Indicate Dominance
- Foraging (Finding Food)
- Establish Territory
- Ensure Reproductive Success

Altruistic Behaviors

Reduces individual fitness but increases inclusive fitness.

Intersexual Selection

Reproductive behaviors to attract a mate
Individuals of one sex choose members of the opposite sex

Examples
- Blue Footed Booby – mating dance (visual)
- Frogs – croaking (auditory)
- Pheromones – (chemical)

Intrasexual Selection

Reproductive behaviors to indicate dominance and compete for access to mates

Examples
- Deer: antler size
- Horned Beetles: strength and size of "horn"