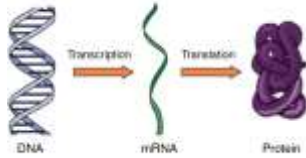


Replication Transcription Translation



A Gene is a Segment of DNA



When a gene is expressed, DNA is transcribed to produce RNA and RNA is then translated to produce proteins.

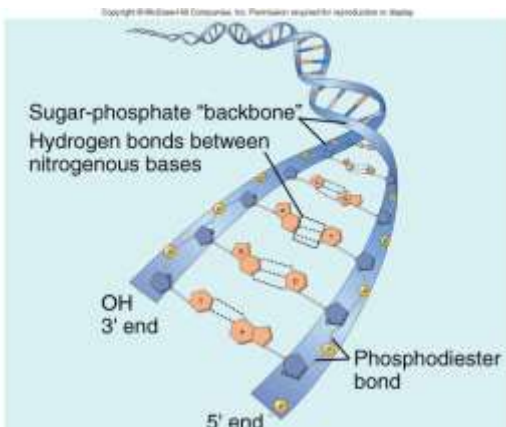
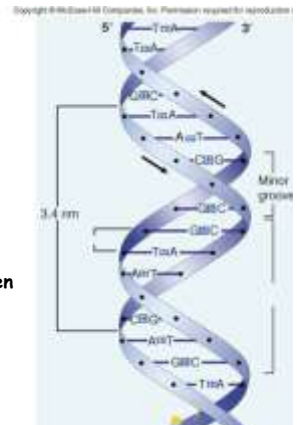
Genotype and Phenotype

- Genotype
 1. Genetic Composition of an Organism
 2. Represents the Potential Properties
 3. THE LETTERS

- Phenotype
 1. The Expression of the Genes
 2. What You See

DNA

1. Double Stranded Helix
2. Subunits: nucleotides
3. Each subunit:
 - A. Deoxyribose (sugar)
 - B. Phosphate group
 - C. Nitrogenous base
4. Hydrogen Bonds between Nitrogenous Base Pairs (rungs of a ladder)
5. Adenine-Thymine (A-T) and Guanine-Cytosine (C-G)



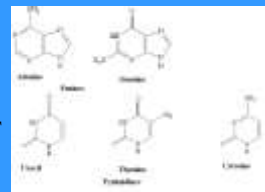
Nitrogen Bases

Purines (2-sugar rings)

- Adenine: A
- Guanine: G

Pyrimidines (1-sugar ring)

- Thymine (DNA only): T
- Cytosine: C
- Uracil (RNA only): U



Bonding of Nitrogen Bases (Chargaff's Rules)

Bonded by weak hydrogen bonds!

DNA to DNA:

A always bonds with T

G always bonds with C

DNA to RNA:

A always bonds with U

G always bonds with C

DNA codes for Proteins (and sometimes RNA)

- The sequence of nucleotides in DNA codes for proteins!!!!
 - Order of nitrogen bases
 - Central to cell function and life
 - Tells the cell what to do, what to produce, and when to do it!!!

DNA Between Organisms



DNA similarity between humans and chimps: 96-99%

DNA similarity between humans and mice: ~85%

DNA similarity between humans and bananas: ~50%

DNA within an Organism

- With few exceptions, ALL cells of an organism have the same DNA and same number of chromosomes but differ in expression of genes
 - Example: Skin cells have the same DNA as your brain cells.
- Multicellular organisms begin as undifferentiated masses of cells!
 - Variation in gene expression and gene activity determines the DIFFERENTIATION of cells and ultimately their SPECIALIZATION

Specialization

How do cells become specialized (*become different*)?

- During differentiation, only specific parts of the DNA are activated (switches on and off)
- The parts of the DNA that are activated determine the function and specialized structure of the cell
- **PROTEINS** (like hormones) can act as switches to turn genes on or off in a cell

Differentiation

- Because all cells contain the same DNA in a organism, all cells initially have the **POTENTIAL** to become any type of cell
- But, once a cell differentiates, the process cannot reverse
 - The cell is stuck in its cell cycle!

Stem Cells

- Unspecialized cells that continually reproduce themselves and have, under **appropriate** conditions, the ability to differentiate into one or more types of cell

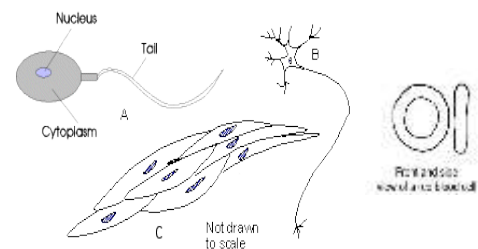
Types of Stem Cells

- Embryonic
 - Not yet differentiated into various cells types
- Adult
 - Differentiated into niches to produce specific types of cells

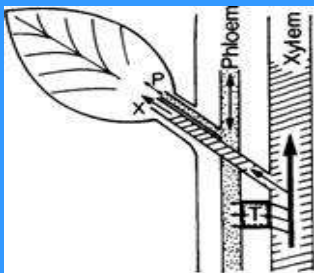
Stem Cell Niches in Humans (Adult Stem Cells!)

- Neural stem cell niche: neurons, nerve cells
- Bone stem cell niche: osteocytes (bone cells) for growth and repair
- Blood stem cell niche: red blood cells, white blood cells, platelets (controls bleeding)
- Muscle stem cell niche: produces satellite cells which differentiate into muscle cells
- Germ stem cell niche: sperm and egg

DNA → Cell Structure → Cell Function



Cell Differentiation in Plants



Xylem: water up!

Phloem: two ways!

Central Dogma of Biology

Biological information only travels in one direction...

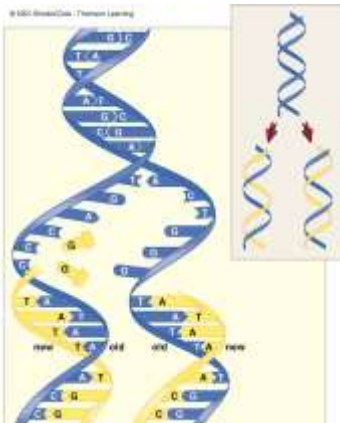
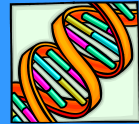
DNA → RNA → Protein

Remember...

- Cells respond to their environment by producing different types and amounts of proteins
- How?
 - The process of protein synthesis
 - 3 parts:
 - Replication
 - Transcription
 - Translation

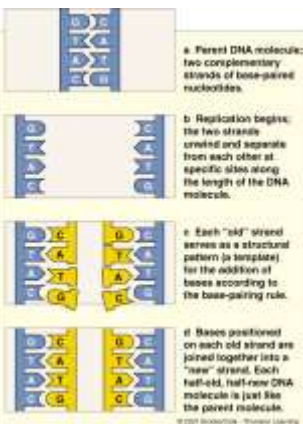
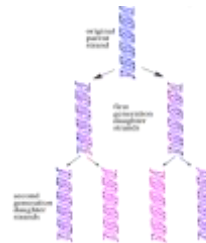
Replication

- The duplication of DNA which occurs during the S phase of Interphase.
- 1 Strand → 2 Complementary Strands
- DNA Polymerase
 - Enzyme that lays down new strand of DNA using the old strand as a template.

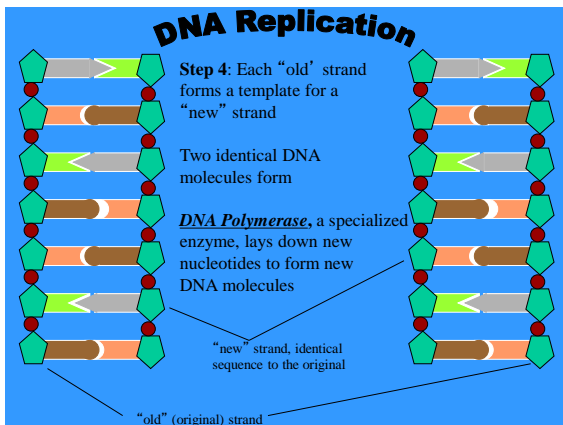
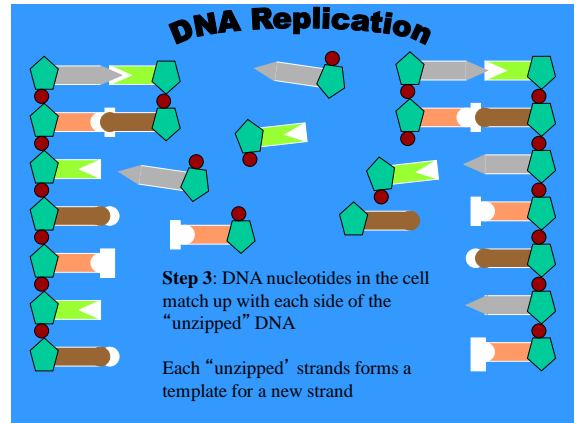
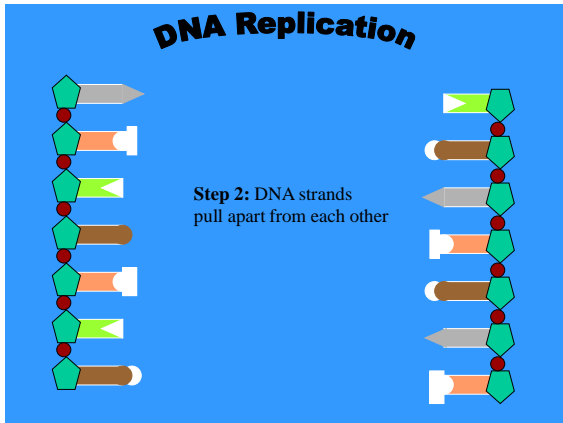
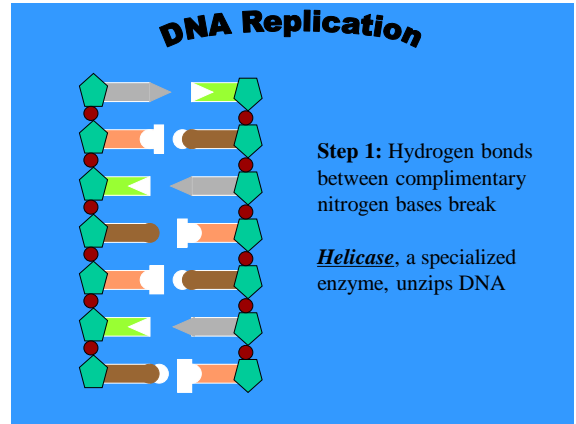
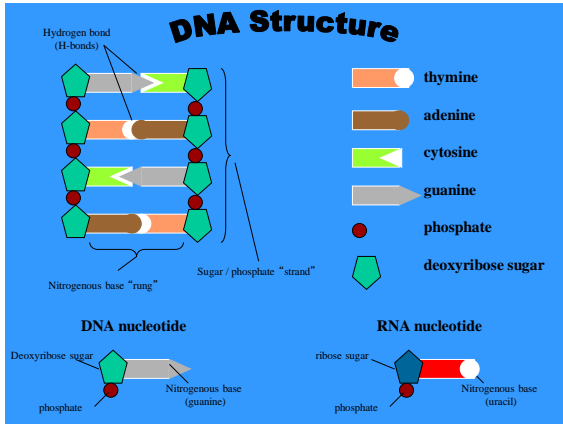


DNA Replication

One of the strands of the **daughter** DNA molecule is from the **parent** DNA molecule.
 Daughter cells have an exact copy of parental DNA.



One More Time!

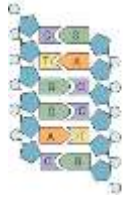


Transcription

- Occurs in the nucleus
- The process by which a molecule of DNA is copied into a complementary strand of RNA.
- 1 Strand DNA → 2 Strands RNA
- RNA Polymerase
 - Enzyme that transcribes DNA to RNA
 - RNA grows in the 3' to 5' direction
- Final product
 - Messenger RNA (mRNA)
 - mRNA leaves the nucleus and moves onto the cytoplasm

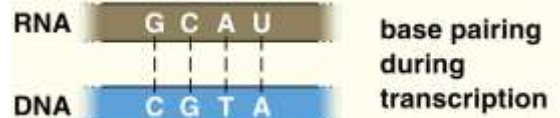
DNA

- Deoxyribonucleic acid
- Sugar: deoxyribose
- Nitrogen bases: A, T, G, C
- Double-stranded
- Self-replicating

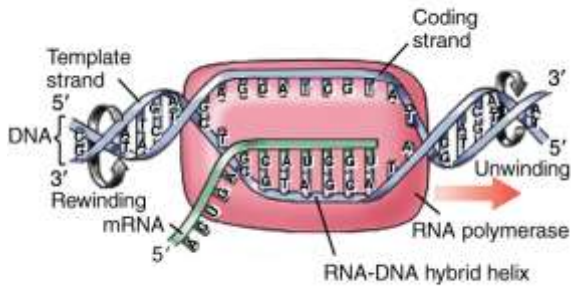


RNA

- Ribonucleic acid
- Sugar: ribose
- Nitrogen bases: A, U, G, C
 - No T (A bonds with U)
- Single strand
- Made only when needed using DNA as a template

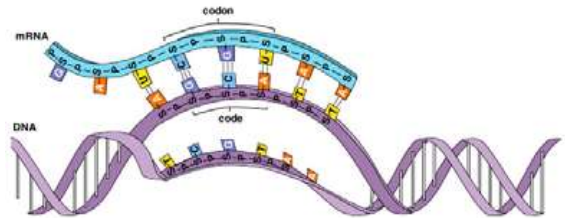


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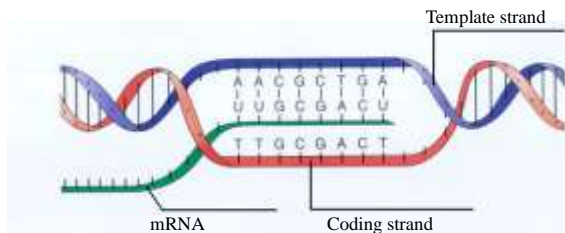


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Transcription

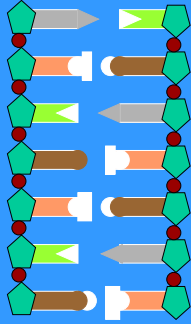


Label the Following



One More Time!

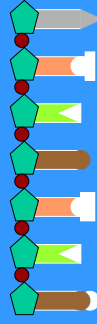
RNA Transcription



Step 1: Hydrogen bonds between complimentary bases break

DNA "unzips"

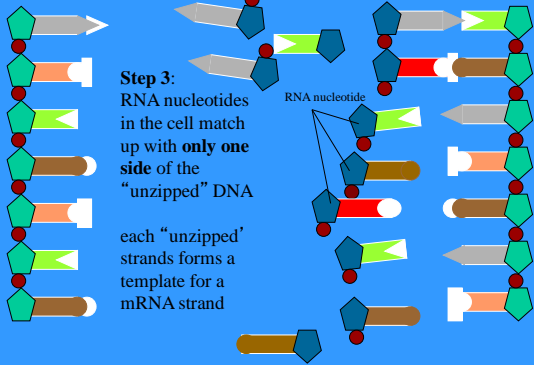
RNA Transcription



Step 2: DNA strands pull apart from each other



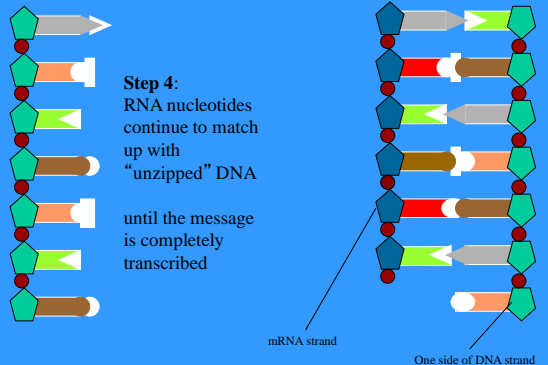
RNA Transcription



Step 3: RNA nucleotides in the cell match up with **only one side** of the "unzipped" DNA

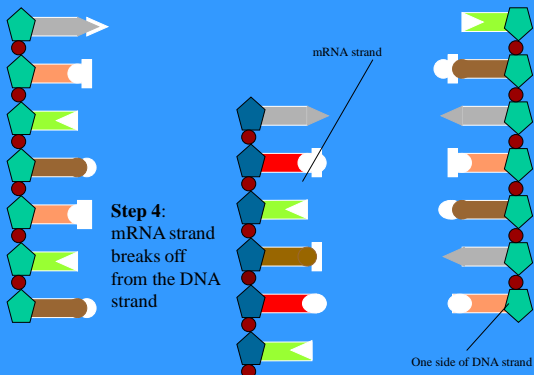
each "unzipped" strands forms a template for a mRNA strand

RNA Transcription



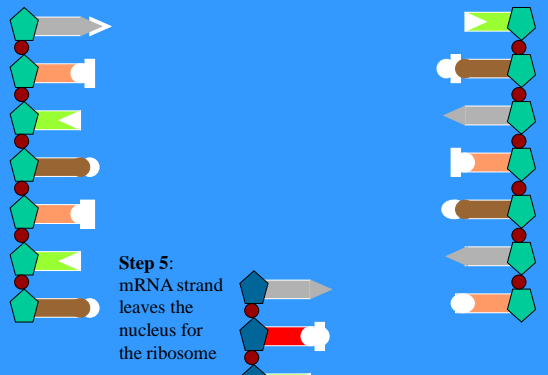
Step 4: RNA nucleotides continue to match up with "unzipped" DNA until the message is completely transcribed

RNA Transcription



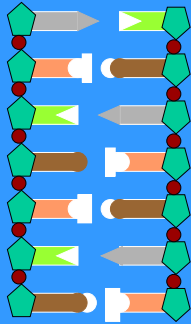
Step 4: mRNA strand breaks off from the DNA strand

RNA Transcription



Step 5: mRNA strand leaves the nucleus for the ribosome

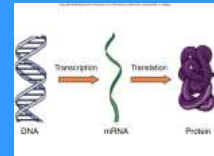
RNA Transcription



Step 6: Once the mRNA leaves, the DNA “zips” back together

DNA Replication, Transcription, and Translation

OVERALL GOAL:
PROTEIN SYNTHESIS



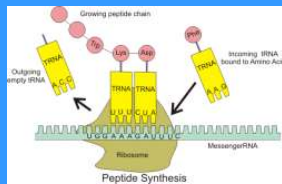
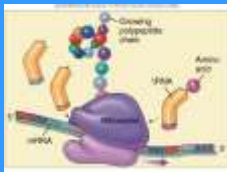
PROTEINS CAN BE:

Structural (forming a part of the cell materials)

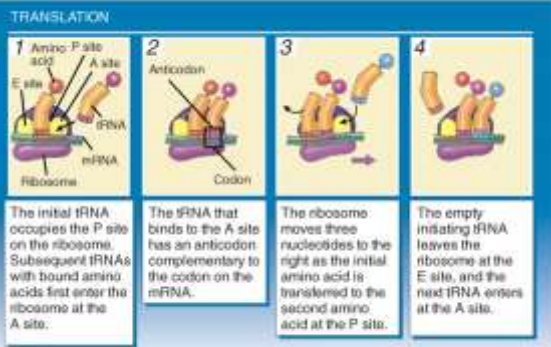
Functional (hormones, enzymes, or chemicals involved in cell chemistry)

Translation

- The process in which the information in the nucleotide base sequence of **mRNA** is used to dictate the amino acid sequence of a protein.
- 1 Strand RNA → Amino Acid Chain → Protein
 - Amino acids are linked by **PEPTIDE BONDS** to form polypeptides
 - Polypeptide chains form protein molecules
- tRNA = Transfer RNA



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RNA and Protein Synthesis

- RNA is a Single Stranded Nucleic Acid
- RNA Acts as a Messenger between DNA and Ribosomes
- Process Takes Amino Acids and Forms Proteins



Why Is It Necessary?

- DNA / Nucleus
- Ribosomes / Cytoplasm
- Need a Messenger

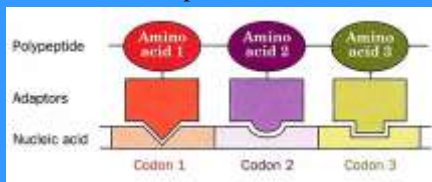


Definitions

- Codon
 1. Three-base segment of mRNA that specify amino acids.
 2. Sense Codons
 3. Nonsense Codons
- Anticodon
 1. Three-base segment of tRNA that dock with a codon.
 2. Docking results in deposition of amino acid.

Protein Synthesis

- Proteins are coded directly from the mRNA with 3 bases (one codon) for each amino acid. What's up with that?



First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

- To read:
 - First letter, second letter, third letter of codon of mRNA tells you the amino acid

