Genavieve Koenigshofer – Honors Bio Fall Final Study Guide

Unit 1

Organic Compound	Monomer	Polymer	Function
Carbs (sugars and starches)	Monosaccharide: Glucose	Polysaccharide: cellulose, amylose/starch, glycogen	Main energy source
Lipids	Fatty acids + glycerol	Fats, oils, waxes	Store chemical energy in living things Make up cell membranes
Proteins	Amino acids (20)	Proteins	Structural, functional
Nucleic acids	Nucleotide	DNA, RNA	Controls heredity (programs proteins)

Compound	Definition	Examples
organic	Has carbon atom	Carbs, lipids, proteins, nucleic acids
inorganic	No carbon atom	Water, hydrochloride, nitrogen, carbon dioxide & monoxide

Carbon: building block of life
makes up organic compounds
has 4 unpaired electrons in outer energy lvl
can **covalently bond** w/ up to 4 other atoms (including carbon)
can form long chain, branch chain, ring

Saturated Fat	Unsaturated Fat
Single carbon-carbon bonds	At least one carbon-carbon double bond
Maximum number of hydrogen atoms (each bonded to a carbon)	Less hydrogen atoms
Solid at room temp	Liquid at room temp
In animals	In plants
Less healthy	More healthy

Polysaccharide	Function
cellulose	Makes up cell walls
Starch/amylose	Store glucose in plants
glycogen	Stores energy in branched in liver and muscle for quick energy

Word	Definition
metabolism	All chemical processes involved in living state of cells and organisms, building and breaking materials to sustain life
catabolism	Destructive metabolism: breakdown, releases energy
anabolism	Constructive metabolism: synthesis, stores energy
Dehydration synthesis	(anabolism) water removed from original molecule, molecules combine (H20 on products right): hydrate first
hydrolysis	(catabolism) water added, molecules separate (H2O on reactant left): hydrate first (how digestion works)

Unit 2

Scientific Method

1. **observation:** qualitative or quantitative	**Independent variable:** manipulated (x-axis)
2. **hypothesis:** possible answer to question	**Dependent variable:** observed & measured (y-axis)
3. **experiment:** test hypothesis	**Controlled variable:** kept the same all these variables must be constant, so we know the cause of the change is the independent variable
4. **analyze:** results and draw conclusions	

Term	Definition	Notes
atom	Smallest basic unit of matter	Has nucleus (protons +, neutrons 0) and electrons (-) in energy levels outside nucleus
element	One type of atom	Living things made of elements
compound	Made of diff elements bonded	Eg water
Ion	atom that gained/lost electrons	Lost=+, gain=-, ionic bonds between opp charged ions
molecule	2+ atoms held by covalent bonds	

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Solutions

solution	formed when one substance dissolves in another
Solvents	Dissolve other substances [dis-solve-nt]
Solutes	Dissolve in solvents [solutes salute solvents]

pH scale

Acid	0-7
Neutral	7
Base	7-14

Bonds

Bond type	**How formed**	**Strength**	**Importance**	**Example**
Covalent	Atoms share pair of electrons	strongest	In molecules, eg carbon	CO_2
Ionic	Between opp charged ions	medium	Common: atoms give and gain electrons	NaCl (salt, sodium chloride)
hydrogen	Between slight + H, - atoms	weak	In water	H_2O
octet rule: atoms have 8 electrons in outer energy lvl; if no, form bonds to fill in (electron configuration)				

Homeostasis

Homeostasis	Maintenance of constant internal conditions to survive in diverse environments; imbalances affect cell function
Positive feedback	As more hormones are produced, more are needed
Negative feedback	If level of hormones drops too low, more are produced
Examples	Sweating to cool down, shivering to keep warm

Enzymes: protein catalysts in living things

Catalyst	substance that speeds up chemical reactions • lower/decrease activation energy • increase reaction rate
Importance	Makes chemical reactions happen quickly enough to support organisms • allow chemical reactions to occur under tightly controlled conditions • homeostatic disruptions can prevent functioning
Substrate	reactant
Active site	Region where substrate and enzyme bond
Lock-and-key model	illustrates enzyme function
Importance of 3D shape	structure determines function

Properties of Water

(Polarity)	**(High specific heat)**	**Cohesion**	**Adhesion**
Slightly charged regions at ends	Heats up slowly	attraction between molecules of **same** substance	attraction between **different** substances
So water forms hydrogen bonds: responsible for these properties:	Takes more energy to heat 1g 1C	Because of H bonds (coworkers)	Stronger than cohesion (capillary action)

Chemical Reactions

Chemical reaction	Bonds break and reform
Reactants	Changed (left side)
Products	Created (right)
Bond energy	Energy # that breaks a bond
Equilibrium	Reactants and products form at same rate
Activation energy	Energy # needed to absorb to start chemical reaction

Exothermic	**Endothermic**
Release (more) energy (than absorbed)	Absorb energy
Reactants have higher bond energy than products	Lower bond energy
Excess energy released	Energy absorbed to make up difference

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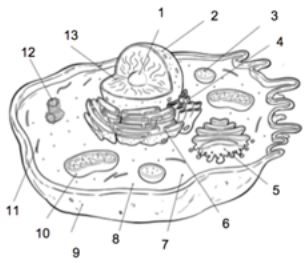
Cell Organelles



1. **nucleolus:** makes ribosomes
2. **nucleus:** stores and protects DNA
3. **lysosome:** break down viruses and bacteria and old cell parts **(animals only):** "suicide sacs" (vesicles with digestive enzymes)
4. **smooth endoplasmic reticulum:** makes lipids
5. **Golgi apparatus:** "packages" proteins, sorts and delivers, tags them where to go: vesicles come off of Golgi, "post office"
6. **rough endoplasmic reticulum:** makes lipids and proteins (studded w/ ribosomes)
7. **cytoplasm:** fills space in cell, helping keep its shape
8. **ribosome:** makes proteins
9. **cell membrane:** protects cell, keeps in organelles, lets only some molecules in and out (made of phospholipids, still in plant cell but in wall)
10. **mitochondrion:** cell's powerhouse, converts sugar and oxygen into energy (processes sugars)
11. **microtubules:** assist cytoskeleton, transport organelles, assist cell division (cilia & flagella); **made up of tubulin proteins**
12. **centrosome (centrioles):** makes microtubules **(animals only)**
13. **chromatin:** DNA, contains genetic code of cell

- **cell wall:** protects, supports, shapes cell (made of cellulose) **(plants only)**
- **chloroplasts:** photosynthesis, chlorophyll makes plants green **(plants only)**
- **central vacuole:** stores water and nutrients, break down waste, keeps plant's shape **(plants only)**
- **nuclear membrane:** layer around nucleus that protects it, pierced with pores allowing large molecules in and out of nucleus
- **cytoskeleton:** supports cell structure, made of microtubules
- **plastid: group of organelles that do the same thing**
- animal cells are rounded and plant cells are rectangular

Pathway for Protein Production	
Nucleus	Command
Rough ER (ribosome)	Production
Golgi apparatus	Packaging
Vesicles (microtubules)	Transportation
Cell membrane	excretion

Cell Membrane	
selectively / semipermeable	lets in some things
fluid mosaic model	made up of phospholipids, carbs, proteins, cholesterol
transport proteins	form channels through membrane to allow specific big molecules in

Passive transport (uses no energy, moves with concentration gradient)		**Active transport** (uses energy, travels from low-high): transport proteins squeeze molecule through	
Diffusion	Fluid moves high to low **Osmosis:** diffusion of water	**Endocytosis**	Membrane engulfs cell **Phagocytosis:** cell eating
Facilitated diffusion	Large molecules move high to low through transport proteins	**Exocytosis**	Membrane of vesicle combines with membrane and releases insides

concentration gradient: high to low concentration of substance

Isotonic	**Normal size**	Water flows in and out at equal rate (dyn equil)
Hypertonic	**Cell shrinks**	More solute outside, less water outside, more water inside, water flows out
Hypotonic	**Cell grows**	Less solute and more water outside, less water inside, water flows in
Dynamic equilibrium: molecules continue to move but balance each other out (water floats in and out of cell at equal rates; molecules always continue to move around at high speeds so it spreads)		

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Cell Theory

Robert Hooke (1665): used compound microscope to look at cork cells, gave name "cells"

all organisms are made of cells
all existing cells are produced by other living cells
the cell is the most basic unit of life

prokaryotes	no nucleus or membrane bound organelles
eukaryotes	nucleus and membrane bound organelles

Endosymbiotic Theory

Definition	organelles (eg mitochondria, chloroplasts) once free-living prokaryotes
How occurred	Prokaryote engulfed another prokaryote with a different function, beneficial symbiotic relationship formed so evolved together
vidence	Similar to bacteria: own ribosomes and DNA (genome), same size, split independently

Function	**Organelles Involved**
Cell energy	Carbohydrates
Cell transport	transport proteins, microtubules
Genetic material	DNA
Enzymes	Lysosomes (filled with digestive enzymes)

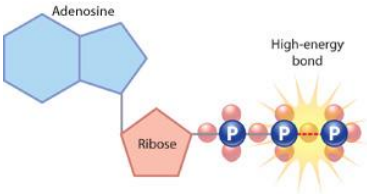
Unit 3

energy: allows objects to do work

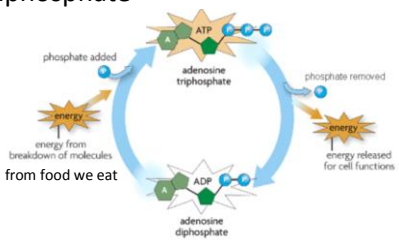
property of objects which can be transferred to other objects or converted into different forms

Energy is stored in the bonds of molecules: energy released to break bonds, energy added to form bonds	
Law of Conservation of Energy	energy can't be created or destroyed, only change into different forms
Kinetic energy	Energy of motion
Potential energy	Stored energy
Chemical potential en.	Energy stored in chemicals
Gravitational potential en.	Height energy, potential energy if dropped

ATP: adenosine triphosphate



Structure



Cycle

What is ATP used for?	Carrying chemical energy that cells can use
Where is energy stored in ATP?	In 3rd phosphate group's bonds
Most important energy sources	Carbs, lipids (proteins less likely to be broken down because storehouse of amino acids)
Structure	Adenosine, ribose, 3 phosphate groups

Autotroph (producer)	make own source of chemical energy
Heterotroph (consumer)	gets energy from other organisms
Chemosynthesis	Method of producing sugar using chemical energy (not sunlight) in hydrothermal vents of deep oceans

Leaf Structure

Structure	**Function**	**Location**
Guard cell	Open and close stoma	Epidermis, around stoma
Stoma	Let gases enter and exit	Btwn guard cells in epidermis
Palisade mesophyll	Food production (photosynthesis)	Top middle layer
Spongy mesophyll	Gas exchange	Middle layer

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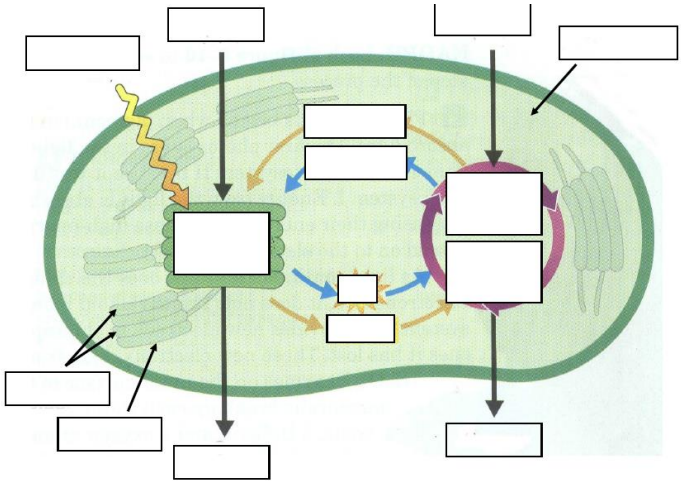
Photosynthesis: light energy to chemical potential energy (sugars)

$6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$

Chloroplasts
Absorb red and blue wavelengths, so reflect green
Thylakoid: coin-shaped, membrane-enclosed compartments
Grana: thylakoid stacks
Membrane: contains chlorophyll, hosts **light-dep reaction**
Stroma: fluid surround grana, hosts **light-ind reaction**

Functions	
Base of food chain	makes food for themselves and other organisms
Regulates Earth's atmosphere	removes CO_2

Stage	**1. electron transport chain**	**2. Calvin cycle**
Reaction	Light-dependent	Light-independent
Powered by…	sunlight	ATP and NADPH
Where occurs	thylakoid membrane	stroma
Reactants and Products	$H_2O \rightarrow O_2$	$CO_2 \rightarrow C_6H_{12}O_6$
	Photosystem II absorbs sun and breaks up H_2O	Energy from ETC + CO_2 makes glucose
	Photosystem I provides extra energy	Energy molecules used up, now ADP, NADP+
	H+ ions move through ATP synthase to make ATP	Recharged at ETC ADP+Pi=ATP, NADP+ + H+ = NADPH
	Recharges ATP and NADPH	



Cellular Respiration: break down sugars to make ATP; chemical potential food en. to ATP chemical potential en

$C_6H_{12}O_6+6O_2 \rightarrow 6CO_2+6H_2O$

Stage	**1. glycolysis** ("glucose breaking")	**2. Krebs Cycle**	**3. electron transport chain**
Reactants & Products	Glucose → pyruvate (pyruvic acid)	Pyruvate → CO_2	$O_2 \rightarrow H_2O$ (aerobic)
Location	cytoplasm	In mitochondria (interior space)	In mitochondria membrane
Net ATP	**2 ATP** (makes 4 but uses 2)	**2 ATP**	**32 ATP**
	Anaerobic (no oxygen needed)	Pyruvate bonds broken for energy	Uses enzymes
	C6 molecule broken into 2 C3 pyruvate molecules	Recharges: ATP (ADP+P), NADH (NAD+ + H), $FADH_2$ (FAD+H)	Oxygen picks up electrons and hydrogen, bonds to water
	Recharges ADP to ATP, NAD+ to NADH	CO_2 released as byproduct	Uses up to ADP, NAD+, FAD
			Electrons pump H+ into ATP synthase

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Mirror image of photosynthesis

Photosynthesis	Cellular Respiration
in chloroplast	In mitochondria
Reactants of photosynthesis are products of respiration	
$6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$	$C_6H_{12}O_6+6O_2 \rightarrow 6CO_2+6H_2O$
ETC, Cycle	Cycle, ETC
Takes in (sun) energy	Releases energy
Occurs in plants (some bacteria/protists)	Occurs in all organisms

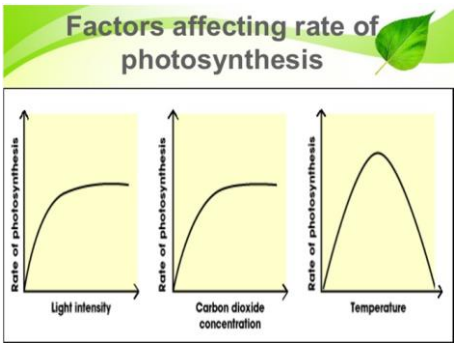
What is Cellular Respiration?
In mitochondria
Aerobic process (needs oxygen)
In plant and animal cells
Makes 36 ATP total

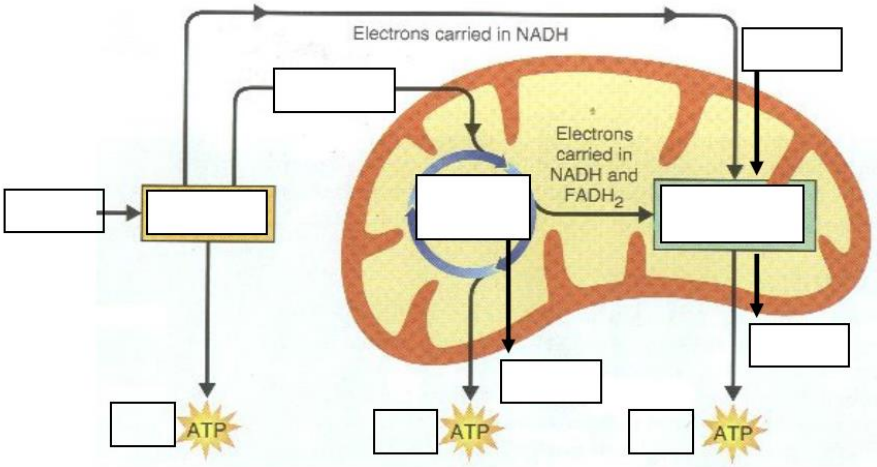
Fermentation

Used to keep making ATP when no oxygen is available
Anaerobic
Does NOT make ATP
Recycles NADH to NAD+
Lactic acid fermentation (in muscles)
Alcoholic fermentation (in anaerobic bacteria, yeast)

energy sources during intense exercise

Stored ATP	A few seconds
Lactic acid fermentation	About 90 seconds
Cellular respiration – glycogen in muscles	15-20 min
Cellular respiration – fats, etc.	Continuous supply





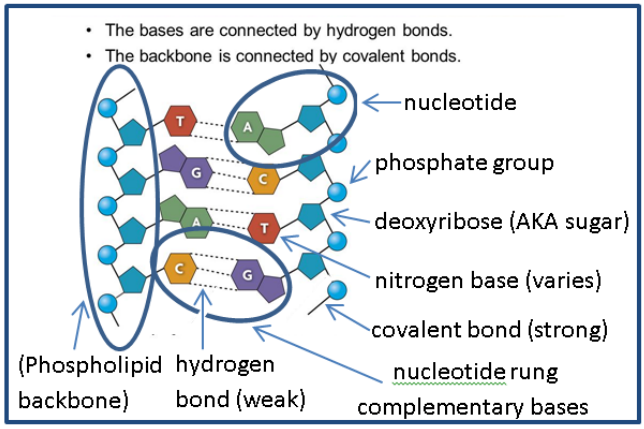
Lab

Question	How do different light levels affect photosynthesis over time?
Independent var	time in light
Dependent var	number of floating disks
Control	covered beaker, made sure any changes did not result from anything other than light
Relationship	As time increased, more disks floated to the top.
Detergent was added to	help the water stick to the leaf disks and encourage photosynthesis
Sodium bicarbonate (baking soda, $NaHCO_3$) was added to…	carbon dioxide, a necessary reactant of photosynthesis
Explanation	When photosynthesis occurred, glucose and oxygen were produced. Oxygen is buoyant and allowed the light disks to float to the surface.
What happened in the dark?	No disks floated in the dark, likely because sunlight provides the activation energy needed to trigger the chemical reaction of photosynthesis.
What couldn't happen in the dark?	In the dark, the light dependent reaction of photosynthesis (electron transport chain) couldn't occur.
Photosynthesis Factors	Light, water and temperature

Unit 4

People	Significance
Griffith, Avery, Hershey & Chase	DNA is genetic material
Chargaff	A=T, G=C
Franklin & Wilkins	double helix
Watson & Crick	3D DNA model, built on others' research

DNA Structure



Pyrimidine: single ring	Purine: double ring
Cytosine (C)	Guanine (G)
Thymine (T)	Adenine (A)

Chargaff's Rule
amount of adenine = amount of thymine
amount of guanine = amount of cytosine

DNA Replication: creates exact copies of genetic info

1. double helix unzips
2. free-floating nucleotides pair up to form complementary strands
3. two identical molecules of DNA formed

Replication is carried out by	enzymes
Importance of hydrogen bonds	Hydrogen bonds are easily broken, allowing unzipping
Source of new nucleotides	Free-floating in nucleus
Result of replication	One old strand, one new strand
How can replication occur in a few hours?	It begins at many different points throughout the strand

What cells undergo mitosis?	Somatic cells
What takes place before mitosis?	DNA replication (interphase)
What does mitosis produce?	2 diploid genetically identical daughter cells
Rates of cell division	Vary widely S, G_2, M stages take about 12 hours in human cells
Why do cells divide?	Volume increases faster than surface area, which is the area of cell membrane that supports cell, so more SA needed

Cell Cycle

Interphase	
Gap 1 (G_1)	Cell grows
Synthesis (S)	Cell copies nuclear DNA
Gap 2 (G_2)	Checkpoint
Mitosis (M)	
Mitosis	Division of cell nucleus and contents
Cytokinesis	Divides cytoplasm, makes 2 identical daughter cells

Chromosomes

Somatic cells	Diploid body cells (most common), in tissues & organs
Germ cells	Cells in reproductive organisms, develop into gametes in meiosis
Gamete (sex cells)	Haploid cells (egg and sperm) that pass DNA to offspring in chromosomes
Autosome	First 22 homologous pairs of homologous chromosomes
Chromosome	One long continuous thread of DNA; 46 in humans
Sex chromosomes	Last pair of chromosomes controlling development of sexual characteristics
Homologous chromosomes	Pair of chromosomes, one from father and one from mother
Chromatid	Identical half of a chromosome
Diploid	Two copies of each chromosome, in somatic
Haploid	One copy of each chromosome, in gametes
Gene	Code to program production of structural & functional proteins 20,000 genes store code in nucleotides

Levels of Organization
Cells
Tissues
Organs
Organ Systems

Stem Cells	
Stem cell	Undifferentiated cell that can become any other cell
importance	Treat leukemia, lymphoma may repair damaged organs may cure diseases (diabetes)

Mitosis Stages: PMAT	
Interphase	Replicates DNA
Prophase	DNA condenses into chromosomes
Metaphase	Chromosomes line up in middle
Anaphase	Chromatids separate to opposite sides of cell
Telophase	Nuclear membrane begins forming
Cytokinesis	Separate stage during telophase: cytoplasm divides, make 2 identical daughter cells w/ full sets of DNA

Mitosis

Cancer	Uncontrolled cell division
Tumor	Disorganized clump of cells
Benign	Harmless: cancer cells remain clustered together, doesn't spread
Malignant	Harmful: Cells break away (metastasize) from tumor and spread through body
How does it form?	Normal cells suffer damage to genes that make proteins for cell division

Meiosis	**Mitosis**
2 cell divisions (PMAT)	1 cell division
Produces 4 haploid cells	Produces 2 diploid cells
Offspring genetically unique	Genetically identical
Sexual reproduction	Asexual

Sexual reproduction	**Asexual reproduction**
Joining of two specialized cells (egg & sperm)	Offspring comes from single parent
Offspring genetically unique	Offspring genetically identical
Eg: meiosis	Eg: **binary fission** (in prokaryotes)
In changing environments, **genetic diversity** increases survival chances	In non-changing environments: well-suited to environment and efficient

Unit 5

Francis Crick's Central Dogma

Replication	DNA making DNA
Transcription	DNA making RNA
Translation	RNA making proteins

Prokaryotes	All take place in cytoplasm
Eukaryotes	Rep and transcription in nucleus Translation in cytoplasm

DNA	**RNA**
deoxyribose	Ribose
Thymine (A=T)	Uracil (A=U)
Double stranded	Single stranded

Transcription: copies DNA sequence

Messenger RNA	Code for translation
Ribosomal RNA	Part of ribosome
Transfer RNA	Brings amino acids to ribosomes

1. DNA begins to unwind
2. complementary RNA strand made from 1 DNA strand
3. RNA strand detaches and DNA reconnects

Mutation: any change in organism's DNA

Single gene mutation	Happen during replication
Genes / chromosome mutation	Happen during meiosis
Phenotype	Physical characteristics
May affect organism	Premature stop codon Change 3D protein shape Change in gene regulation
May not affect organism	Codes for same amino acid In "silent" DNA region Don't affect protein folding
Body cell mutations	Can't be passed on
Sex cell mutations	Passed on, can be harmful or beneficial
Natural selection	Removes mutant alleles until best fits survive
Causes	Replication errors, mutagens

Translation: amino acids coded by mRNA base sequences

Monomer	Amino acid
Polymer	Protein (polypeptide)
Codon	3-letter RNA code for one amino acid
64 combinations per codon	Only 20 amino acids exist, so same amino acid can be coded by many combos
Anticodon	tRNA's complementary 3-letter codon
Special codons	Start and stop codons (signal ends of gene)
Universal code	Same in almost all organisms: suggests common ancestor; validates gene insertion
Translation tools	Ribosomes (where proteins are made) tRNA (attaches to specific amino acid with 3-letter anticodon)

1. mRNA binds to ribosome
2. ribosome pulls mRNA strand through one codon at a time
3. tRNA carries free-floating amino acids from cytoplasm to ribosome
4. exposed codon attracts complementary tRNA
5. tRNA attaches to a specific amino acid using anticodon
6. amino acids bond together
7. tRNA leaves to find another amino acid
8. ribosome keeps attaching more amino acids until stop codon

Gene Expression: cells can turn genes on and off

Cell specialization	Only certain genes are expressed in each cell type