

Organic Molecules

4. What is an organic molecule?
5. What is the difference between a monomer and a polymer?
6. What are functional groups? List the functional groups studied in class. Draw a picture of each type of functional group. Provide an example of a molecule in which each functional group can be found.

Carbohydrates

7. Draw a monosaccharide (the monomer of all carbohydrates).
8. What is the difference between alpha glucose and beta glucose?

9. What is the formula for glucose?
10. Give the function for the following carbohydrates.
- a. Sucrose
 - b. Starch
 - c. Cellulose
 - d. Glycogen
 - e. Chitin
11. In what types of foods do you find carbohydrates?
12. Which indicator tests for a monosaccharide? Polysaccharide? What colors will they turn?

Lipids

13. Draw and give the function for the following lipids.
- a. Triglycerides (fats...saturated and unsaturated)

 - b. Phospholipids

 - c. Steroids (cholesterol and sex hormones)

Proteins

14. Draw an amino acid (the monomer of a protein).

15. How are amino acids joined together?

16. Describe the following protein structures.
 - a. Primary

 - b. Secondary (alpha helix and beta pleated)

 - c. Tertiary (globular) Give the three types of bonds that help form the tertiary structure and explain the hydrophobic effect.

 - d. Quaternary structure

Nucleic Acids

16. Draw a nucleotide (the monomer of nucleic acids).

17. Give the five types of nitrogen bases and identify them as purines or pyrimidines.

18. Draw a molecule of RNA and one of DNA and give the basic functions of each.

Enzymes

19. Enzymes are globular, quaternary structured proteins. What is the main function of an enzyme?

20. What is activation energy and how do enzymes affect the activation energy in a reaction?

21. What is the difference between catabolism and anabolism? Together, these reactions are referred to as metabolism.

22. Draw a picture of an enzyme catalyzed reaction and label the following.
 - a. Substrate, active site, enzyme, enzyme-substrate complex, products

 - b. Why do enzymes follow the so-called lock and key model or induced fit model?

23. Give an example of three enzymes and their substrates. How do you know which one is the enzyme, if only given the names?

3. Give four differences between plant and animal cells.

Cell Membrane Structure

4. Draw a section of the plasma membrane and label the following...Beside each label, provide the function of each structure
 - a. Phospholipids
 - b. Hydrophilic heads
 - c. Hydrophobic tails
 - d. Cholesterol
 - e. Integral proteins: channel, transport, electron transport (see chemiosmosis)
 - f. Peripheral proteins: recognition, receptor, and adhesion

Cell organelles

5. What is the function of the following organelles.
 - a. Nucleus
 - b. Ribosomes
 - c. Rough ER

- d. Smooth ER
- e. Golgi body
- f. Vesicles
- g. Mitochondria
- h. Chloroplasts
- i. Lysosomes
- j. Centrioles
- k. Vacuoles
- l. Flagella
- m. Cilia
- n. Cell Wall

6. List and describe each type of cell junction.

7. What are the functions of the following components of a cell's cytoskeleton: microtubules, intermediate filaments, and microfilaments

Cell Membrane Function

8. What does it mean that the cell membrane is selectively permeable?

9. Create a chart comparing the following processes: diffusion, osmosis, facilitated diffusion, and active transport.

Include the following in your chart:

- a. passive or active
- b. with or against the gradient
- c. proteins or no proteins involved
- d. if proteins are involved, what type
- e. substances moved by each process

10. Draw a cell in a hypertonic, hypotonic, and isotonic solution

11. Describe the process of plasmolysis

12. Vesicular transport: Draw the processes of exocytosis, endocytosis (phagocytosis and pinocytosis)

Unit III: Cellular Energetics

Cell Respiration

1. Give the formula
2. All organisms undergo glycolysis in their cytoplasm. What is glycolysis?
3. All eukaryotes undergo chemiosmosis in their mitochondria. Why don't prokaryotes?
4. Describe the basic structure of ATP and describe the energy cycle between ADP and ATP.

Glycolysis

5. Glucose is broken down into _____.
6. How many ATP's are invested? What is the net yield of ATP?
7. How many NADH are produced?
8. Where does this occur?

Kreb's Cycle (aka Citric Acid Cycle)

9. What are the 2 pyruvates converted into before they can enter the citric acid cycle?
10. What is released in the process?
11. How many ATP's are released?
12. How many NADH's? Where do they go?
13. How many FADH₂'s? Where do they go?
14. In animal respiration, what happens to the CO₂ that is released?
15. Where does this occur?

Electron Transport Chain

16. Why is this process called chemiosmosis or oxidative phosphorylation?

17. What do the NADH and the FADH₂ do for this process?

18. Describe the ETC in five steps. Be sure to include NADH, FADH₂, cytochrome carrier proteins, H⁺ ions, concentration gradient, pump, ATP synthase, ADP, ATP, oxygen as the final electron acceptor.

19. What is produced when oxygen accepts the final electrons?
20. How many ATP's are produced?
21. Where does this occur?

Anaerobic Respiration

22. What happens if no oxygen is present in the cell after glycolysis?

23. What is the difference between anaerobic respiration in animals vs. anaerobic respiration in plants, yeast, and bacteria?

24. What is another name for anaerobic respiration?

Photosynthesis

25. Give the equation for photosynthesis.

26. What types of organisms undergo photosynthesis?

27. What is the purpose of photosynthesis?

Light Reaction (aka Noncyclic photophosphorylation)

28. Provide a flowchart for the steps of the light reaction. Include the following terms:
 - a. photosystem II (P680)
 - b. photolysis
 - c. primary electron acceptor
 - d. electron transport chain
 - e. ADP-ATP
 - f. Photosystem I (P700)
 - g. Primary electron acceptor
 - h. Electron transport chain
 - i. NADP-NADPH

29. Where do all of these steps occur?

30. What is cyclic photophosphorylation?

Calvin Cycle

31. Provide a flowchart for the steps of the Calvin cycle. Include the following terms:

- a. Carbon fixation
- b. Rubisco
- c. CO₂
- d. RuBP
- e. PGA (3C)
- f. Glucose (6C)

32. Where does this process take place?

~~C4 and CAM Photosynthesis~~

~~33. What happens when there is not enough carbon dioxide entering the leaf?~~

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Unit IV: Cell Division and Genetics

Cell Cycle

1. Name the four functions of cell division (mitosis)

2. Which cells divide by mitosis?

3. Distinguish between the following terms and name the phase of the cell cycle in which you would find these structures.
 - a. Chromosomes

 - b. Chromatids

 - c. Centromere

 - d. Complementary strands

4. What happens during G1, S, G2, and G0 of interphase?

5. Name the major events of prophase, metaphase, anaphase and telophase.

6. How is cytokinesis different in animal cells and plant cells?

7. How are the following involved in cell division...
 - a. Surface to volume ratio

 - b. Density dependent inhibition

 - c. Checkpoints

Meiosis

8. Which cells divide by meiosis?
9. Meiosis I: List the phases of meiosis I and include the following terms as you describe the phases.
 - a. Reduction division
 - b. Homologous chromosomes
 - c. Diploid
 - d. $2n$
 - e. Crossing Over
 - f. Tetrad
 - g. Synapsis
 - h. Independent assortment
10. Meiosis II: List the phases of meiosis II and include the following terms as you describe the phases.
 - a. Haploid
 - b. $1n$
 - c. Sister chromatids
11. Which process produces genetic variation and recombination, mitosis or meiosis?

Heredity

12. Define or describe the following Mendelian inheritance terms.

- a. Locus
- b. Gene
- c. Allele
- d. Homologous pairs
- e. Dominant
- f. Recessive
- g. Phenotype
- h. Genotype
- i. Homozygous
- j. Heterozygous
- k. Monohybrid cross
- l. Dihybrid cross
- m. P, F₁, F₂ generations
- n. Test cross

13. Describe the following rules and laws of Mendel's and give examples of each.

- a. Dominance
- b. Segregation
- c. Independent Assortment

14. Define or describe the following non-Mendelian Inheritance patterns.

a. Incomplete dominance

b. Codominance

c. Multiple alleles

d. Epistasis

e. Pleiotropy

f. Polygenic inheritance

g. Linkage

h. Sex-linked

i. X inactivation

j. Non-disjunction

k. Deletion

l. Duplication

m. Translocation

n. Inversion

Unit V. Molecular Genetics and Biotechnology

DNA Replication

1. Describe the steps for DNA Replication by creating a flowchart or drawing.
Use the following terms in your description.
 - a. Semiconservative replication
 - b. Template strand
 - c. DNA polymerase
 - d. Leading strand
 - e. Lagging strand
 - f. Helicase
 - g. Replication fork
 - h. Single stranded binding proteins
 - i. DNA ligase
 - j. Okazaki fragments
 - k. RNA primase
 - l. RNA primer
 - m. 3' and 5' ends

2. Where in the cell does replication occur?

3. Draw examples of the following types of gene mutations
 - a. Point (aka substitution)
 - b. Frameshift (insertion and deletion)

Protein Synthesis

4. Describe the experiment that led to the one-gene-one-enzyme hypothesis (one-gene-one-polypeptide)

5. Describe the steps of transcription while including the following terms
 - a. mRNA
 - b. RNA polymerase
 - c. RNA processing
 - d. Introns
 - e. Exons
 - f. 5' cap
 - g. Poly-A tail

6. Where in the cell does transcription occur?

Translation

7. Describe the steps of translation while including the following terms

- a. mRNA
- b. codon
- c. tRNA
- d. anticodon
- e. rRNA
- f. ribosome
- g. small RNA subunit
- h. large RNA subunit
- i. P site
- j. A site
- k. Wobble
- l. Stop Codon
- m. Start Codon (Met)
- n. Initiation
- o. Elongation
- p. Termination

8. Where in the cell does translation occur?

9. Name three ways that replication and protein synthesis are different in prokaryotic and eukaryotic cells.

DNA Organization

10. Draw or describe the following
 - a. Chromatin
 - b. Histone proteins
 - c. Nucleosomes
 - d. Euchromatin
 - e. Heterochromatin
 - f. Transposons

Viral Reproduction

11. Draw a bacteriophage.
12. Label the capsid, envelope, and genetic material.
13. Describe how a retrovirus infects a cell and describe the role of reverse transcriptase.
14. Give two examples of retroviruses.

Bacterial Reproduction

15. What is a plasmid?
16. Draw or describe the following processes.
 - a. Conjugation
 - b. Transduction
 - c. Transformation

17. Create a flow chart for the gene expression of the lac operon gene. Include the following terms:
- a. Regulatory gene
 - b. Repressor protein
 - c. Promoter
 - d. Operator
 - e. Structural gene
 - f. Lactose

18. Create a flow chart for the gene expression of the tryp operon gene. Use the terms listed above, but also include tryp operon, tryptophan, and corepressor

Biotechnology

19. Describe (you may want to include pictures) the following processes.
 - a. Creating recombinant DNA (include the following terms restriction enzymes, sticky ends, ligase, plasmids (vector))
 - b. Gel electrophoresis
 - c. RFLPs (restriction fragment length polymorphisms) and DNA fingerprinting
 - d. PCR (polymerase chain reaction)
 - e. DNA library
 - f. cDNA library
 - g. Reverse transcriptase
 - h. Probes
 - i. DNA sequencing
 - j. Human Genome project
 - k. Southern blotting

Unit VI: Evolution

Darwin

1. Compare Darwin's and Lamarck's Theory of Evolution.

2. What is meant by "Descent with Modification"?

3. Describe the relationship between "Natural Selection" and "Survival of the Fittest"?

4. How do the five listed observations made by Darwin contribute to his theory of natural selection?
 - a. many more offspring are born than survive
 - b. resources are limited
 - c. members of a population show variety
 - d. much of this variation is heritable

5. List and explain 5 evidences of evolution.

Evolution of Populations

6. What is a population? What is a gene pool?

7. Gene pools can be described by the Hardy-Weinberg theorem. State the Theorem.

8. List and explain the 5 conditions that must be met for a population to be in Hardy-Weinberg equilibrium.

9. Write and explain the two equations used to determine if a population is in H-W equilibrium.

10. At a locus with a dominant and recessive allele in H-W equilibrium. 16% of the individuals are homozygous for the recessive allele. What is the frequency of the dominant allele in the population?

11. Draw a graph for and give an example of a situation that would cause

- a. directional selection
- b. disruptive selection
- c. stabilizing selection

12. Describe and give an example of heterozygote advantage.

Origin of species

13. List and explain the 5 prezygotic and 3 postzygotic reproductive barriers preventing hybridization between species.

14. Compare mechanisms of allopatric and sympatric speciation.

15. Polyploidy is an important mechanism for speciation in what type of organisms?

16. Defend the statement "Evolution is not goal oriented".

Phylogeny

17. Draw an example of a monophyletic group, a paraphyletic group, and a polyphyletic group of a phylogenetic tree.

18. Use the following chart to construct a cladogram:

0 = characters absent

x = characters present

	lancelet	lamprey	tuna	salamander	turtle	leopard
hair	0	0	0	0	0	x
Amniotic egg	0	0	0	0	x	x
Four walking legs	0	0	0	x	x	x
Hinged jaws	0	0	x	x	x	x
Vertebral column	0	x	x	x	x	x

~~Unit VII. Biological Diversity~~

~~Domain Eubacteria~~

- ~~1. Draw a typical bacterial cell and label the structures. Provide any unique characteristics of the labels.~~

~~7. On one of your drawings, identify the following and provide the functions of each~~

- ~~a. Epidermis~~
- ~~b. Root hairs~~
- ~~c. Cortex~~
- ~~d. Endodermis~~
- ~~e. Casparian strip~~
- ~~f. Stele (vascular cylinder)~~
- ~~g. Xylem~~
- ~~h. Phloem~~

~~8. Draw a picture of a leaf and label the structures. Provide the functions of the structures as well.~~

Plant Hormones

9. Provide the functions of the following plant hormones.

- a. Auxin
- ~~b. Gibberellins~~
- c. Cytokinins
- d. Ethylene Gas
- ~~e. ABA (Abscisic acid)~~

Plant Reproduction

10. Draw a flower and label the structures. Place the functions of the structures beside each label.

11. Describe alternation of generations by briefly describing these steps in a cycle fashion.

- a. Multicellular sporophyte ($2n$)
- b. Meiosis
- c. Spores ($1n$)
- d. Mitosis
- e. Multicellular gametophyte ($1n$)
- f. Mitosis
- g. Gametes ($1n$)
- h. Fertilization
- i. Multicellular sporophyte ($2n$)

12. Describe double fertilization in angiosperms. How does double fertilization form the various parts of the seed?

13. Draw a picture of a seed and label the following. Place the functions beside each label.

- a. Embryo
- b. Seed coat
- c. Endosperm
- d. Cotyledons (seed leaves)
- e. Hypocotyl (embryonic stem)
- f. Radicle (embryonic root)

Plant Response

14. Create a chart of the four plant responses and include the hormones responsible for each response.
 - a. Phototropism
 - b. Gravitropism
 - c. Thigmotropism
 - d. Nastic movement

15. Describe photoperiodism in plants. Include the following terms in your description.
 - a. Circadian rhythm
 - b. Night length
 - c. Phytochrome proteins (P_{fr} and P_r)
 - d. Long day plants
 - e. Short day plants
 - f. Day neutral plants
 - g. Examples of each type of plant

~~Unit IV: Animal Form and Function~~

~~Respiratory System~~

- ~~1. Describe how gills work with emphasis on counter current exchange.~~

Digestive System

15. Outline the steps of digestion focusing on the following:
- a. Mouth (salivary amylase, mechanical digestion)
 - b. Pharynx
 - c. Epiglottis
 - d. Esophagus
 - e. Peristalsis
 - f. Stomach (gastric juices, HCl, pepsin, mucus, mechanical digestion, pyloric sphincter)
 - g. Small intestine (duodenum - proteases), (pancreas- chymotrypsin, lipase, amylase) (absorption through villi)
 - h. Liver and gall bladder (bile emulsifying fats)
 - i. Large intestine (water absorption, E.coli symbiotic bacteria)

Nervous System

16. Describe the structures of the nervous system and the functions of each of the following:
- a. CNS (brain and spinal cord)
 - b. Peripheral nervous system (sensory and motor neurons)
 - Somatic division
 - Autonomic division
 - Sympathetic
 - Parasympathetic
17. Describe the steps of a typical reflex arc.

18. Draw a neuron and label it while providing the functions of the following:

- a. Cell body
- b. Dendrites
- c. Axon
- d. Synapse
- e. Myelin sheath
- f. Schwann cells

19. Describe the steps of the action potential while creating a flowchart.

20. Describe the function of acetylcholine in neuromuscular junctions.

21. Describe the role of epinephrine, dopamine, and serotonin in synapses.

Immune System

22. Describe the following defenses in the non-specific (aka first line) defense

- a. Skin
- b. Anti-microbial proteins

- c. Gastric juices
- d. Tears
- e. Phagocytes

23. Describe the process of inflammation including histamine, vasodilation and phagocytes.

24. Create two flowcharts, side by side, outlining the cell-mediated immune response versus the humoral (antibody mediated) response.

25. Describe passive versus active immunity classify the following as such:

- a. Vaccine
- b. Actually getting sick
- c. Mother passing antibodies to baby

26. Describe the differences between complement and interferon. How does each work?

Endocrine System

27. Describe negative feedback versus positive feedback.

28. Outline a negative feedback loop for the regulation of blood sugar, and calcium balance. You should use insulin and glucagon for the blood sugar loop and parathyroid hormone and calcitonin for the calcium loop.

29. Describe the roles of the following glands and the hormones they release:

- a. Hypothalamus
- b. Posterior pituitary (ADH, oxytocin)
- c. Anterior pituitary (TSH, ACTH, FSH, LH)

30. Describe the role of the following ductless glands and the hormones they release:

- a. Pancreas (insulin and glucagon)
- b. Adrenal (epinephrine and aldosterone)
- c. Gonads (ovaries...estrogen and progesterone) (testes...testosterone)

31. Create a diagram of how the following hormones work on their target cells:
- Steroid hormones-transcription factors
 - Protein hormones- secondary messengers

Animal Reproduction and Development

32. Outline oogenesis and spermatogenesis.

33. Outline the female menstrual cycle using the following: (Trace the path as if the egg had been fertilized and the path as if the egg had not)
- GnRH (hypothalamus)
 - FSH (pituitary)
 - Estrogen (ovary)
 - LH (pituitary)
 - Progesterone (corpus luteum)
 - Ovulation
 - Human Chorionic Gonadotropin

Unit IX: Ecology and Behavior

Ecology

1. Define and give examples of biotic and abiotic ecological factors.

2. Distinguish between a population, community, and an ecosystem.

3. Distinguish between a habitat and a niche. Give an example of each.

4. Describe and give example of 3 types of symbiosis.

5. Feeding Relationships: Compare the following
 - a) Autotrophs and heterotrophs

 - b) Herbivores, carnivores, and omnivores

 - c) Trophic level, food chain, and energy pyramid

6. Cycles in Nature—Nitrogen cycle: use the following words to diagram a simple nitrogen cycle: nitrogen fixation, legume, N_2 , nitrification, nitrates, dinitrification, bacteria, decomposition, plants, herbivores, carnivores.

7. Cycles in Nature—Water cycle: use the following terms to diagram a simple water cycle: Precipitation, transpiration, evaporation, runoff, seepage, ground water, plants

8. Cycles in Nature—Carbon cycle: use the following terms to diagram a simple carbon cycle: plants, animals, photosynthesis, respiration, CO₂, combustion. Decomposition.

9. Compare the following relationships:
- a) Intraspecific and interspecific competition

 - b) Competitive exclusion and resource partitioning

 - c) Keystone, indicator, and invasive species

 - d) Type I, type II, and type III survivorship curves

 - e) Primary and secondary ecological succession

 - f) Biomagnifications and bioaccumulation

 - g) Batesian and Mullerian mimicry

Behavior

1. When considering behavior, what are ultimate and proximate questions?

2. Explain Fixed Action Pattern (FAP) using stickleback fish as an example.

3. What is a sensitive period and how does it apply to imprinting?

4. Describe and give an example of each of the following types of movements: kinesis, taxis, and migration.

5. Explain the difference and give an example of classical conditioning and operant conditioning.

6. What are energy costs and benefits of foraging behavior? How does this determine foraging behavior?

7. Define:
 - a) Altruism

 - b) Kin selection

 - c) Reciprocal altruism