Station 1: Biological monomers and polymers (22pt)

1-3. Match the monomer to the corresponding polymer (1pt each):

a. Amino acid
b. Glucose
c. Fatty acid
d. Ribonucleotide
e. deoxyribonucleotide

1. Glycogen
2. RNA
3. Protein
4. DNA
5. Triglyceride

6. You have the amino acid sequence of a protein – what level(s) of structure is this?(2pt)

7. You enter the sequence into an online website that gives you which regions of your protein that are alpha helices. What level(s) of structure is this (2pt)?

8. You look at your protein using cryo-electron microscopy. What level(s) of structure would you expect to see (2pt)?

9. Given this **non-template strand** DNA sequence, write the corresponding template RNA sequence, from 3' to 5' (6pts):

3'ATG GCA AAA GAG CTC GAA GCT AGG AAT TAG 5'

10. Given the same non-template DNA sequence, write the **1-letter amino acid** sequence of the polypeptide encoded. Write out any stop codons as (STOP) (5pts)

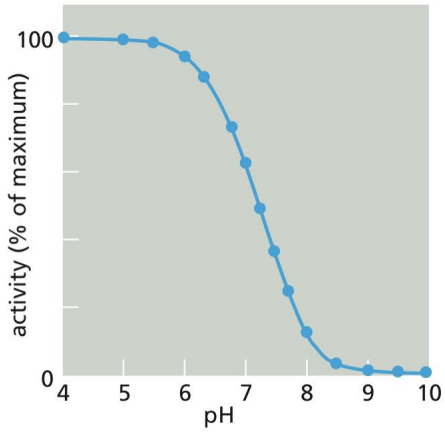
Station 2: Cellular homeostasis (12 pt)

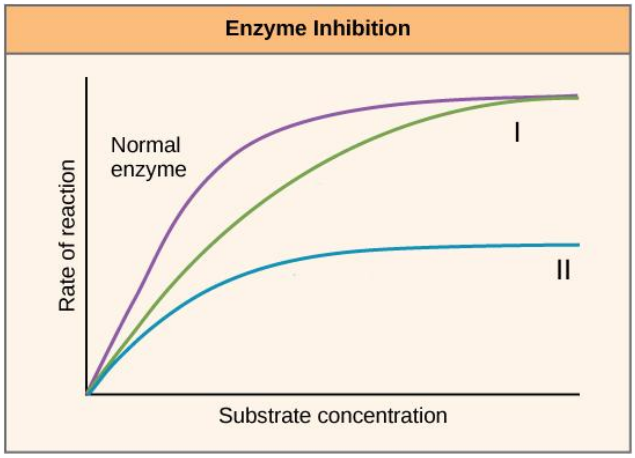
1. What is the buffering system used by the blood to maintain pH(2pt)?
2. What pH range does this system maintain (2pt)?
3. What is the term to describe a membrane that only allows certain molecules in or out (2pt)?

4-6. (2pt each) Match the words to describe the solutions:
Hypotonic, isotonic, hypertonic

4. A cell is placed in distilled water and begins to swell
5. A cell is placed in honey and begins to shrivel
6. A cell is placed in a salt solution and maintains its shape

Station 3: Enzymes and inhibition (20pt)





The above left image shows the activity of an enzyme with a histidine in the active site. Histidine is known to be catalytically important, but it hasn't previously been known whether the histidine is in a protonated or deprotonated state when active.

1. Based on the figure, which is more likely to be the case (2pt)?
2. How can you tell (2pt)?
3. What are the two models of enzyme ligand binding (4pt)?

The above right image shows the reaction rate vs substrate concentration plots for an enzyme with two different inhibitors.

4. What kind of inhibitor is inhibitor I(2pt)?
5. How does inhibitor I affect the Michaelis-Menten constant(Km) of the enzyme (2pt)
6. How does inhibitor I affect the maximal velocity (Vmax) of the enzyme (2pt)?
7. What kind of inhibitor is inhibitor 2(2pt)?
8. How does inhibitor II affect the Michaelis-Menten constant(Km) of the enzyme (2pt)
9. How does inhibitor II affect the maximal velocity (Vmax) of the enzyme (2pt)?

Station 4: Bioenergetics (24pt)

1. Which enzymes involved in the citric acid cycle involve converting NAD+ to NADH? (6 pts)?
2. What steps do each of the enzymes that involve converting NAD+ to NADH catalyze (list starting material and product e.g. citrate to cis-aconitate)(6pt)?
3. Where does the citric acid cycle occur in eukaryotes? (2pt)
4. Beta-oxidation is the process that breaks down what kind of molecule(2pt)?
5. What is the molecule that beta-oxidation produces that is also found in the citric acid cycle(2pt)?

Match the fermentation process to the food (1pt each):

a. Lactic acid
b. Ethanol
c. Both
d. Not fermented

6. Kimchi
7. Kombucha
8. Sourdough bread
9. Yogurt
10. Tofu
11. Chocolate

Station 5: Cell Structure (14 pt)

Match the organelles to their purposes (1pt each)

1. Mitochondria
2. Chloroplast
3. Lysosome
4. Golgi complex
5. Rough endoplasmic reticulum
6. Smooth endoplasmic reticulum
7. Nucleus
8. Ribosome
9. Vacuole
10. Cytoskeleton

a. Capture solar energy
b. Package and distribute products
c. Digest excess products
d. Contain DNA
e. Transform energy through respiration
f. Produce proteins
g. Store substances
h. Site of chemical reactions that contains ribosomes
i. Provides internal structure
j. Site of chemical reactions where lipids are synthesized

11. What features distinguish a eukaryotic cell from a prokaryotic cell (4pt)?

Station 6: Cell Walls (19pt)

Match the cell wall component with the type of organism (you may use organisms more than once or not at all) (1pt each)

1. Cellulose
2. Chitin
3. Silica
4. Pseudopeptidoglycan
5. Peptidoglycan
6. Carrageenan
7. Agar
8. Hemocellulose
9. Pectin

a. Land plant
b. Algae
c. Diatoms
d. Archaea
e. Fungi
f. bacteria

10. What enables the apparent rigidity of plant cell walls?(2pt)
11. What does lignin do to plant cell walls (2pt)?
12. What are the 3 layers that can be found in plant cell walls (3pt)?
13. What do we call the two types of cell wall in bacteria and where do they get their names? (3pt)

Station 7: Membrane structure (26pt)

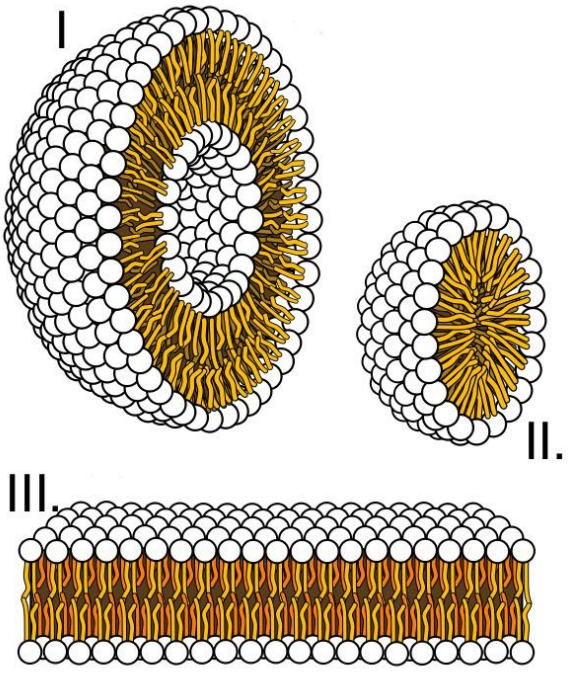
Fill in the blanks (2pt per blank):

1. Flippases catalyze the transport of lipids from the ____a___ side of the membrane to the ____b____ side.
2. Floppases catalyze the transport of lipids from the ____a____ side of the membrane to the ____b____ side.
3. A membrane composed primarily of phospholipids with ____a_____ chains is more dynamic than a membrane composed primarily of phospholipids with _____b____ chains.

4. What is the most common phospholipid head group (2pt)?
5. What are 2 major lipid components found in lipid rafts that distinguish them from the rest of the membrane (2pt each)?
6. Caveolae are a type of lipid raft characterized by the presence of what protein (2pt)

The next three questions are about the image below (2pt each)

7. What kind of lipid/membrane structure is I?
8. What kind of lipid/membrane structure is II?
9. What kind of lipid/membrane structure is III?



Station 8: Vesicles (19pt)

1. The Nobel Prize in medicine was awarded in 2013 for work on cell vesicles. What are the names of the scientists who won it (3pt)?
2. There are three types of vesicle coat proteins. What are they? (6pt)
3. The surface proteins that identify cargo and help facilitate fusion are called what (2pt)?
4. Vesicle fusion requires membranes to be how close together (2pt)?
5. List three functional types of vesicles (6pt)?

Station 9: Cell cycle (18pt)

A cell has just divided! Order the phases of the cell cycle (where 1 is first and 8 is last) using the word bank below (1pt each)

G2, metaphase, S, anaphase, G1, prophase, telophase, cytokinesis,

1-8.

9. There are two main checkpoints, when are they (4pt)? (format as phase 1 to phase 2)

10. At the first checkpoint (after division), the cell checks for ___a___ so that __b___ (process)can happen (2pt each blank).

11. At the second checkpoint, the cell checks for ___a___ so that __b___ (process) can happen (2pt each blank).

12. What are the two main components of cell cycle regulation in eukaryotes (4pt)?

Station 10: Apoptosis and cancer (20pt)

1. What is a gene that has potential to cause cancer called (2pt)?

Match the example of a cancer driving protein with what kind of protein it is (2pt each)

2. VEGFR
3. C-Src
4. Raf
5. Ras
6. Myc

a. Regulatory GTPase/G protein
b. Receptor tyrosine kinase
c. Cytoplasmic serine/threonine kinase
d. Transcription factor
e. Cytoplasmic tyrosine kinase

7. What kind of cell death results from acute cellular injury (2pt)?
8. What kind of cell death results in development of fingers and toes during development (2pt)?
9. What are the two pathways that can initiate apoptosis (4pt)?
10. What are the highly conserved proteases involved in apoptosis called (2pt)?

Station 11: Plants (17pt)

Decide whether each plant is a C3, C4, or CAM plant (1 pt each)

1. Sugarcane
2. Pineapple
3. wheat
4. Cacti
5. Orchids
6. Corn
7. Daisies
8. Rice
9. Aloe vera
10. Cabbage
11. Barley

12. C3 is also known as what (2pt)?
13. C4 is also known as what(2pt)?
14. CAM is an abbreviation for what (2pt)?

Station 12: Cell signaling (20pt)

1. What nucleoside triphosphate do G proteins use for signal transduction(2pt)?
2. Pseudephedrine (Sudafed, a nasal decongestant) binds to and activates the beta-adrenergic receptor, a GPCR which couples to Gs. What is the second messenger effect you would expect (2pt)?
3. Propranolol (a beta-blocker) also binds to the beta-adrenergic receptor, but does not activate it. What is this mechanism called (2pt)?

The epidermal growth factor receptor (EGFR) is an RTK activated by epidermal growth factor (EGF).

4. When EGF binds an EGFR, what is the first change that happens(2pt)?
5. After that change happens, what kind of side chain is phosphorylated (2pt)?
6. After phosphorylation, what are the two types of protein domains that can bind (4pt)?

Match the following scenarios with the correct kind of signaling (2pt each)

7. Signaling that involves molecules that diffuse over short distances like fibroblast growth factors
8. Signaling that involves molecules that diffuse over long distances via the circulatory system like hormones
9. Signaling that occurs via two proteins on two different cells that interact
10. Signaling that occurs when secreted molecules bind receptors on the same cell that secreted them

a. Paracrine signaling
b. Autocrine signaling
c. Endocrine signaling
d. Juxtacrine signaling