Exam #1 (Ch 1-6)

This is a preview of the published version of the quiz

Started: Sep 23 at 5:31pm

Quiz Instructions

This is exam#1 for Biology 366 (Fall 2024). It covers the material from the lectures covering Chapters 1-6.

You will have 75 minutes to complete the exam. Students registered with SDS will receive approved accommodations. The format is 25 questions worth 4 points each for a total of 100 points.

Although this exam is open book and notes, it must be completed independently and without assistance from another individual or ChatGPT.

Good luck!

Dr. Ellis

Question 1 4 pts

Select the appropriate microscope to use for the following experiments:

1. Imaging the internal contents of a cell to differentiate organelles from one another.

2. Determine the precise location of a protein of interest within a cell.

- 1. Fluorescent Microscope; 2. Scanning Electron Microscope
- 1. Light Microscope; 2. Fluorescent Microscope
- 1. Scanning Electron Microscope; 2. Transmission Electron Microscope
- 1. Transmission Electron Microscope; 2. Fluorescent Microscope

Question 2 4 pts

Which is TRUE of an indirect immunofluorescence assay?

○ These assays involve separate antibodies for targeting the protein of interest and for giving off a fluorescent signal.

○ These assays use electron microscopes to characterize the localization of proteins within a cell.

○ These assays involve a single antibody which both recognizes a target protein of interest and gives off a fluorescent signal.

○ In the long run, these assays are less time and cost effective than direct immunofluorescence assays because you require twice as many antibodies.

Question 3 4 pts

ATP is utilized in our cells for energy production. Which organelle would you expect to be in high abundance in heart cells to generate more ATP?

○ The lysosome, to break down macromolecules into ATP using acid hydrolases.

○ The mitochondria, to oxidize sugars into ATP.

○ The chloroplast, to harvest solar energy and convert it into ATP.

○ The endoplasmic reticulum, to rapidly synthesize ATP produced by DNA in the nucleus.

○ The nucleus, to provide more DNA for the cell to create more ATP.

Question 4 4 pts

How does a polar covalent bond differ from a hydrogen bond?

○ A polar covalent bond involves the equal sharing of electron between two elements, while a hydrogen bond involves the donation of electrons by hydrogen.

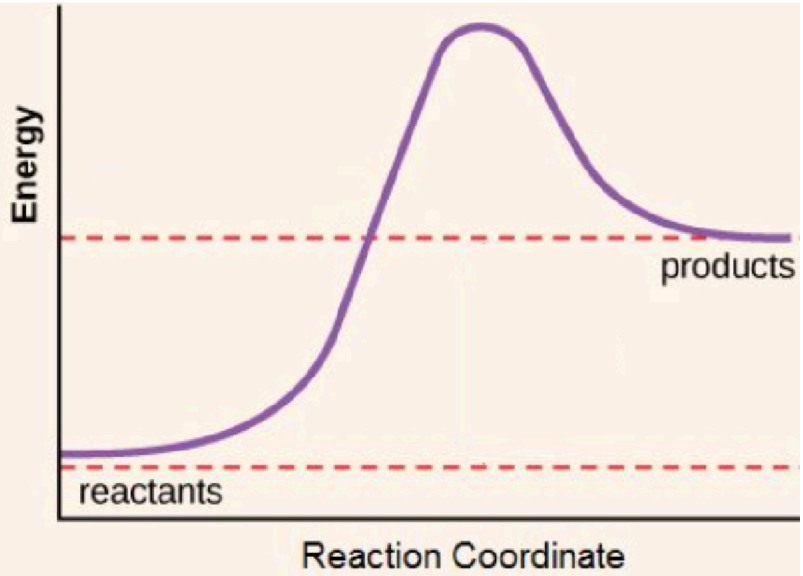
○ A polar covalent bond involves the unequal sharing of electrons between two elements, while a hydrogen bond is a noncovalent interaction between hydrogen and an electronegative element.

○ A polar covalent bond is an electrostatic interaction, while hydrogen bonding is a hydrophobic interaction.

○ A polar covalent bond involves the unequal sharing of electrons between two elements, and a hydrogen bond is simply a specific type of polar covalent bond involving hydrogen.

Question 5 4 pts

Which is TRUE of the following reaction:



○
The reaction is spontaneous.

○
An enzyme alone is sufficient to covert a majority of reactants to products by lowering the activation energy.

○
If coupled with an activated carrier, such as ATP, it is possible that this reaction could become energetically favorable.

○
The increased ΔG indicates that the disorder of the universe will increase, in accordance with the second law of thermodynamics.

Question 6 4 pts

For *all* spontaneous reactions, which of the following is TRUE?

○
The ΔH will be negative, according to the first law of thermodynamics.

○
The ΔS will be negative, according to the second law of thermodynamics.

○
The free energy of the products is lower than the free energy of the reactants.

○
This type of reaction will occur rapidly.

Question 7 4 pts

Which is FALSE about catalysts?

Catalysts reduce the ΔG between the metastable transition state and the reactants.

Catalysts notably increase the kinetics of a reaction and thus the rate of product formation.

Some catalysts are irreversibly chemically altered after interacting with reactants.

Catalysts can orient two substrates into favorable positions to increase the likelihood of a productive interaction.

Question 8 4 pts

Which of the following is TRUE of ATP?

Both reaction directions of the chemical loading and unloading of energy via ATP are spontaneous, making it a useful activated carrier.

ATP is a catalyst as it allows unfavorable reactions to take place.

The hydrolysis of ATP is a highly energetically favorable interaction.

There are typically no covalent bonding interactions between ATP and the reactants with which it is coupled, only non-covalent interactions.

Question 9 4 pts

Which of the following coupled reactions would be *spontaneous*?

$$A + B \longrightarrow AB; \Delta G = -15 kcal/mol$$

$$C + D \longrightarrow CD; \Delta G = +20 kcal/mol$$

$$EF \longrightarrow E + F; \Delta G = -40 kcal/mol$$

$$HI + J \longrightarrow HJ + I; \Delta G = +45 kcal/mol$$

CD + E + F

AB + C + D + EF

EF + HI + J

A + B + C + D

Question 10 4 pts

Place each descriptor in the appropriate level of protein structure:

1. An antibody consists of 2 light chain and 2 heavy chain subunits connected by disulfide bonds.

2. A protein's N-terminus region functions to bind a specific ligand, while the C-terminus region provides a hydrophobic core for embedding in the plasma membrane.

3. One section of the protein has a tryptophan residue next to a glycine, followed by an isoleucine.

4. Hydrogen bonding between the atoms of two peptide bonds along the protein backbone.

○
Tertiary; Primary; Secondary; Tertiary

○
Quaternary; Quaternary; Primary; Tertiary

○
Quaternary; Tertiary; Primary; Secondary

○
Tertiary; Tertiary; Primary; Secondary

Question 11 4 pts

Which of the following is FALSE about protein folding?

○
There is only ever one conformation a protein will stably fold into regardless of the external environment.

○
Alpha helices and beta sheets form intramolecularly, along the backbone, as part of protein secondary structure.

○
Covalent bonds between amino acid residues contribute to the stability of protein structure in addition to non-covalent interactions.

○
Hydrogen bonding is extremely important in the determination of protein 3D structure.

Question 12 4 pts

Choose the correct description of regulatory control of enzymatic activity:

○
Competitive inhibitors bind to an allosteric site on an enzyme, preventing the binding of the substrate.

○
Adding a large excess of substrate can overcome the reaction-slowing effects of a competitive inhibitor.

Allosteric binding always reduces protein activity by preventing product formation.

A non-competitive inhibitor always prevents the binding of the substrate to the active site.

Question 13 4 pts

The pH of the blood of the peripheral tissues is lower than that of the lungs. This change causes the oxygen binding curve of hemoglobin to shift, while stabilizing the "T" state of hemoglobin.

Which of the following is FALSE?

The affinity for oxygen to remain bound is reduced in the peripheral tissues.

If the above were not true, and hemoglobin remained in the "R" state in the peripheral tissues, it would be highly inefficient at offloading its bound oxygen.

The shift in the oxygen binding curve observed in the peripheral tissues makes it more difficult for hemoglobin to release its bound oxygen due to binding cooperativity.

The lowered pH will affect non-covalent bonding interactions within hemoglobin, altering the overall folding geometry of the protein.

Question 14 4 pts

Hemoglobin consists of 4 subunits, each capable of binding one O_2 molecule. Carbon monoxide (CO) is released into the lungs as a result of smoking cigarettes. CO binds to the *same site* as O_2 in hemoglobin, this binding event is *irreversible*, and CO binding increases the affinity for O_2 to remain bound to the *other binding sites* within hemoglobin.

Which of the following is TRUE?

If 50% of a person's hemoglobin binding sites are occupied by CO, it is possible to overcome this inhibition by flooding the system with O_2 to outcompete the CO and return to maximal function.

CO is a non-competitive inhibitor of O_2 binding to hemoglobin as it regulates O_2 binding at sites other than the site where it binds and this effect cannot be overcome with an excess of O_2.

CO is both a competitive inhibitor and an allosteric regulator of O_2 binding to hemoglobin.

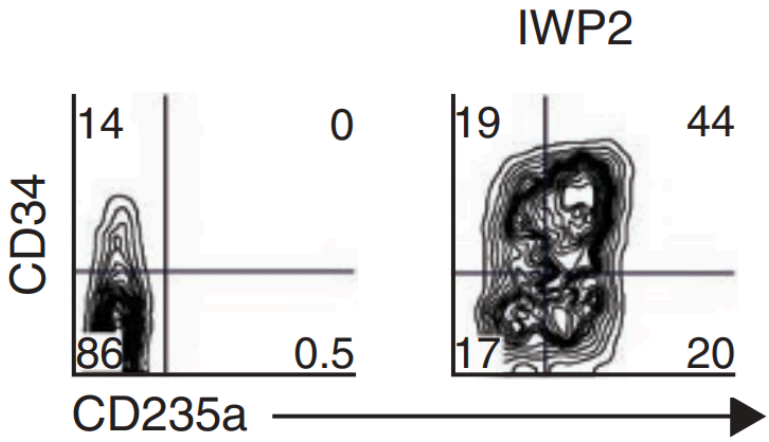
○

CO is only a competitive inhibitor of O_2 binding to hemoglobin as they are in direct competition for the same binding sites.

Question 15 4 pts

Consider the following flow cytometry data adapted from Sturgeon et al. The numbers shown indicate the respective percentages of cells in each quadrant.

Which of the following is TRUE?



○
In the absence of IWP2 there is a notable population of cells that are doubly positive for CD34 and CD235a.

○
There is a comparably larger percentage of cells positive for CD34 before IWP2 addition versus after IWP2 addition.

○
The population of cells in the left plot are highly positive for CD235a.

○
The addition of IWP2 increases the number of cells expressing CD235a.

Question 16 4 pts

Why would you want to perform multiple injections of the same antigen into the same host species when generating a new antibody?

○
The first injection creates a primary antibody against your target of interest, while the second injection creates a secondary antibody against the first antibody.

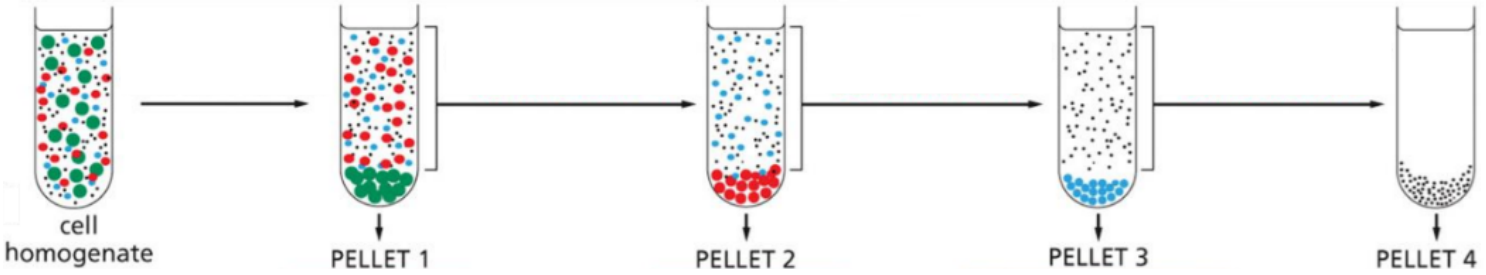
○
Antibodies have a notoriously short half-life in the bloodstream, so repeat injections are necessary to collect the antibodies that do exist before they are degraded.

Once the host's immune system recognizes an antigen, the host's B cells will proliferate and secrete large amounts of the antibody to protect against future infection. This will be amplified through repeat injections.

It is unlikely for the antigen to be recognized by the host after the first injection, so repeated injections increases the likelihood of generating an antibody.

Question 17 4 pts

Which is a correct description of the technique shown in the image below?



This is the process of FACS sorting which allows the collection of subsets of a cell population through fluorescent marker expression.

This is the process of homogenization, which mechanically breaks apart cells sequentially to isolate selective cellular components.

This is the process of differential centrifugation, which leverages varying speeds of centrifuging cell lysate supernatant to selectively isolate cellular components by size.

This is the process of mass spectrometry which separates cellular components according to their size using ionizing radiation.

Question 18 4 pts

You are trying to purify your protein population using ion-exchange chromatography. Your column (the blue rectangle) contains *negatively charged beads*.

Which of the following is FALSE?

○
Protein X is positively charged while Protein Y is negatively charged. It would take longer for Protein X to pass through your column due to interactions with the negatively charged beads.

○
If you added SDS to your sample, which coats proteins with a negative charge, before loading it into the column, it would take a much longer time to elute your protein of interest.

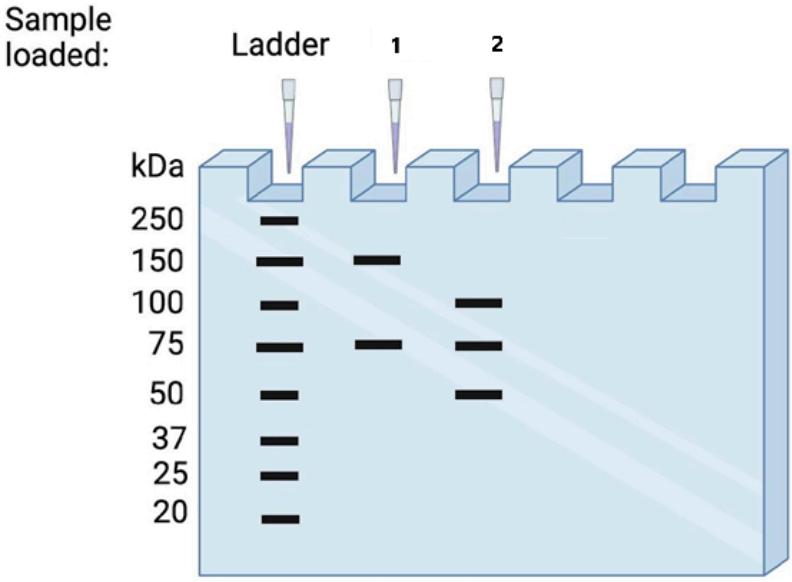
○
If you added enough solvent (liquid) and waited a long enough time without changing the elution container, you would collect your entire protein population, which would still be mixed.

○
Due to the strength of the covalent electrostatic interactions between positively charged proteins in your sample and the negatively charged beads, it would be required to add a reagent such as SDS to your column to release your bound proteins of interest for collection after all non-bound proteins have been eluted and thrown away.

Question 19 4 pts

You are running an SDS polyacrylamide-gel electrophoresis to uncover information about the proteins in your sample. In the lane marked "1" you did not add DTT, which breaks disulfide bonds. In the lane marked "2" you added DTT before loading your sample into the gel.

Which is a correct interpretation of your result?



○ The protein of size 75 kDa consists of multiple subunits connected by disulfide bonds.

○ Your sample contains two proteins, one of which has two subunits connected by a disulfide bond.

○ Your sample contains three independently functional proteins, as demonstrated by the three distinct bands seen in the gel in lane 2.

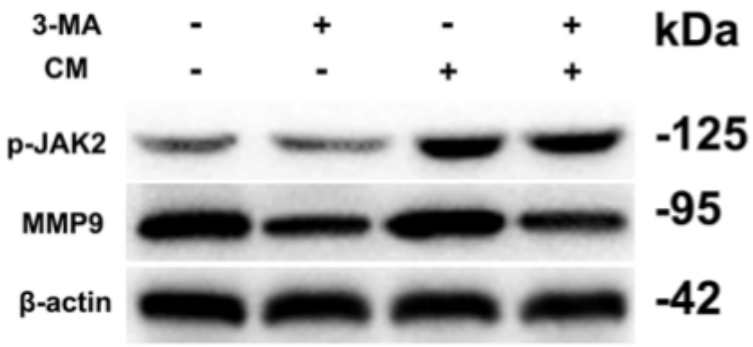
○ There are no disulfide bonds in any of the proteins in your sample.

Question 20 4 pts

Consider the following western blot adapted from Chu et al.

3-MA and CM are different treatment conditions prior to analyzing protein expression, the plusses and minuses indicate whether or not that treatment was used. β-actin serves as the loading control.

Which of the following is a correct interpretation of the result?



○ Both 3-MA and CM have a notable effect on β-actin expression levels.

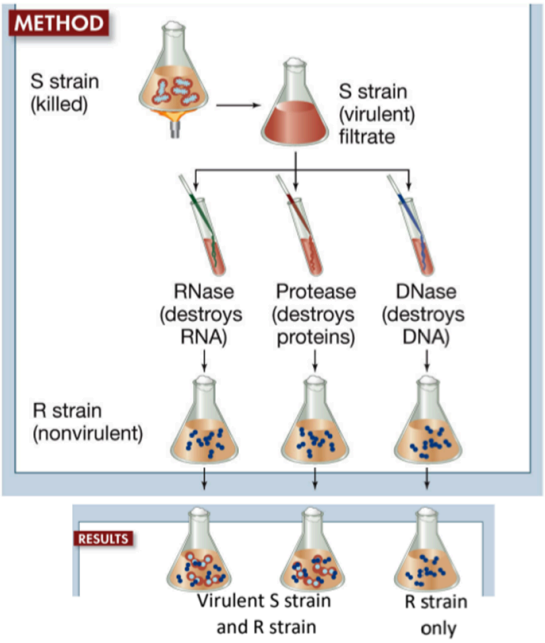
The effect of 3-MA on MMP9 expression is more potent than the effect of CM on MMP9 expression.

3-MA treatment increases the expression of MMP9.

CM treatment reduces the expression level of p-JAK2.

Question 21 4 pts

Below is the schematic for the Avery, MacLeod, and McCarty experiment. How did this experiment demonstrate which molecule carriers heritable traits?



The scientists demonstrated that the addition of protease led to the resurgence of the virulent S strain after it had already been killed, demonstrating that protein carries heritable traits.

The scientists demonstrated that the addition of RNase led to the resurgence of the virulent S strain after it had already been killed, demonstrating that RNA carries heritable traits.

The scientists demonstrated that the addition of DNase prevented the resurgence of the virulent S strain after it had already been killed, demonstrating that DNA carries heritable traits.

Two of the other answers are correct.

Question 22 4 pts

Which of the following is FALSE about histones?

The tight wrapping of DNA around histones is indicative of genes with high transcriptional activity.

Histones are an octomer of protein subunits, each with a tail that can be chemically modified to remodel nearby chromatin.

While methylation tends to lead to gene silencing and acetylation to gene expression, the gene expression process is in reality much more tightly regulated by an overall combination of histone modifications.

Together with DNA, histones form nucleosomes, the basic structural unit of chromatin.

Question 23 4 pts

Why is RNA utilized in the replication of DNA?

RNA polymerase adds nucleotides in the opposite direction from DNA polymerase, from 3' to 5', and so is required for the replication of the lagging strand of DNA due to its inherent antiparallel nature.

RNA is only utilized in the extension of telomeres at the very ends of DNA strands to avoid shortening of the chromosomal ends with each replication cycle.

This is not true, RNA is only utilized for transcription from DNA, not for DNA replication.

DNA polymerase requires a base-paired 3' -OH in order to perform enzymatic chain elongation. This is not required by primase, an RNA polymerase, and so a short RNA primer is initially utilized to begin strand synthesis in DNA replication.

Question 24 4 pts

Which of the following is TRUE of *lagging strand* synthesis in DNA replication?

Lagging strand synthesis does not require topoisomerase as the formation of short Okazaki fragments reduces the torsional strain of the unwinding DNA helix.

For a given replication bubble, the lagging strand of the right-hand-side replication fork will also be the lagging strand of the left-hand-side replication fork.

If you were to freeze time during the middle of DNA replication prior to completion, there is likely to be more RNA present in the lagging strand than in the leading strand.

Lagging strand synthesis happens continuously running 3' to 5' along a replication fork of DNA.

Question 25 4 pts

Why is mismatch repair (MMR) essential to prevent replication errors in DNA?

- Mismatch repair is the principal mechanism to repair DNA double strand breaks.
- Without mismatch repair, an incorrectly paired base during DNA replication would maintain this error as a permanent mutation for all subsequent DNA replication cycles.
- Mismatch repair is another name for DNA polymerase's proofreading capability which checks on the previously added nucleotide to ensure it is correct, and replaces it if it is not.
- As only 1 mistake is likely to occur for every 10 million nucleotides added during DNA replication, mismatch repair is really not essential as these replication errors are highly unlikely and those that do occur will have a limited impact.

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