BIOL 112: Unit 1 Practice Questions

This document contains some questions for you to practice. The questions are grouped by topic along with the learning objectives associated with each of the topics. We encourage you to use the learning objectives to guide your studying; ask yourself if you could answer each objective if it was in the form of a question. There are different levels of questions provided:

1. **Study questions**: these are questions on your direct knowledge of the topics, so essentially 'drills' on the basics – practice to make sure you get the fundamentals. Work with these questions first to build up your skills.
2. **Exam-type questions, of which there are two types:**
    a. **Multiple choice:** these are the types of questions you are likely to see on the exam – various levels of application of the fundamental knowledge and skills for each topic area.
    b. **Open response questions (ORQs):** a few examples to give you an idea of the kinds of short answer questions you will see on the exams.

Topic:
General properties and types of cells

This topic provides a general introduction to cells as the basic unit of life, their structure, diversity and the evolutionary relationship of all living organisms.

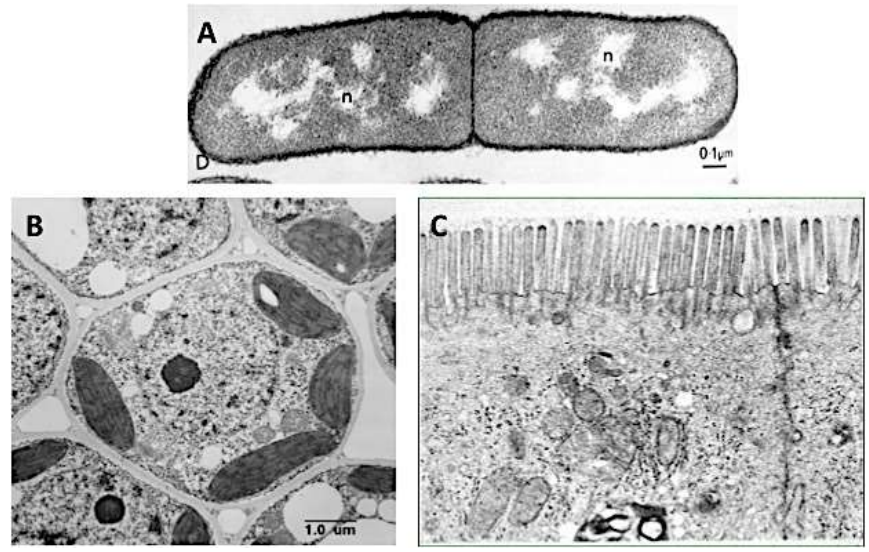
- **Summarize** the cell theory and **List and evaluate** the characteristics that define cells as the smallest unit of life.
- **Discuss** diversity in cell size, structures; cells as organisms *versus* cells in organisms; unicellular versus multicellular.
- **Discuss** the factors contributing to the limitation of cell size (solute concentration, transport, diffusion).
- **List** the three domains that comprise the tree of life.
- **Compare and contrast** the structural properties of bacterial and eukaryotic cells.
- **Explain** the endosymbiotic theory as the origin of eukaryotic cellular life and **discuss** the evidence that supports it. (don't worry about discussing evidence at this point in the course).

Study questions:

1. What are the key features that define "what is a cell?"
2. What is the function of the plasma membrane?
3. What is the purpose of some cells having internal membranes?
4. What are the three domains on the tree of life?
5. What are the differences between bacterial cells and eukaryotic cells?
6. What is the main chemical form of energy stored inside the cell?

Exam-type questions:

1. Examine the micrographs of cells shown and answer the questions below.



a) Explain how each cell is addressing cell size-related limitations for dilution, diffusion and surface area to volume ratio.
In A, the bacterial cell is small in size; in B, the cells have lots of compartments; in C, the several foldings and projections of the cells increase surface area to volume ratio.

b) The image above shows bacterial, plant and human cell types. What are some differences between these types of cells? What characteristics could you use to distinguish between them?
A is bacterial, because it has no membrane bound compartments; B is plant cell, eukaryotic – has a nucleus, lots of membrane-bound compartments, and chloroplasts; C is an animal cell, eukaryotic – has many membrane-bound compartments, no chloroplasts.

2. Which of the following clues would tell you whether a cell is bacterial or eukaryotic?

A. The presence or absence of a rigid cell wall
B. Whether or not the cell is partitioned by internal membranes
C. The presence or absence of ribosomes
D. Whether or not the cell carries out cellular metabolism
E. Whether or not the cell contains its own genome.

3. Why is water capable of forming hydrogen bonds with the major macromolecules?

A. The hydrogen atoms carry partial positive charges.
B. The oxygen atom carries a partial negative charge.
C. It is a polar molecule.
D. The hydrogen atom is less electronegative than the oxygen atom.
E. All of the above apply.

Topic:

Introduction to macromolecules in cells

This topic introduces the four major macromolecules that form the structural and functional components of cells. We will cover specific macromolecules in more detail throughout the course.

- **List** the four major categories of macromolecules in cells.
- For each of the macromolecules, **List** and **identify** the monomers, types of covalent bonds linking the monomers together, the directionality of the macromolecules, and the reason for the directionality.
- **Explain** and **relate** the importance of functional groups to macromolecule polymerization and directionality.
- **Recognize** the general structure, chemical properties and functional groups of monomers that make up each type of macromolecule.
- *Refer to Chemistry for Biology Learning objectives, which will be featured throughout the course.*

Study questions:

1. What are the four main types of biologically important macromolecules? What is the general role of each type? What are the monomers ("building blocks") of each of these macromolecules?
2. What is the general structure of the monomer (building block) of proteins? Describe and draw this structure.
3. What are the names of the termini (ends) of a protein chain?
4. What is the general structure of the monomer (building block) of nucleic acids? Describe and draw this general structure. What are the differences between the DNA monomer and the RNA monomer?
5. Look at Figure 2.18. Predict the types of non-covalent interactions that nucleic acid monomers can participate in.
6. What are the names of the termini (ends) of a nucleic acid?
7. What is the general structure of the monomer (building block) of complex carbohydrates?
8. Look at Figure 2.23. Predict the types of non-covalent interactions that carbohydrate monomers can participate in.
9. What are the names of the termini (ends) of a carbohydrate?
10. What types of lipids are found in cell membranes?
11. What is the general structure of the monomer (building block) of phospholipid?
12. Look at Figure 2.28. Predict the types of non-covalent interactions that phospholipids can participate in.
13. By convention how is the directionality of a DNA molecule expressed?
14. What is the directionality observed in a polypeptide?

Exam-type questions:

1. Fill in the blanks: Macromolecular structures are assembled in this order: _____ are joined together by _____ bonds to form biological _____, which associate with each other by _____ bonds, forming larger structures.

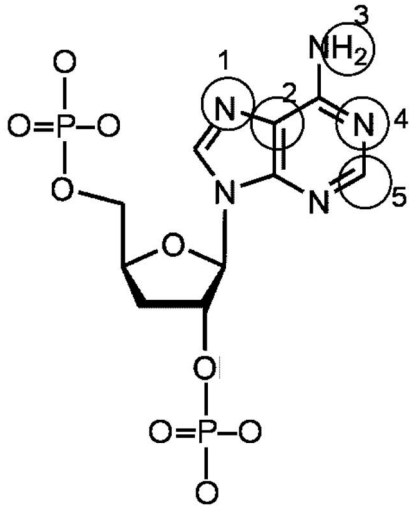
    a. Monomers, covalent, polymers, noncovalent
    b. Polymers, covalent, monomers, noncovalent
    c. Monomers, noncovalent, polymers, covalent
    d. Polymers, noncovalent, monomers, covalent

2. Conditions of low pH (which means that the hydrogen ion (H^+) concentration is increased) will affect amino acids and proteins. For some amino acids, side chains that were negatively charged at neutral pH may become neutral and for other amino acids side chains that were neutral may become positively charged. These effects might contribute to altering the tertiary and quaternary structures of a protein by which of the following mechanisms?

    1. Breaking of peptide bonds.
    2. Changing the ionic interactions.
    3. Making new Induced Dipole-Induced Dipole interactions
    4. Changing the amino acid sequence.
    5. Causing charge repulsion.

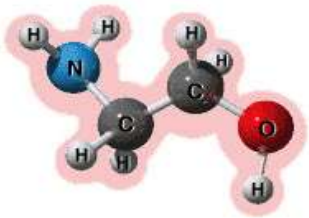
    a. All 5 probably contribute.
    b. 1, 2, 3, 4 probably contribute.
    c. 2 and 5 probably contribute.
    d. 3 and 4 probably contribute.
    e. 1, 3 and 4 probably contribute.

3. In this picture showing one of the nitrogenous bases in DNA, Which of the circled atoms could make hydrogen bonds with water?



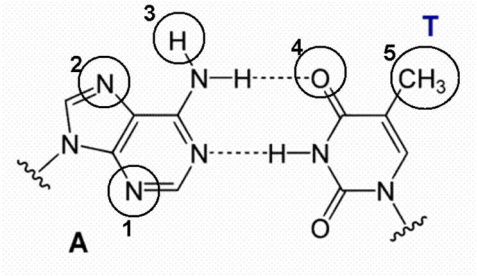
a. All 5
b. 1, 2, 3 only
c. 1, 3, 5 only
d. 1, 3, 4 only
e. 3, 4 only

4. How many atoms in the pictured molecule can form H-bonds with water molecules?



a. 7
b. 3
c. 2
d. 5
e. 8

5. Below is a diagram showing two molecules that are H-bonded to each other. An isoleucine in the primary structure of a protein was shown to interact with these molecules. Using just this information, which one of the circled atoms/groups shown on the molecules below is likely to have an induced-dipole – induced-dipole interaction with the isoleucine?



a. group 1
b. group 2
c. group 3
d. group 4
e. group 5

Topic: Lipids – Phospholipids, membrane structure, and membrane self-assembly

This topic deals with the general biochemical and structural properties of lipids and how they self-assemble into larger structures. Membrane assembly of phospholipids is a specific example to understand thermodynamics and system stability and how this relates to general principles of macromolecular assembly.

- **Explain** the amphipathic nature of phospholipids.
- **Predict** which non-covalent interactions will likely form when phospholipids are mixed with water.
- **Predict** which structures that will form when different kinds of lipids are mixed with water and provide a rationale.
- **Discuss** spontaneous assembly of phospholipid bilayers using the language of thermodynamic system stability, including the role of enthalpy and entropy in driving the process (reaction) to occur.
- **Relate** the general properties of membranes to the properties of membrane phospholipids.
- **Describe** the Fluid Mosaic model of the biological membrane structure.

Study questions:

1. Why do phospholipids spontaneously assemble into specific lipid structures? Look at Figure 5.3, why does each of these structures form? What determines whether a micelle, bilayer or liposome forms?
2. What are the different components that make up a phospholipid?
3. What is the fluid mosaic model of membrane structure? Why is it called this?
4. Explain, in your own words, why the formation of a phospholipid bilayer in an aqueous solution is a spontaneous process using the terms delta G, entropy, hydrophobic effect and non-covalent interactions.

Exam type questions:

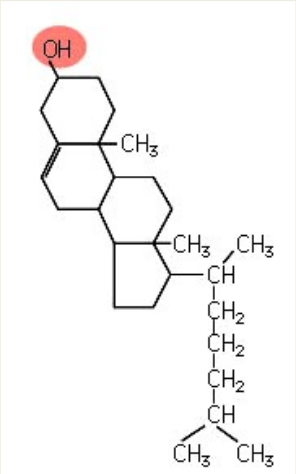
1. What is the most important factor explaining the spontaneous assembly of phospholipids into a bilayer in an aqueous solution?

a. Increased entropy of water, and thereby the stability of the system
b. Increased entropy of lipids, and thereby the enthalpy of the system
c. Formation of ionic bonds between the phospholipids, and thereby increased ΔH
d. Stabilization of permanent dipole-induced dipole interactions
e. Increased Induced dipole induced dipole interactions between the phospholipid head groups
f. Many non-covalent interactions between the hydrocarbon tails of the phospholipids

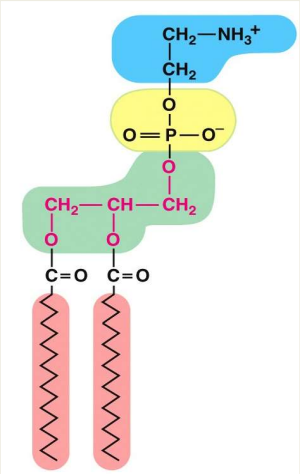
2. Based on the structures shown, which of these lipids can form bilayers on their own?

   a. A only
   b. B only
   c. Both
   d. Neither

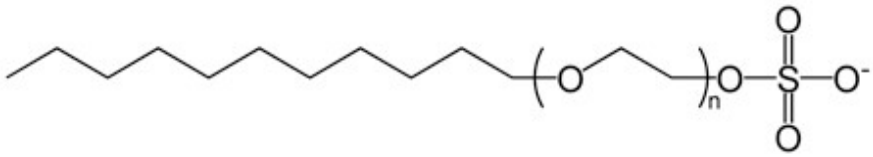
Lipid A



Lipid B



3. The structure below is for sodium dodecyl sulfate (SDS), a commonly used laboratory detergent. Which statements may be true regarding the structure of SDS? and the observed behaviour listed for SDS below?



   1. Many SDS molecules in solution will form a micelle due to the hydrophobic tails and the hydrophilic head.
   2. The negatively charged oxygen atom would be exposed on the hydrophilic surface of the membrane.
   3. The amphipathic nature of this molecule can result in SDS inserting into the cell membrane.
   4. The nonpolar portion of SDS can form Induced Dipole-Induced Dipole interactions with the hydrocarbon chains of the phospholipids.

      a. 1, 2, 3
      b. 1, 3, 4
      c. 1 and 2 only
      d. 3 and 4 only
      e. All statements are true.

4. Why are phospholipids well suited to be the main structural components of membranes?

   1. They are completely insoluble in water.
   2. They can self assemble into a bilayer
   3. They form a structure in which the hydrophobic portion faces outward.
   4. They are made from atoms that are commonly available in foods.
   5. They form a single sheet in water.
   6. They form a selectively permeable structure.

      a. 1, 4 and 6
      b. 2, 3 and 5
      c. 3 and 5
      d. 2 and 6
      e. 1 and 6

Topic:

Lipids - Membrane selective permeability, transport, diffusion, and osmosis

This topic describes the selective permeability of cellular membranes and the various mechanisms cells use to transport molecules across the lipid bilayer.

- **Predict** the permeability of various types of molecules across lipid bilayers based on size and charge.
- **Discuss** selective permeability of biological membranes and structural features that contribute to the selective permeability.
- **(Self Study) Distinguish** between the process of diffusion and osmosis.
- **(Self Study) List** some strategies that cells use to deal with the consequences of osmotic pressure build up as a result of the selective permeability of membranes.
- **Compare and contrast** the transport proteins, carriers versus channels.
- **Distinguish** between the different types of membrane transports (simple diffusion, facilitated diffusion and active transport) in terms of concentration dependence, protein transporters, and energy requirements.

Study questions:

1. What are the different types of passive transport across cell membranes? What are the similarities and differences of each type?

2. What is the definition of diffusion, how does this relate to the different types of passive transport?

3. Look at Figure 5.9. Describe what the green solute particles are doing in each flask. Are they static, or are they moving? If so in what direction?

4. What is osmosis? How is this the same or different from other types of passive transport?

5. Look at Figure 5.11. Compare this figure to Figure 5.9, what is different in this scenario?

6. Look at Figure 5.14, explain why the red blood cell changes shape? Relative to the shown solute concentration, what is the water concentration inside the cell? Outside the cell?

7. How does active transport compare to passive transport?

8. What is an electrochemical gradient?

9. Compare the active transport that is shown in Figure 5.12 and 5.13? What are the similarities and differences?

Exam-type questions:

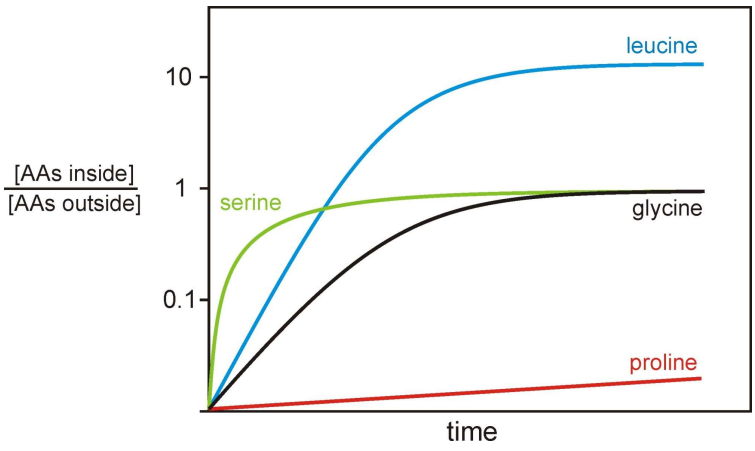
1. Which of the following statements is true about passive diffusion?
    a. Passive diffusion operates independently of concentration.
    b. Passive diffusion phenomena can never reach equilibrium.
    c. Passive diffusion requires no expenditure of cellular energy.
    d. Passive diffusion moves molecules into a cell, but not out of the cell.
    e. Passive diffusion does not occur in cells that possess a cell wall.

2. You are hiking in the woods, and you fall and end up with a particularly nasty, dirty wound. Unfortunately, you have forgotten your first aid kit, but you seem to recall that packing a large amount of sugar into the wound might help to prevent a bacterial infection by killing the bacteria. What is the most reasonable explanation for this?
    a. The sugar will give your skin cells energy to kill the bacteria.
    b. The sugar will make it difficult for the invading bacteria to diffuse into the wound.
    c. The sugar inhibits bacterial growth by inducing dehydration.
    d. The sugar kills the bacteria by cell rupture due to excess water.
    e. The sugar kills the bacteria by cutting off its air supply.

3. If the transport of a particular solute from a cell to the outside always requires energy, then which of the following is always true?
    1. The concentration of the solute must be higher inside the cell than outside it.
    2. A transport protein will change conformation to allow for movement of the molecules.
    3. The concentration of the solute must be lower inside the cell than outside the cell and a transport protein is involved.
    4. The lipid bilayer is permeable to the solute.

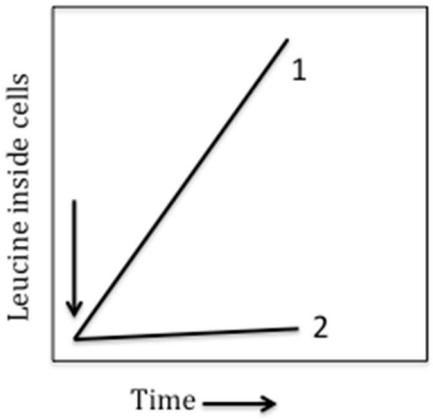
    a. 1 and 2
    b. 2 and 3
    c. 1 only
    d. 2 only
    e. 3 only

4. The figure below shows the uptake of 4 amino acids into cells. Given these data and your knowledge of relative permeability of lipid bilayers to different kinds of molecules, which of the following conclusions are correct?



    a. Leucine gets in by active transport; serine, glycine and proline get in by passive transport.
    b. Serine and leucine get in by active transport; glycine and proline get in by facilitated diffusion.
    c. Leucine gets in by active transport; serine, glycine and proline get in by facilitated diffusion
    d. All four amino acids get in by facilitated diffusion
    e. Leucine, serine, and glycine get in by active transport; proline gets in by facilitated diffusion

5. The figure shows two experiments of the uptake of leucine into the bacterium *E.coli*. Leucine was added at the arrow. The two curves show the uptake at two different temperatures, 35° for curve 1, and 15°C for curve 2.

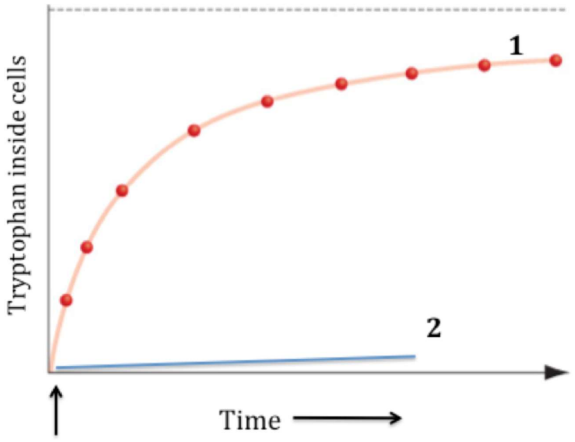


From the data, which of the conclusions can you make for sure?

1. The transport mechanism is active transport.
2. The transport mechanism is facilitated diffusion.
3. The transport mechanism is passive diffusion.
4. The cytoplasmic membrane is more permeable to leucine at the lower temperature.
5. The cytoplasmic membrane is more permeable to leucine at the higher temperature.

a. Only conclusions 1 &4 can be made.
b. Only conclusions 1 &5 can be made.
c. Only conclusions 3 & 4 can be made.
d. Only conclusions 2 & 5 can be made.
e. Only conclusion 4 can be made.
f. Only conclusion 5 can be made.
g. Only conclusion 3 can be made.

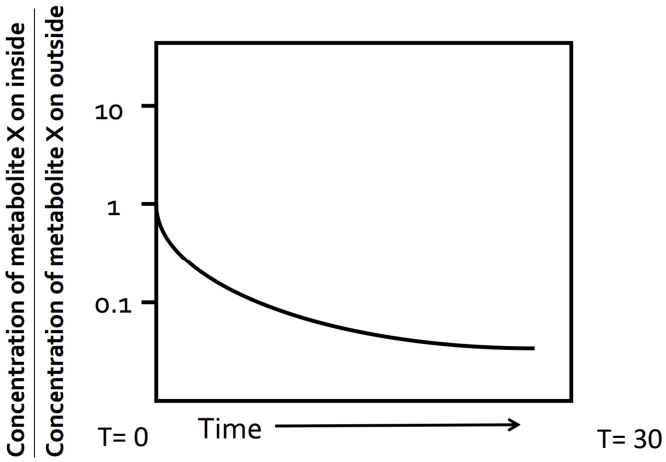
6. The figure shows data from two experiments of the uptake of the amino acid tryptophan in *E.coli* cells. At the arrow in the graph, a solution containing tryptophan was added to the media. For experiment 1, tryptophan alone was added. For experiment 2, tryptophan + KCN (potassium cyanide, a known ATP synthesis inhibitor) were added. Which of the following is the most likely explanation for the differences observed in the two uptake curves?



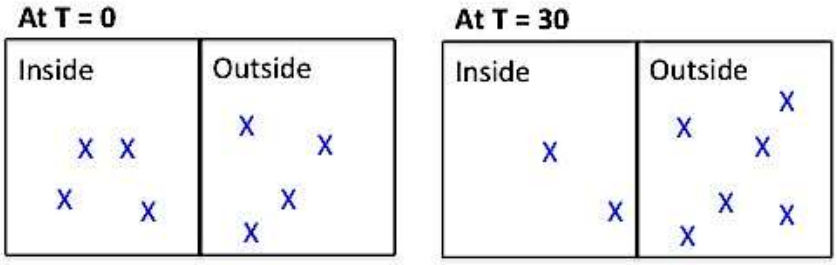
a. KCN binds to the phosphate groups on the phospholipids in the cytoplasmic membrane, reducing the permeability as shown in curve 2
b. Tryptophan is taken up by facilitated diffusion in curve 1 and by active transport in curve 2 with ATP providing the energy for uptake.
c. Tryptophan is taken up by active transport in curve 1 and no uptake in Curve 2 without available ATP.
d. KCN binds to tryptophan making it too big to diffuse through the membrane (curve 2).

7. A protein named PGP can be found in the membrane of kidney cells. PGP is known to be a membrane transporter of Metabolite X – but you don't know what type of transporter it is. To investigate this, kidney cells were placed in growth media containing Metabolite X, and the concentration of this metabolite was measured over time inside and outside the cells over a period of 30 minutes.

   From the following graph, interpret the data by answering the following questions.



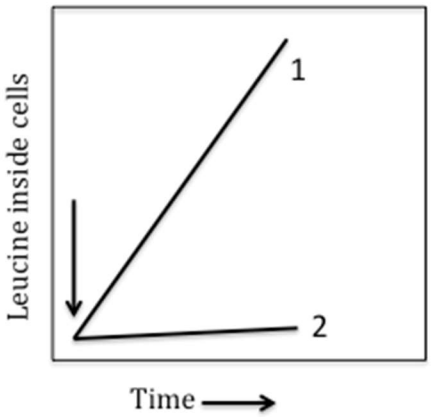
   a. Using the letter X to represent metabolite X, draw the relative concentrations of the metabolite at the initial time and later time:



   b. Based on the data, what type of transporter is PGP?

      Active transporter

8. The figure below shows two experiments of the uptake of leucine into the bacterium *E.coli* measured using the method described in the lectures. Leucine was added at the arrow. The two curves show the uptake at two different temperatures, 35° for curve 1, and 15°C for curve 2.



a. What do the data show?

In Curve 1 cells at 35°C, uptake of Leucine is linear with time.

In Curve 2 cells at 15°C, there appears to almost no (or very little) uptake of Leucine over time.

a. What inference can you draw from the data shown?

The cell membrane is more permeable to leucine at the higher temperature.

Topic:

Proteins - Structure and self-assembly

This topic focuses on one of the major macromolecules that function in a cellular environment, proteins. Here we discuss the biochemical and thermodynamic principles that underlie protein structural assembly.

- **List** the various roles of proteins in cellular activities.
- **Draw** the generic structure of an amino acid and **identify** the key functional groups.
- **Recognize** a peptide bond between amino acyl residues in a polypeptide (be able to circle it on a structure).
- **Classify** amino acids on the basis of the hydrophilic/ hydrophobic properties of their side chains (R-groups).
- **Distinguish** between primary, secondary and tertiary structure of polypeptides and the molecular interactions that give rise to them.
- **Predict** the location of different types of amino acids within a protein's folded structure based on their R-group features.
- **Define** protein denaturation, and **predict** the effects of protein denaturation on structure and function.
- **Predict** the effects of changing amino acids on protein structure and function.
- **List and evaluate** the factors contributing to correct protein folding.

Study questions:

1. Look at figure 4.2. Based on the structures, what is the strongest type of non-covalent bond that the polar amino acid side chains can participate in with each other? (The table on Connect "Chemical bonds for biology" may be helpful here.)

a. Ionic bonds
b. Ion – Permanent-dipole
c. Permanent-dipole – Permanent-dipole
d. Permanent-dipole – Induced-dipole
e. Induced-dipole – Induced-dipole

2. Look at figure 4.3. What is the best description of this figure?

a. Peptide bonds are formed by the carboxyl group of both amino acids being covalently linked by sharing electrons.
b. Peptide bonds are formed by the carboxyl group of one amino acid being covalently linked to the amino group of another amino acid.
c. Peptide bonds are formed by the carbon attached to R-group being covalently linked to the next R-group.
d. Peptide bonds are formed by the central carbon atom in an amino acid being covalently linked to 4 groups.
e. Peptide bonds are formed by a nitrogen and a carbon within one amino acid being covalently linked.

3. Look at figure 4.6 and 4.7. Which statement(s) are true about protein secondary structure? (Choose any/all that apply)

1. They form as a result of repetitive H-bonds between two carbonyl groups of the peptide bond
2. They form as a result of repetitive H-bonds between the carbonyl oxygen of one amino acyl residue and the hydrogen on the amide group of another.
3. They form as a result of repetitive H-bonds between the peptide bond groups and the adjacent R-groups.
4. They form as a result of repetitive H-bonds between R-groups
5. One type is an α – helix
6. One type is a β-pleated sheet

4. Tertiary structures of proteins results from which of the following interactions? (Choose any/all that apply)

1. Non-covalent interactions between the backbone and the R-groups
2. Non-covalent interactions between the R-groups
3. Covalent bonds between the backbone and S-containing R-groups
4. Covalent bonds between two S-containing R-groups

Exam Type Questions:

1. Conditions of low pH (which means that the hydrogen ion (H^+) concentration is increased) will affect amino acids and proteins. For some amino acids, side chains that were negatively charged at neutral pH may become neutral and for other amino acids side chains that were neutral may become positively charged. These effects might contribute to altering the tertiary and quaternary structures of a protein by which of the following mechanisms?

1. Breaking of peptide bonds.
2. Changing the ionic interactions.
3. Making new Induced Dipole-Induced Dipole (van der Waals) interactions
4. Changing the amino acid sequence.
5. Causing charge repulsion.

a. All 5 probably contribute.
b. 1, 2, 3, 4 probably contribute.
c. 2 and 5 probably contribute.
d. 3 and 4 probably contribute.
e. 1, 3 and 4 probably contribute.

2. You are given the amino acid sequence of a protein. All 20 of the common amino acids are present in the protein. Which statements are most likely to be correct when considering the final conformation this protein will assume?

1. H bonds between the atoms of the amino acid R groups will help stabilize the 3° structure.
2. An alpha helix will form within the protein.
3. In the 3° structure a disulphide (S-S) bond will form between 2 cysteine residues, which will stabilize the 2° structure.
4. 2° structures form as a result of repetitive H-bonds between the backbone groups of the polypeptide.
5. The 1° structure will determine if a beta pleated sheet will form.

a. 2, 4 and 5 only
b. 1, 3 and 5 only
c. 2 and 3 only
d. 1, 4 and 5 only
e. 3 and 5 only

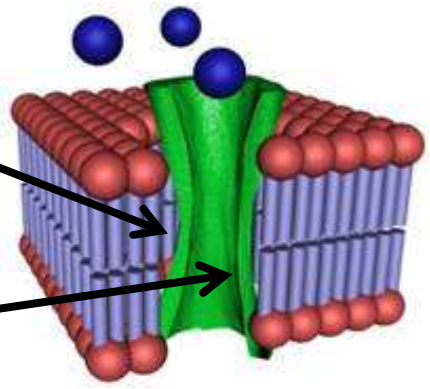
3. Imagine that leucine is in the hydrophobic region of a particular protein. By mutation, one of the other amino acids is substituted in place of that leucine. Which substitution would have the least effect? *(See the chart of amino acids in your textbook – amino acid structures will be provided on exam)*.

a. Asparagine
b. Valine
c. Aspartic acid
d. Glutamic acid
e. Lysine

4. The green structure in the picture shown represents an outer membrane protein called a porin found in some bacteria. Porins are water channels that allow the transport of small ions or charged molecules.

9. The R-groups of the amino acids lining the outer surface of the porin spanning the lipid bilayer and making contact with the lipid tails, are likely to be:

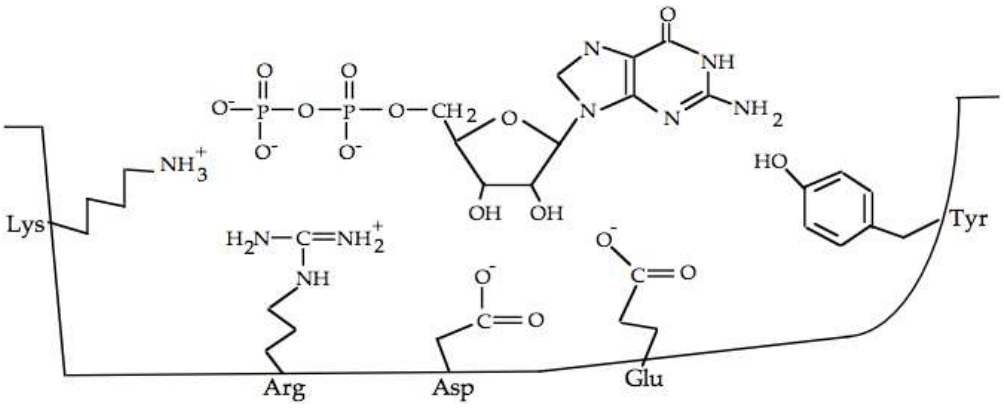
a. mainly polar and charged R groups.
b. an equal mix of charged and uncharged R groups.
c. mainly non-polar R groups.



10. **The R-groups of the amino acids lining the inner surface of the porin water channel are likely to be:**

a. mainly uncharged R groups.
b. an equal mix of charged and uncharged R groups.
c. mainly polar R groups.

5. In biology, non-covalent bonds are very important in stabilizing specific interactions between molecules. For example, the figure below shows a nucleotide interacting with a protein's amino acid side chains. The amino acids are labeled with their three-letter codes.



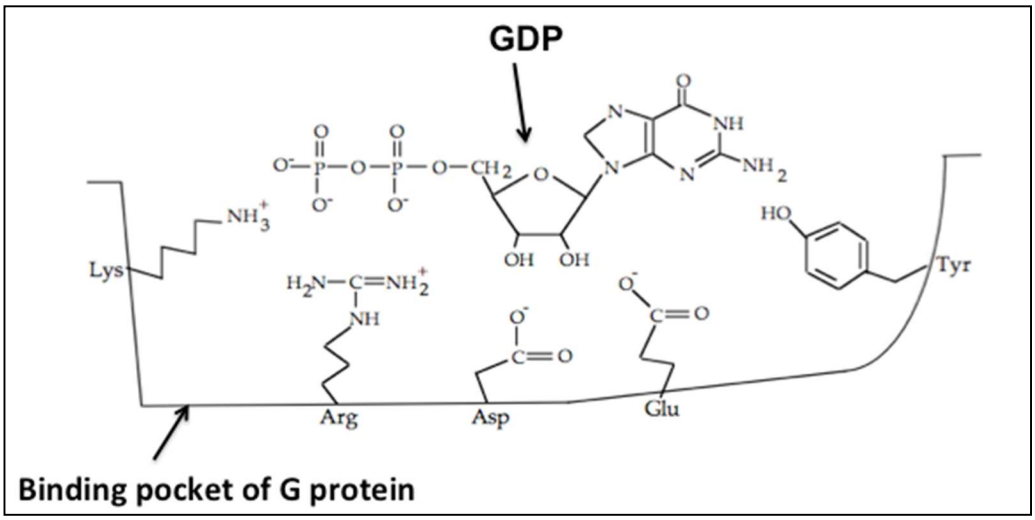
For each pair given below, draw (using dashed lines) the strongest type of non-covalent bond on the diagram. (If there is a 'tie' choose the closest interaction.)

a. The interaction between the side chain of Lys, and the phosphate group of the nucleotide. What type of non-covalent interaction is this? Ionic.

b. The interaction between the side chain of Glu, and the ribose group of the nucleotide. What type of non-covalent interaction is this? IPD

c. The interaction between the side chain of Tyr and the base of the nucleotide. What type of non-covalent interaction is this? PDPD.

6. The figure below shows GDP in the binding pocket of a G protein.



a) Name the most likely interaction that could occur between the side-chain of Lysine (Lys) in the binding pocket with the phosphate group of GDP? Ionic

b) You make single amino acid changes in the GDP-binding pocket of the G protein and examine their effects on the binding of GDP. Consider the nature (e.g. charge, polarity, hydrophilicity, hydrophobicity) of the amino acid side chains and give the **most likely** reason **why** each of the amino acid change has the stated effect.

Consider each amino acid change independently.

i. Arg is changed to a Lys, resulting in a G protein that still binds GDP.

Any statement that indicates the following explanation is acceptable:

Lys is +vely charged (just like Arg) and likely did not change the interactions in the region much.

ii. Lys is changed to a Glu, resulting in a G protein that cannot bind GDP.

Glu is –vely charged and this would lead to charge repulsion with Phosphate of GDP – which is likely preventing GDP from binding to G-protein.

Topic:

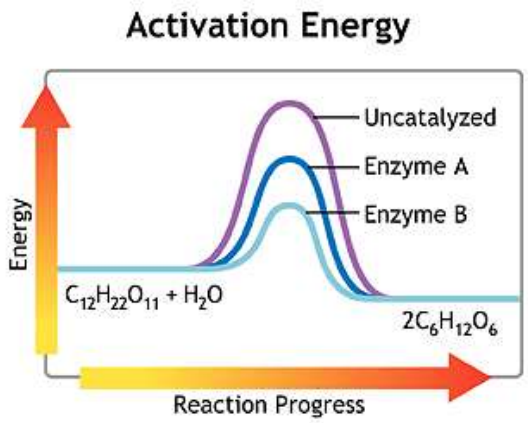
Proteins: Enzymes as reaction catalysts

Proteins can have many different functions in cells. This topic focuses on a subset of proteins that can function as enzymes.

- **Describe** in general terms how enzymes can increase reaction rates.
- **Contrast** the progress curve of an enzyme catalyzed reaction and uncatalyzed reaction.
- **Compare** competitive, non-competitive, allosteric enzyme inhibitions as a way of regulating enzyme activity.

Study questions:

1. The graph presents three activation energy profiles for a chemical reaction (the hydrolysis of sucrose): an uncatalyzed reaction, and the same reaction catalyzed by two different enzymes.



Rank these by reaction rate, as measured by the rate of product formation per unit time, from lowest reaction rate to highest reaction rate.

1. Uncatalyzed reaction
2. Reaction catalyzed by Enzyme A
3. Reaction catalyzed by Enzyme B

1. Which statement is true, regarding this reaction?

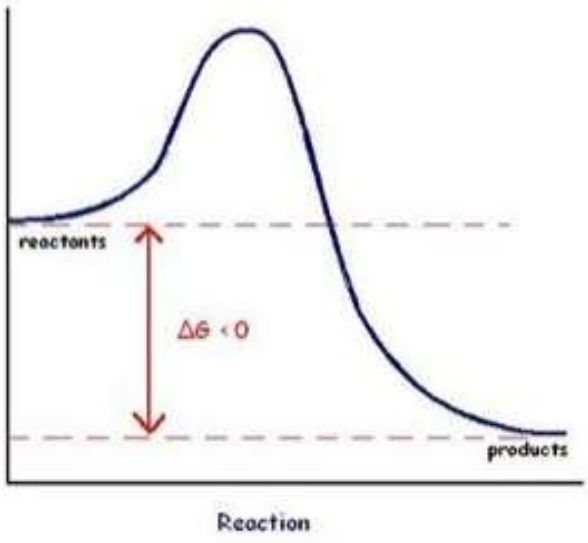
A + B → C Delta G > 0

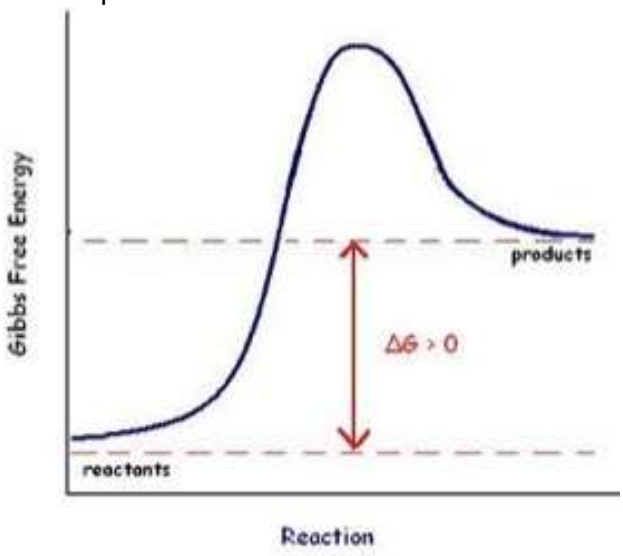
A. The reaction rate can be sped up by an enzyme only in the forward direction
B. The reaction rate can be sped up by an enzyme only in the backward direction.
C. The reaction rate can be sped up by an enzyme in either direction.

2. The two reaction curves shown below both represent two different un-catalyzed reactions. On each, draw the curve for the enzyme catalyzed reaction.

Reaction 1: **Reaction 2:**

For each curve, is the reaction spontaneous or non-spontaneous? Explain





Exam Type Questions:

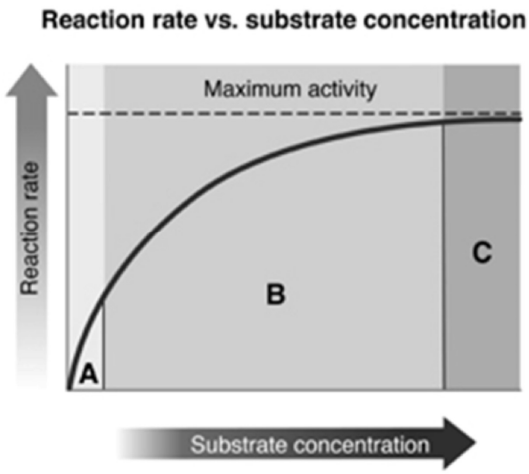
3. What is a transition state in an enzyme-catalyzed reaction?
   A. An interaction between reactants with high kinetic energy, due to high temperature.
   B. The complex formed as covalent bonds are being broken and re-formed during the reaction.
   C. The place where an allosteric regulatory molecule binds to an enzyme.
   D. The shape adopted by an enzyme that has an inhibitory molecule bound at its active site.
   E. The state that has the most stable delta G value compared to the reactants and products.

4. How does the presence of an enzyme affect whether a reaction is spontaneous or not?
   A. It makes the reaction more spontaneous
   B. It makes the reaction less spontaneous
   C. It increases the reaction free energy change
   D. It decreases the reaction free energy change
   E. None of the above

5. Look at the graph on the right, of reaction rate versus substrate concentration for an enzyme.

   In which region (A, B, or C) is the enzyme saturated with substrate?

   C



6. Enzymes work by _____.
   A. increasing the potential energy difference between reactant and product.
   B. decreasing the potential energy difference between reactant and product.
   C. decreasing the overall delta G of the reaction.
   D. decreasing activation energy.
   E. increasing the stability of the products.

7. A(n) _____ inhibitor has a structure similar to the substrate of an enzyme, where as a(n) _____ inhibitor does not need to have a structure similar to the substrate.
   A. competitive; reversible
   B. competitive; non-competitive
   C. non-competitive; irreversible
   D. reversible; irreversible
   E. non-competitive; competitive