BIO1140 Introduction to Cell Biology

Professor: Dr. Caroline Petit-Turcotte

Midterm Exam 1 – Version FF: Saturday February 4th, 2017

PLEASE DO NOT OPEN EXAMS UNTIL YOU ARE INSTRUCTED TO DO SO.

MAKE SURE YOU HAVE A COMPLETE EXAM PACKAGE – 1 QUESTIONNAIRE (14 PAGES) AND 1 SCANTRON SHEET

General Instructions:

1. This exam is worth 15% of your final mark.
2. You will have 1hour and 15 minutes (75 minutes) to write the exam.
3. Write your name and student number within the spaces provided on all 16 pages.
4. You should only have writing material, a Scantron and this exam on your desk, nothing else. Calculators are not permitted.
5. When you have finished, you may return your exam and leave the room. But please remain in your seat during the last 10 minutes.

Part A Instructions (20 marks): Multiple Choice.

1. Use pencil. On the Scantron, write down your exam version code (BIO1140FF) in the course code field. Also write your student number and name, and be sure to fill in the bubbles accordingly.
2. Indicate only one answer for each of the 20 multiple choice questions, directly on the computer scan sheet (Scantron). *Do not attempt to change an answer if you use ink*. This will be recorded as 'incorrect'. You will need a new Scantron sheet.
3. Please transfer all your answers to the Scantron sheet prior to the end of the exam. You will not be given extra time to do so and the proctors will not do it for you.
4. Follow instructions on the computer Scantron sheet.

Parts B-D Instructions (46 marks): Long Answers.

1. You may write in ink or in pencil. If you choose to answer in pencil, a remarking review may not be awarded and is at the discretion of the professor or course coordinator.
2. Please provide a written answer for all questions within the space provided. You may use point form as long as these points are clear and complete.
3. Marks will not be given for irrelevant or illegible writing. Organize your thoughts carefully.
4. You may use a diagram as an aid, but a diagram alone will not constitute a complete answer.

Cellular phones, unauthorized electronic devices or course notes are not allowed during this exam. Phones and devices must be turned off and put away in your bag. Do not keep them in your possession, such as in your pockets. If caught with such a device or document, the following may occur: academic fraud allegations will be filed which may result in you obtaining a 0 (zero) for the exam.

By signing below, you acknowledge that you have ensured that you are complying with the above statement.

Student Name: ____MARKING SCHEME_____/ Signature: _____

Student Number: _____

Student number: _____

Section A – Multiple Choice Questions (20 questions – 1 mark each)

Please transfer your answers, in pencil, to the Scantron sheet provided – <u>we will not transfer answers</u>

1. This is a question for pedagogical research purposes only and you will get 1 mark regardless of your answer. ***Please answer it honestly.*** Thank you.

For this exam I feel I am:

a) Absolutely ready

b) Somewhat ready

c) A little nervous

d) Pretty stressed

2. Which of these 4 statements is NOT a part of the cell theory?

a) Cells arise from division of pre-existing cells

b) Cells must have a nucleus

c) Organisms are made of one or more cells

d) Cells are the basic unit of all living organisms

3. In which type of microscopy are shifts in light phases converted to different brightness of sample in the image?

a) Phase-contrast

b) Fluorescence

c) Nomarski (Differential interference contrast)

d) Electron microscopy

4. Based on evidence gathered, scientists have been able to propose a chronological order for the appearance of life on Earth. Which of the following corresponds to the most plausible order?

a) Small inorganic molecules; protocells; prokaryotes; eukaryotes

b) Small protocells; archaea; multicellular prokaryotes; eukaryotes

c) Protocells; small inorganic molecules; prokaryotes; eukaryotes

d) Bacteria; mitochondria; amyloplasts; fungi

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5. The best technique to study the internal components of a lipid bilayer is:

a) FRAP

b) Enzymatic degradation

c) Electron microscopy

d) Freeze fracture

6. Which of these cellular roles is not carried out by the extracellular matrix?

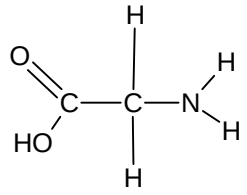
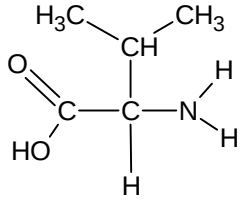
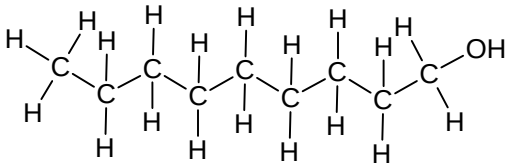
a) Pigment transportation

b) Recognition

c) Anchoring

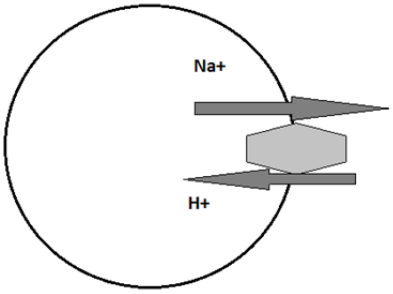
d) Signalling

7. Which of the following molecules has an asymmetric central carbon?

		
A	B	C

Student number: _____

8. In the following figure, how is H+ transported across the membrane?



a) Secondary antiporter

b) Secondary symporter

c) Primary active transport

d) Facilitated diffusion

9. Which of these statements is the most plausible scenario to explain how plant membranes can adapt to the hot temperatures in the summer?

a) Cell wall becomes thinner; cells are less insulated

b) Increase in saturated fatty acids; decrease in fluidity

c) Increase in unsaturated fatty acids; increase in fluidity

d) Increase in unsaturated fatty acids; decrease in fluidity

10. The plant cell wall is made of cellulose microfibrils, where many hundred chains of cellulose are aligned. This structure gains its strength with what type of chemical bond between the individual strands?

a) Ionic bonds

b) Hydrogen bonds

c) Covalent bonds

d) Van der Waal forces

e) There are no bonds used

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11. Which of these steroids is found in the membrane of plants?

a) Ergosterol

b) Cholesterol

c) Phytosterol

d) Aldosterone

12. Which of these junctions is sensitive to calcium concentration?

a) Tight junctions

b) Corner junctions

c) Gap junctions

d) Anchoring junction

13. Pinocytosis is an example of which type of membrane transportation?

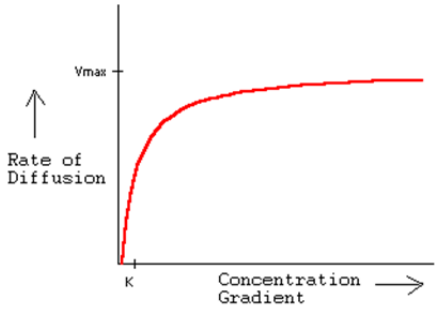
a) Exocytosis

b) Endocytosis

c) Co-transport

d) Passive diffusion

14. Using the figure below depicting the rate at which glucose is transported across the plasma membrane; determine which type of transport is being used.



a) Passive diffusion

b) Active transport

c) Co-transport

d) Facilitated diffusion

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15. Justify your answer to question 14:

a) Because the plasma membrane is highly permeable to glucose

b) Because there is no other concentration gradient besides glucose

c) Because the rate of diffusion eventually saturates

d) Because the cell runs out of ATP

16. Which of these atoms/molecules has the highest membrane permeability?

a) Cl^-

b) H_20

c) Urea

d) Glucose

17. It is thought that life developed initially in conditions where RNA (as ribozymes) acted as both an information carrier and a catalyst. Which of these statements best explains why current living organisms use DNA and protein rather than RNA to carry out those tasks?

a) Proteins are present in great numbers in most cells
b) DNA is made from RNA by changing the sugar component
c) Proteins are more efficient catalytically and DNA is more stable and better conserved
d) Proteins can recruit enzymes and DNA is a by-product of RNA

18. Where are eukaryotic ribosome subunits assembled?

a) Nucleus

b) Nucleolus

c) Lysosome

d) Golgi

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19. Which of the following statements is true? Animal tissues are composed of cells…

a) … packed tightly together, with plasma membranes of adjacent cells in direct contact with one another.

b) … with cell walls linked by channels to allow passage of certain molecules (e.g., water, cell signals).

c) … and intercellular space containing a complex matrix that may be liquid, solid, semi-solid, or elastic.

d) … and cytoskeletons secreted by specialized cells elsewhere in the body transported to appropriate types of tissue.

20. Which of the following is not one of the components of the extracellular matrix?

a) Pepsin
b) Proteoglycans
c) Glycosaminoglycans
d) Elastin

YOU HAVE COMPLETED SECTION A…CONTINUE TO THE NEXT PAGE FOR SECTION B

Student number: _____

Section B – General knowledge (Total 9 marks)

Please answer within the provided space – make sure your answer is clear and legible

1. Sort the following from smallest to largest: (there is only 1 correct answer – no partial marks – total 1 mark)

a. Ribosome

b. Plant cell

c. Virus

d. Chloroplast

e. Phospholipid

Smallest to largest order: 1. ____e_____ 2. ____c_____ 3. ____a_____ 4. ___d_____ 5. _____b_____

OR EACDB

1. Define the term *kleptoplasty* and provide an example: (2 marks)

Endosymbiotic/Symbiotic process during which one organism steals plastids from the other. (1 mark)

Example: sea slugs stealing chloroplasts from algae / Dinoflagelates steals plastids from algae. (1 mark)

2. Define the term *amphipathic* and provide a specific example of such a molecule. (2 marks)

A molecule that has both hydrophobic/non-polar and hydrophilic/polar areas (1 mark)

Examples: Any receptor, transporter, cytochrome, components of the Electron Transport Chain, etc. or phospholipids. (will not accept just lipids or fatty acids)

NOTE: integral or transmembrane proteins are not acceptable as question asks for a SPECIFIC molecule

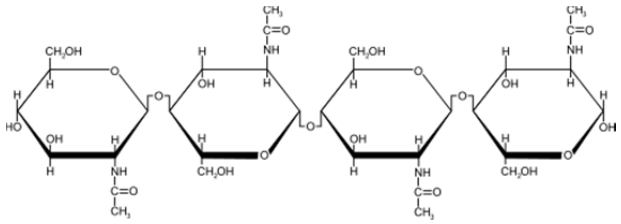
3. In order to transport a vesicle from the Golgi complex to the smooth ER, which a) motor protein **and** b) cytoskeletal fiber will be used? (2 marks)

a)_____Dynein_____

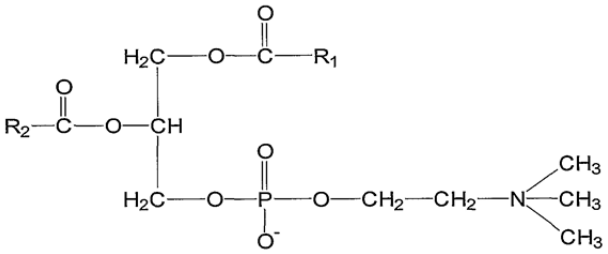
b)_____Microtubules_____

Student number: _____

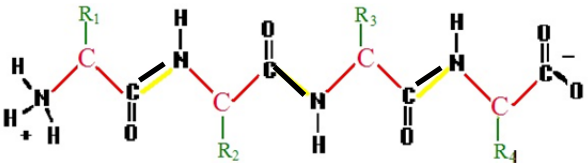
4. Identify which type (class) of macromolecules are represented below (be as precise as you can): (2 marks)

A) 

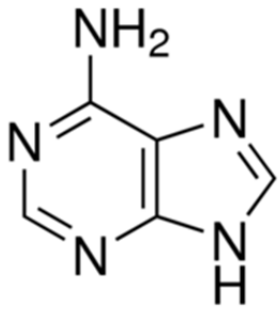
Polysaccharide OR carbohydrate OR oligosaccharide

B) 

__ phospholipid OR phosphatidylethanolamine ___

C) 

____ peptide OR polypeptide OR protein OR chain of amino acids OR amino acid sequence ___

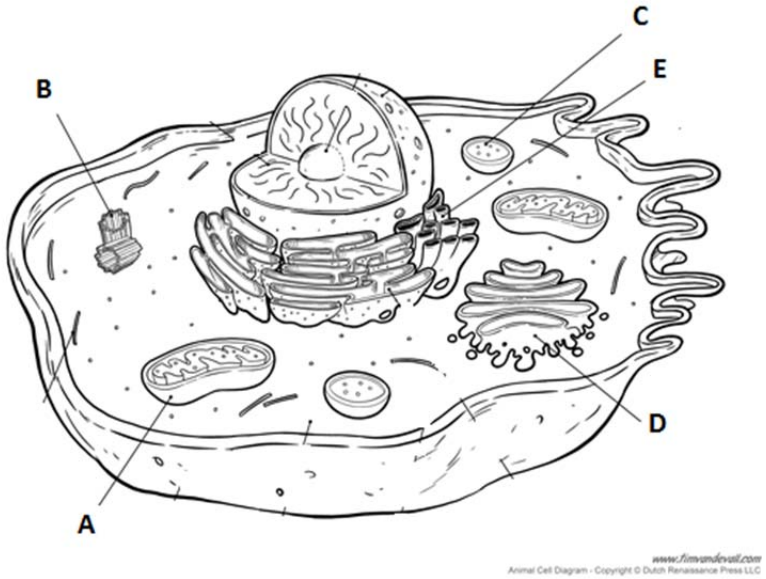
D) 

_____ Purine OR nucleic acid OR nitrogenous base _____

Student number: _____

Section C – Fill in the blanks / Associate (27 marks)

1. Identify the labelled structures and provide a brief description of their main role in the cell: (5 marks)



	Name	Role **(needs to match name to receive 0.5 mark)**
A	mitochondrion	Cellular respiration OR ATP production OR metabolic regulation OR produces energy aerobically OR metabolic and non-metabolic actions (NOT accepting powerhouse of the cell)
B	Centrosome OR centrioles	MTOC (microtubule organising centre) OR Mitosis OR cell division OR Basal bodies OR centre of cytoskeleton organisation
C	Lysosome OR Peroxisome	Lysosome: Autophagy OR heterophagy OR degradation/digestion Peroxisome: enzymatic degradation / anti-oxidation
D	Golgi (apparatus/complex)	Post-translational modifications OR protein sorting OR protein modification/maturation OR protein packaging
E	**Smooth** endoplasmic reticulum **note: no marks for ER**	Lipid synthesis OR detoxification

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2. Provide two ways the plasma membrane can maintain its asymmetry: (2 marks)

Each bullet worth 1 mark (maximum of 2 marks)

- Different ratios of phospholipids on both leaflets (e.g. more Phosphatidylserine on inner leaflet)
- and presence of glycoproteins and glycolipids
- integral proteins
- Many types of phospholipids are distributed throughout leaflet – maintained by lateral diffusion, translocation (flip flop) – and with varying lengths and degrees of saturation of the fatty acid chains thanks to desaturase enzyme
- Varying amount of cholesterol introduced or removed in each leaflet

3. The plasma membrane has multiple roles in cells. Choose and name 2 of those roles and for each explain what properties or features of the membrane allow it to carry out that specific role. (4 marks)

Pick out of these possible answers:

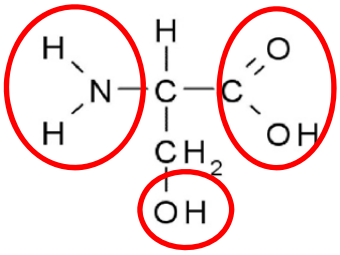
Roles of membranes (1 mark)	**Properties / Features (needs to match role to receive 1 mark)**
Boundary OR selective permeability	Diversity in lipid and protein content OR Fluidity, OR diffusion, OR asymmetry OR phospholipid properties (chain length, saturation, etc.)
Organize OR scaffold	Organelles OR functional compartmentalisation
Regulate transport OR transport	Mechanisms using channels OR transporters OR pumps OR porins
Receive signals OR signalling	Receptors for signal detection OR integral/transmembrane proteins OR cell juntions
Communication OR recognition	Cellular junctions (Gap junctions OR plasmodesmata) OR glycolipids/glycoproteins

Protection is NOT a role of the plasma membrane

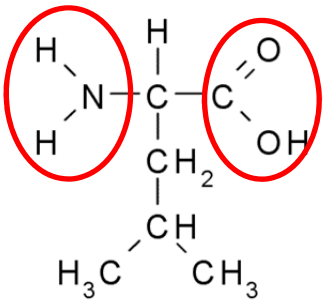
Student number: _____

4. Compare the two molecules below. (4 marks)

A:



B:



a) Identify on each molecule **any/all areas** that contribute to its polarity. You can highlight, circle, point with an arrow. However, ensure that it is CLEARLY labelled. (1 mark)

b) Which of the molecules above (labelled A and B) is the MOST polar? (1 mark)

Circle your answer: A or B

c) Explain your choice of the most polar molecule by <u>comparing</u> them to each other (2 marks):

Only A has a electronegative atom (O), or hydroxyl group, in the radical group (compared to the carbon chain in B) (1 mark)
This results in an uneven distribution of charge and polarity for this amino acid (A) (1 mark)

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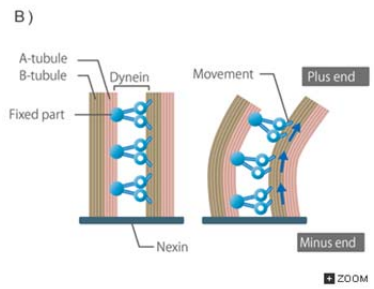
5. A mouse has been designed so that it cannot express the gene for nexin. With the help of a structural description, explain what will be the consequences of no longer producing this cross-linking protein. You can use a drawing to assist you in your answer, but make sure it is appropriately labelled. (5 marks)



In the absence of nexin, the microtubule doublets are not linked with each other in cilia/flagella.
As dynein uses one doublet as its cargo and 'walks' on the next doublet in the 9+2 structure, it will result in both doublets sliding apart from each other rather than exerting the bend required for cilia and flagella to accomplish their motion.

Elements needed in answer (each worth 1 mark):

- Structure of cilia or flagella (9+2 microtubule doublets)
- Dynein is the molecular motor exerting the force to accomplish movement and one end attached to one doublet and other end attached to other doublet.
- Nexin is the cross linker and keeps the doublets anchored together
- In absence of nexin doublets slide apart
- Movement of cilia or flagella is not accomplished (0.5 marks) – if cilia, immediate surroundings are not swept away, if flagella, organism or cell cannot propel itself (0.5 marks)

6. You wish to <u>localize and quantify</u> a specific protein, *titin*, which is found in the contractile unit of skeletal muscles (the sarcomere). You have the choice between various chemical markers or antibodies to label the protein. You have other experiments to conduct with this sample after your observations. Which microscope would be best suited for you to achieve your objective? Briefly justify your answer. (3 marks)

- Fluorescence / confocal microscopy (1 mark)
- The magnification is sufficient to visualize cellular compartments/organelles where we expect to find our protein. (1 mark)
- This technique allows you to: (0.5 marks each for a maximum of 1 mark)
    - specifically label different proteins in cells (using different fluorescent probes/markers),
    - visualize their location and
    - interaction with other macromolecules,
    - while keeping the integrity of the cells

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7. Using any 2 lines of evidence, explain why the Theory of endosymbiosis is the most plausible hypothesis for the appearance of eukaryotes. (4 marks)

Each line of evidence is worth 2 marks (need to mention both organelles for full marks):

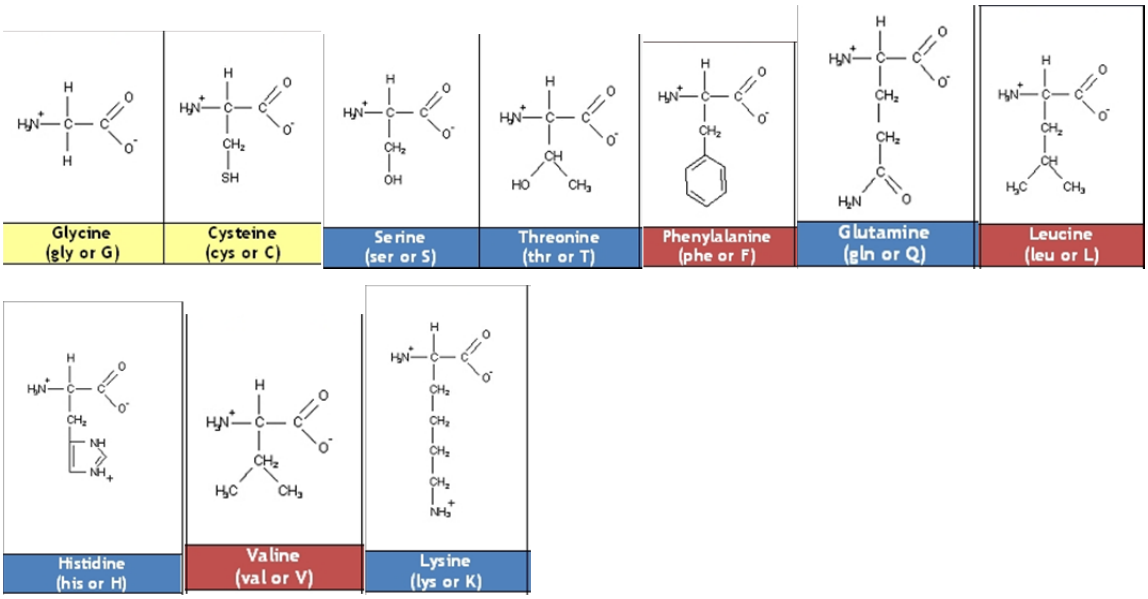
- Morphology: shape and size are similar; cyano/bacteria (chloroplast) or proteobacteria (mitochondria)
- Ability to reproduce by binary fission (prokaryotes and these organelles)
- Have a proper Genome – cpDNA and mtDNA
- Ability to accomplish transcription and translation
- ETC / double membrane / produce own energy
- Sequence – coincides with cyanobacteria and proteobacteria

Continue on to next page for the last question

Student number: _____

Section D – Long answer question (10 marks)

1. Using these 10 amino acids as building blocks, propose a sequence for an **integral protein**. Your sequence must have a transmembrane portion of a length of 6 amino acids, and you must have at least 2 amino acids inside **and** 2 amino acids outside the cell. **Draw and label your polypeptide with respect to the plasma membrane** (you can use abbreviations and you do not need to draw the molecular structures). **Be sure to clearly label ALL elements of your drawing.**



Many sequences possible; There MUST be a drawing

Diagram must clearly identify the portion of the peptide that is outside the membrane, on the outside of the cell (i.e. extracellular), and on the inside of the cell (i.e. intracellular), as well as the portion that is located within the membrane (ie transmembrane)

1 mark for labelling each region of the cell and the membrane (outside/extracellular, within membrane, inside cell/intracellular)
Within each region of an integral protein (**other protein types will not be awarded marks**):
1 mark for diagram and labelling of amino acids (must be clear that it is supposed to be a particular amino acid)
1 mark for the proper placement of amino acids in intra/extracellular locations; 2 marks for proper placement of amino acids in membrane. (Deduct 0.5 marks for each incorrectly located amino acid or amino acid that is missing (for a max of -1 for intra/extracellular location and -2 for in membrane)
Possible intra/extracellular amino acids; Cysteine, Serine, Threonine, Glutamine, Histidine, Lysine
Possible amino acids within the membrane; Glycine, Cysteine, Phenylalanine, Leucine, Valine

Cysteine can be considered a polar OR non-polar amino acid

You have completed the first midterm exam!