BIO1140 Introduction to Cell Biology

Professor: Dr. Caroline Petit-Turcotte

Midterm Exam 1 – Version FF: Saturday February 14th, 2015

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 14 pages.
4. You should only have writing material and this exam on your desk, nothing else.
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 scan 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 (67 marks): Long Answers.

1. You may write in ink or in pencil. If you choose to answer in pencil, a marking 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.

Good luck!

Student Name: ___CORRECTION KEY_____

Student Number: _____

Vs FF Student number: _____

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

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

1. I was the first to coin the term *Cellulae* after looking at cork under a microscope. Who am I?

a) Anton Van Leeuwenhoek

b) Robert Hooke

c) Rudolph Virchow

d) Robert Brown

e) Cupid

2. Which of these 4 statements is NOT a tenet 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 is the sample illuminated at an angle?

a) Bright field

b) Fluorescence

c) Dark field

d) Confocal

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

a) Fluorescence Recovery after Photobleaching (FRAP)

b) Enzymatic degradation

c) Electron microscopy

d) Freeze fracture

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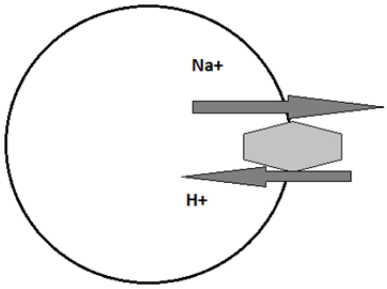
5. In the following figure, how is H+ transported across the membrane?



a) Secondary antiporter

b) Secondary symporter

c) Primary active transport

d) Facilitated diffusion

6. How could a trout adapt to a rapid decrease in temperature in order to retain membrane fluidity?

a) Change the ratio of PC/PE

b) Increase the amount of desaturase

c) Reduce the amount of desaturase

d) Both a and c are correct

e) Both a and b are correct

7. Using the figure below, which depicts 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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8. Justify your answer to question 7:

a) Because the plasma membrane is 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

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

a) Ergosterol

b) Cholesterol

c) Phytosterol

d) Aldosterone

10. During cellular respiration in eukaryotes, which step does not take place in the mitochondria?

a) Oxidative phosphorylation

b) The citric acid cycle

c) Fatty acid oxidation

d) Glycolysis

11. ATP synthesis using the F-pump ATP synthase takes place where?

a) The matrix

b) The outer mitochondrial membrane

c) The intermembrane space

d) The inner mitochondrial membrane

12. Which of these choices is NOT used for calcium storage?

a) Binding proteins

b) Endoplasmic reticulum

c) Mitochondrion

d) Lysosome

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

a) Pigment transportation

b) Recognition

c) Anchoring

d) Signalling

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

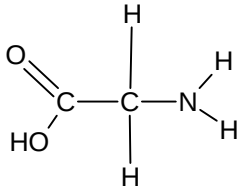
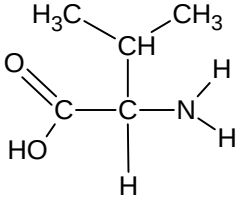
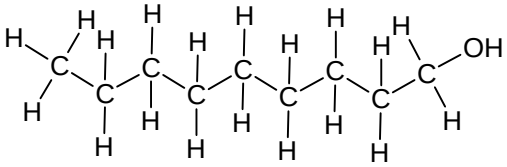
a) Tight junctions

b) Corner junctions

c) Gap junctions

d) Anchoring junction

15. Which of the following molecules has an asymmetrical carbon?

		
A	B	C

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

a) Exocytosis

b) Endocytosis

c) Co-transport

d) Passive diffusion

17. Which of these statements about photosynthesis is NOT correct?

a) Allows capturing photons of light and converting them to chemical energy

b) Allows capturing photons of light and creating functional macromolecules

c) Is only present in plants

d) Needs both H_20 and CO_2

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18. Which of these statements about chemiosmosis is incorrect?

a) It is only useful for ATP synthesis in mitochondria

b) It harnesses the energy produced by the proton-motive force

c) It is dependant upon availability of ADP and H^+ ions

d) It is a unidirectional process in the membrane

19. Which of these molecules has the highest membrane permeability?

a) Cl^-

b) H_20

c) Urea

d) Glucose

20. Which of these structures is the smallest in terms of scale?

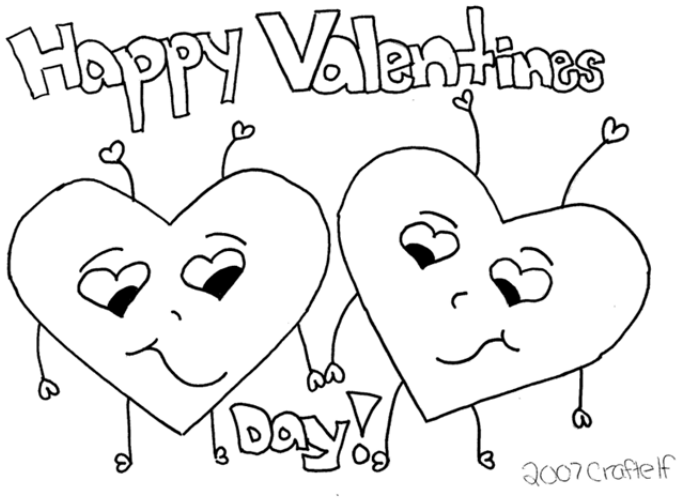
a) Virus

b) Eukaryotic cell nucleus

c) Ribosomal subunit

d) *Escherichia coli*

Continue to the next page for short answer questions – sections B to D



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Section B – Short answers (1 mark each – Total 5 marks)

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

1. Within which organelle can you find granum?

_____chloroplasts_____

2. Define the term Kleptoplasty:

Symbiotic process during which one organism steals plastids from the other. (1 mark)
For example sea slugs stealing chloroplasts from algae (0.5 marks)
Maximum 1 mark

3. Integral proteins are amphipathic. What does this mean?

A protein that spans the membrane (0.5 marks) and as such has both hydrophobic/non-polar and hydrophilic/polar areas (0.5 marks)

4. What makes the rough endoplasmic reticulum *rough*, and what function does it serve in a cell?

The presence of ribosomes on the membrane. (0.5 marks)
The rough ER is responsible for protein translation (accept synthesis) (0.5 marks)

5. Which organelle is responsible for synthesis of ribosomal RNA?

_____nucleolus_____

Section C – Fill in the blanks / Associate (1 mark each – total of 50 marks)

Vs FF Student number: _____

1. Complete the following sentences using the most appropriate term: (11 marks)

a. Polysaccharides are formed by long chains of monosaccharides; α-glucose units joined end to end in 1,4 linkages can form __amylose (0.5 for starch)____, the basic energy storage form used in plants. However, when the hydroxyl groups are on __opposite/different_ sides of the plane formed by the glucose carbon ring, we obtain the ___beta___ arrangement for glucose. Linking these together can produce ___cellulose_____ which is found in the cell wall of plants.

b. A triglyceride is a macromolecule formed by adding three ____fatty acid (2 marks)_____ _____ chains to a _glycerol_____ backbone.

c. __Nucleotides/nucleic acids _____ are macromolecules formed by joining a ___nitrgenous____ base, a deoxyribose molecule and a ___phosphate____ group. There are four possible conformations and when joined together to form polymers, they will make up the most famous double helix, ____DNA_____.

2. Your favorite cell incorporates a membrane receptor and wishes to transport the vesicle formed containing it towards degradation. Name (a) the process the cell will use to internalize the receptor, then which (b) motor protein will carry this vesicle on the microtubules and finally, to which organelle (c) it will deliver it: (3 marks)

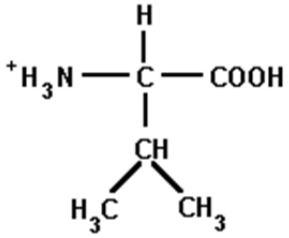
a) _____ (receptor mediated -optional) endocytosis_____

b) _____dynein_____

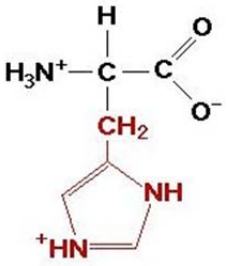
c) _____lysosome_____

Vs FF Student number: _____

3. Compare the two following amino acids. Discuss their polarity and the impact they could have on the structure of a peptide. (4 marks)



Valine



Histidine (His)

Valine has a radical group that evenly shares electronegativity (0.5) and so, it is a non polar amino acid (1), while histidine has higher electronegativity (0.5) and therefore an uneven distribution of electrons, due to the NH group that is charged and so is a charged polar amino acid (1).

Polar aa such as histidine tend to be part of soluble, flexible secondary structures such as alpha helix (0.5), while non polar aa such as valine tend to be part of more rigid secondary structures such as beta pleated sheets (0.5). If only rigidity discussed correctly 0.5 marks. Supercoiling acceptable for full marks.

Both of these aspects must be directly compared for full marks. If a particular aspect is not directly compared with its partner, deduct 0.5 marks (maximum -1 overall).

4. What properties or features of the plasma membrane allow it to carry out its five basic roles:

(5 marks)

(0.5 marks for each element in table)

Roles of membranes	**Properties / Features (needs to match role to receive marks)**
Boundary – selective permeability	Diversity in lipid and protein content – Fluidity, diffusion
Organize and scaffold	Organelles / functional compartmentalisation
Regulate transport/ transport	Mechanisms using channels, transporters, pumps, porins
Receive signals/signalling	Receptors for signal detection, integral proteins
Communication/recognition	Cellular junctions (Gap / plasmodesmata) / glycolipids

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5. Complete the following table by adding the name of the organelle or describing the role: (5 marks)

1 mark for each element in table

Organelle / Structure	Function / Role
Nucleoporins / Nuclear pore complex	A protein-based path that mediates the exchange of molecules between the nucleus and cytoplasm.
Mitochondria	Double membrane organelle responsible for metabolic and non metabolic activities in the cell, ex. cellular respiration (0.5 marks for metabolic and non-metabolic roles)
Central vacuole	Held together by tonoplast, regulates turgor of the cell, as well as degradation and detoxification activities.
Smooth endoplasmic reticulum	Extensive network of interconnected membrane channels; responsible for lipid synthesis and detoxification Lipids (0.5)
Golgi complex/apparatus	Series of membrane folds, usually entered by the cis face and exited by the trans face, where many chemical modifications to proteins occur.

6. Associate the following structures with the given sizes: (2 marks)

0.5 marks for each element

Structures	Sizes (write the letter corresponding to appropriately-sized structure)
A. Nucleus	_C__ 0.2 nm
B. Eukaryote	__D__ 0.13 m
C. Ribosome	__A__ 5000 nm
D. Ostrich egg	_B__ 0.05 mm

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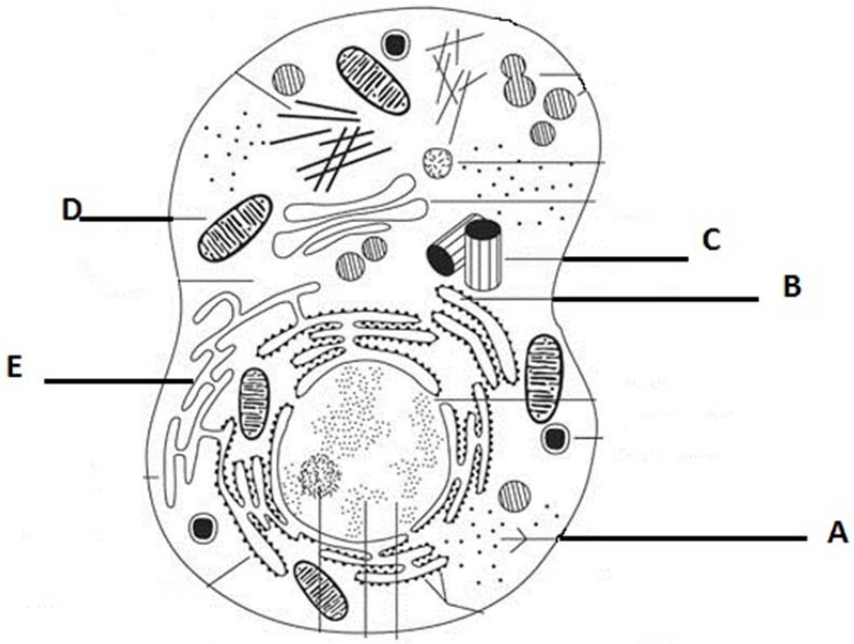
7. Identify the structures marked by an arrow: (Total 5 marks)



A	Ribosomes
B	Rough ER
C	Centriole / Centrosome
D	Mitochondria
E	Smooth ER

8. Explain how the Theory of Endosymbiosis applies to chloroplasts? (2 marks)

1 mark for each of the following elements. Max of 2 marks. Prokaryote engulfs chloroplast Genome – cpDNA Size / morphology ETC / double membrane Sequence – coincides with cyanobacteria

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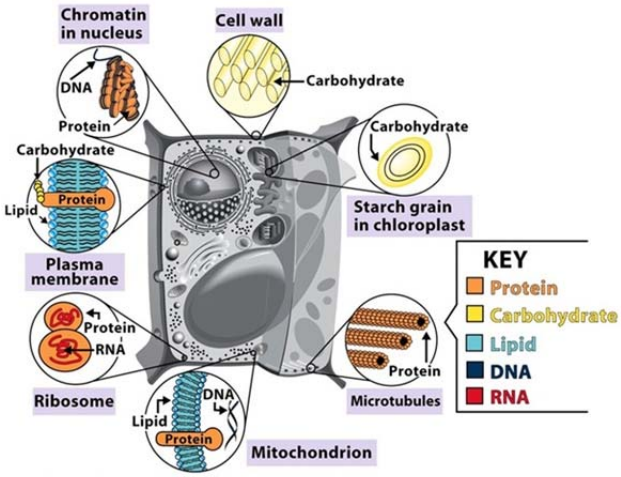
9. Complete the following table, identifying for each of these macromolecules, where they would be synthesized in the cell and in what location they accomplish their role: (5 marks)

0.5 marks for each element

Macromolecule	Synthesis	Functional location
Albumin (soluble protein)	Cytosolic ribosomes	Cytosol
Keratin	Rough ER	Intermediate filaments
Pyruvate dehydrogenase	Rough ER	Outer mitochondrial membrane
Steroids	Mitochondria (accept smooth ER)	Plasma membrane
Ribosomal RNA	Nucleolus	Ribosomes

10. Name two macromolecules important in cell biology and give an example of how they interact with each other: (2 marks)

Many possible answers here;



- DNA and protein – interact to form chromatin in nucleus; translation, replication
- RNA and protein – transcription, virus capsule
- Protein and carbohydrate – glycoproteins in cell membrane
- Protein and lipids – GPI anchored proteins, transmembrane proteins in cell membrane

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11. Compare and contrast motility using cilia and flagella. (6 marks)

0.5 marks per element in table. Stating only length, location or 9+2 is not acceptable for marks.

Characteristics	Cilia	Flagella
Structure	Multiple short structures (9+2 complex of microtubule doublets)	Single long structure (9+2 complex of microtubule doublets)
Movement of structure	Whiplike (oarlike) back and forth movement	Smooth s-wave from base to tip
Direction of movement	Away from the cell surface	Away from origin
End result	Moves extracellular content on cell surface away from cell (eg mucus, liquid, substances)	Propels the cell away from the movement imposed (displaces the cell in environment)
Number	Many	Few

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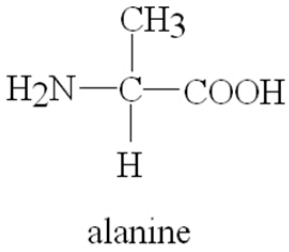
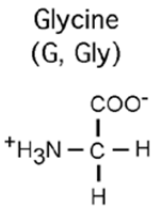
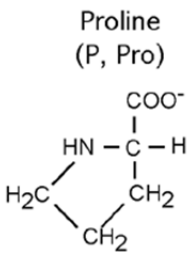
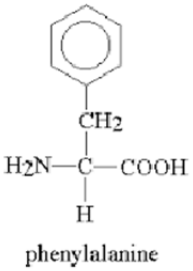
Section D – Long answer questions (12 marks)

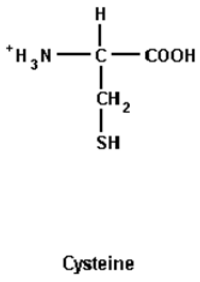
1. Using these 10 amino acids as building blocks, propose a sequence for an integral protein. Your sequence must have a transmembrane portion of a length of 6 amino acids, and you must have at least 2 amino acids inside and outside the cell. Draw your polypeptide sequence within the membrane. Elements of your diagram must be clearly labelled. (9 marks)

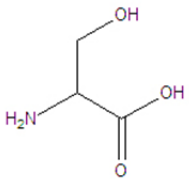


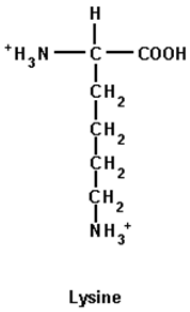


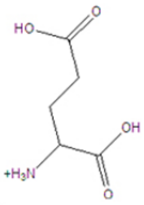


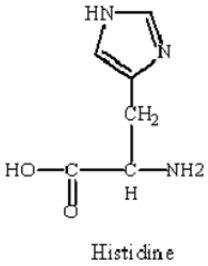


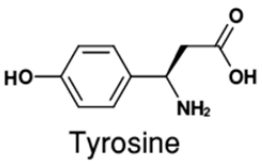












Many sequences possible;

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

1 mark for labelling each region of the cell and the membrane (outside/exracellular, within membrane, inside cell/intracellular)
Within each region:
1 mark for diagram and labelling of amino acids (must be clear that it is supposed to be a particular amino acid) (-0.5 marks if minimum number of amino acids in each portion of protein not present)
and
1 mark for the proper placement of amino acids. Deduct 0.5 marks for each incorrectly located amino acid (for a max of -1 for each location)
Possible intra/extracellular amino acids; serine, tyrosine, glutamic acid, histidine, lysine, cysteine
Possible amino acids within the membrane; Alanine, Glycine, phenylalanine, cysteine, proline

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

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2. You have just isolated a protein from heart cells. You want to determine where it is located within the cells, and what macromolecules it interacts with, in order to determine the function of this lovely protein. Propose 3 things that you could do **experimentally** to try and solve this mystery. (3 marks)

Possible answers; 1 mark each (max of 3 marks)

- Microscopy (each type counts as separate answer)
- Centrifugation
- FRAP
- Freeze fracture and electron microscopy
- Membrane transport – inhibition, saturation, assess rate of diffusion
- Sequence analysis
- Isolate proteins and examine their interactions (0.5 marks)
- Staining/GFP/fluorescence used to identify/label protein of interest (0.5 marks)

You have completed the first midterm exam. Enjoy Reading Week!