BIO1140 Introduction to Cell Biology
Professor: Dr. Caroline Petit-Turcotte
Midterm Exam 1 – Section A: Tuesday February 6th, 2018
PLEASE DO NOT OPEN EXAMS UNTIL YOU ARE INSTRUCTED TO DO SO.

MAKE SURE YOU HAVE A COMPLETE EXAM PACKAGE – 1 QUESTIONNAIRE (13 PAGES) AND 1 SCANTRON SHEET

General Instructions:

1. This exam is worth 12.5% 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 13 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.

Part A Instructions (20 marks): Multiple Choice.

1. **Use pencil.** On the Scantron, write down your exam version code (**BIO1140A**) 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 scantron sheet.

Part B Instructions (55 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!

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: You will be asked to leave immediately the exam, 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: _____

Section A - 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. 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 definition is most appropriate to define a cell?

a) A living organism with chemical properties

b) A living system divided into several reigns

c) The smallest structural and functional unit of the living

d) An organism capable of producing its own energy

3. Which definition best describes a virus?

a) A cell that has a nucleus containing DNA and whose organelles are surrounded by a plasma membrane.

b) A cell without a nucleus and specialized organelles.

c) An infectious agent that is an obligate parasite.

d) An infectious agent composed entirely of proteins.

4. What technique would be most appropriate to use to observe the movements of condensed chromosomes during cell division?

a) light microscopy

b) scanning electron microscopy

c) transmission electron microscopy

d) super-resolution fluorescence microscopy

5. A primary objective of cell fractionation is to:

a) view the structure of cell membranes.

b) sort cells based on their size and weight.

c) determine the size of various organelles.

d) separate the major organelles so that their particular functions can be determined.

e) separate lipid-soluble from water-soluble molecules.

6. 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

7. Which of the following is a major cause of the size limits for certain types of cells?

a) limitation on the strength and integrity of the plasma membrane as cell size increases

b) the difference in plasma membranes between prokaryotes and eukaryotes

c) evolutionary progression in cell size; more primitive cells have smaller sizes

d) the need for a surface area of sufficient area to support the cell's metabolic needs

e) rigid cell walls that limit cell size expansion

8. The nuclear lamina is an array of filaments on the inner side of the nuclear membrane. If a method were found to cause the lamina to fall into disarray, what would you expect to be the most likely consequence?

a) the loss of all nuclear function

b) the inability of the nucleus to divide during cell division

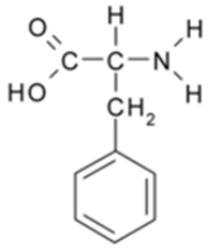
c) a change in the shape of the nucleus

d) failure of chromosomes to carry genetic information

e) inability of the nucleus to keep out destructive chemicals

Section A - Student number: _____

9. Choose the correct association for the following molecule;



a) Carbohydrate; nonpolar

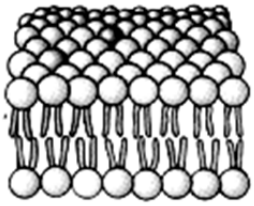
b) Amino acid; acidic

c) Amino acid; polar

d) Carbohydrate; basic

e) Amino acid; nonpolar

10. The most abundant molecules in this structure are:



a) structural proteins.

b) polysaccharides.

c) triacylglycerols.

d) phospholipids.

e) polypeptides.

11. In the extracellular matrix of animal cells, there are different molecular components. One in particular acts as a link between the transmembrane proteins and the matrix, specifically to collagen. Choose the correct answer:

a) Vimentin

b) Integrin

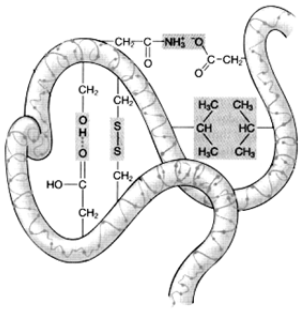
c) Fibronectin

d) Cholesterol

e) Proteoglycans

Section A - Student number: _____

12. All of the following types of chemical bonds are responsible for maintaining the tertiary structure of this polypeptide *except*:



a) ionic bonds.

b) hydrogen bonds.

c) hydrophobic interactions.

d) disulfide bonds.

e) peptide bonds.

13. A rapid drop in lake temperature takes a colony of frogs by surprise. How will their membranes immediately adjust to retain adequate 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

14. Which of these sterols is found in the membrane of animals?

a) Ergosterol

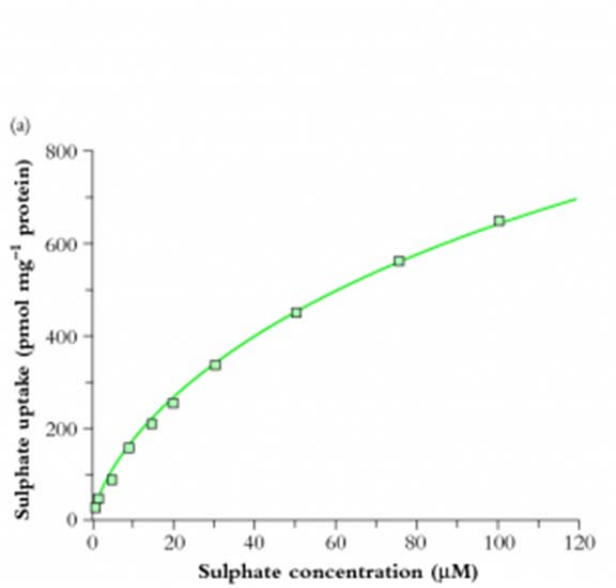
b) Cholesterol

c) Phytosterol

d) Aldosterone

Section A - Student number: _____

15. Using the figure below, which depicts the rate at which sulphate is transported across the plasma membrane, determine which type of transport is being used.



a) Passive diffusion

b) Active transport

c) Osmosis

d) Facilitated diffusion

16. Justify your answer to question 15:

a) Because the plasma membrane is permeable to sulphate

b) Because there is no other concentration gradient besides sulphate

c) Because the rate of diffusion eventually saturates

d) Because the cell runs out of ATP

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

a) Pigment transportation

b) Recognition

c) Anchoring

d) Signalling

Section A - Student number: _____

18. Which of these junctions attaches cells together using connexins?

a) Tight junctions

b) Corner junctions

c) Gap junctions

d) Anchoring junction

19. Vinblastine, a drug that inhibits microtubule polymerization, is used to treat some forms of cancer. Cancer cells given vinblastine would be unable to

a) form cleavage furrows during cell division.

b) migrate by amoeboid movement.

c) separate chromosomes during cell division.

d) extend pseudopods.

e) maintain the shape of the nucleus.

20. Which motor protein travels along microfilaments in an anterograde fashion (toward + end)?

a) Kinesin

b) Dynein

c) Myosin

d) Actin

e) None of the above

Continue to the next page for short answer questions – section B

Section A - Student number: _____

Section B – Written answers (Total of 55 marks)

Please answer within the provided space (answers outside those areas will not be marked) – make sure your answer is clear and legible

1. Identify three functions of proteins **other than enzymes** and briefly discuss or describe each. (3 marks)

   Must have 3 corresponding functions and descriptions to have full marks. Description must match function to receive marks. Each correct element is worth 0.5 marks.

Functions of proteins	Briefly describe
Storage	Storage of amino acids or protein (ex. casein)
Defense	Protection against disease (ex. antibodies)
Receptors (recognition not acceptable)	Response to chemical stimuli
Transport	Transport various substances (ex hemoglobin)
Hormones/Signaling/Cell communication	Coordinate organism's activities – act as chemical signal molecule
Contractile and motor proteins (Motion – acceptable, but not ideal)	Movement of cells or cellular components
Structural/Anchoring	Support/Anchoring cells together or to ECM

2. Some cells are very large, seemingly in defiance of maintaining a large surface area to volume ratio. Propose one strategy or adaptation that these cells may use in order to maintain a reasonable surface area to volume ratio. (2 marks)

1 mark for strategy:
Examples can include elements such as:

- Elongated shape
- Many projections, folds (microvilli, cilia, etc…)

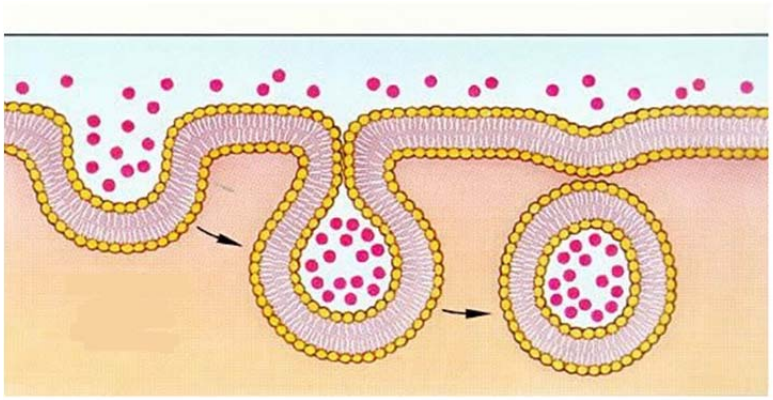
1 mark for explanation of strategy:
For example;
Neuronal cells can be very long cells, their axons can reach nearly 1 metre in some cases. However, the axons are small in diameter, and the cell body has many small projections called dendrites. Together, they allow the cell to be very long, while maintaining an appropriate surface area to volume ratio.

3. Glycogen is not amphipathic. What does this mean? (2 marks)

It means that it does not have both a polar (hydrophilic) and non polar area (hydrophobic). (1 mark)
Glycogen is polar (hydrophilic). (1 mark)

Section A - Student number: _____

4. Use the following figure to answer both parts of the question: (6 marks)



a) Name the process illustrated in this figure (1 mark): ____Pinocytosis (accept endocytosis)_____

b) For each of the following, indicate by T (true) or F (false), if it possible for them to use the process you identified in a (from the figure) (5 marks):

Compound	**Indicate by T (true) or F (false):**
Potassium ions	T
Peptide hormones	F they bind to receptors
Carbon dioxide	F Small gas diffuses across membrane
Amine neurotransmitters	F They bind to receptors
Glucose	T

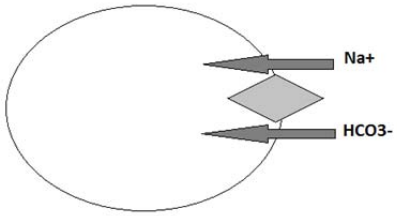
5. Why is the Theory of Endosymbiosis accepted within the scientific community? (Use 2 elements of evidence) (2 marks)

Elements (0.5 marks for naming element and 0.5 marks for small explanation)

1. Morphology/Structure/Size: Shape of mitochondria and chloroplasts and size (µm) are similar to bacteria and archea
2. Reproduction/Division: Only by binary fission
3. Genome/DNA: circular mDNA and cpDNA (similar to bacteria)
4. Transcription and translation: machinery in place
5. Electron transport chain: double membrane with ETC (Mentioning energy production not specific to theory of endosymbiosis)
6. Sequence: bacterial branch on tree of life (mitochondria = proteobacteria; chloroplasts =cyanobacteria)

Section A - Student number: _____

6. Using the following diagram, name the type of membrane transport the cell uses to get HCO3- into the cell: (1 mark)



Answer: ____Secondary active transport of the symport type__ (2/3 concepts is worth 0.5 marks)

7. Which of these associations are a correct match – justify your answer if false? (4 marks)

1 mark for correct True answer. 0.5 marks for correct False answer and 0.5 marks for correct explanation.

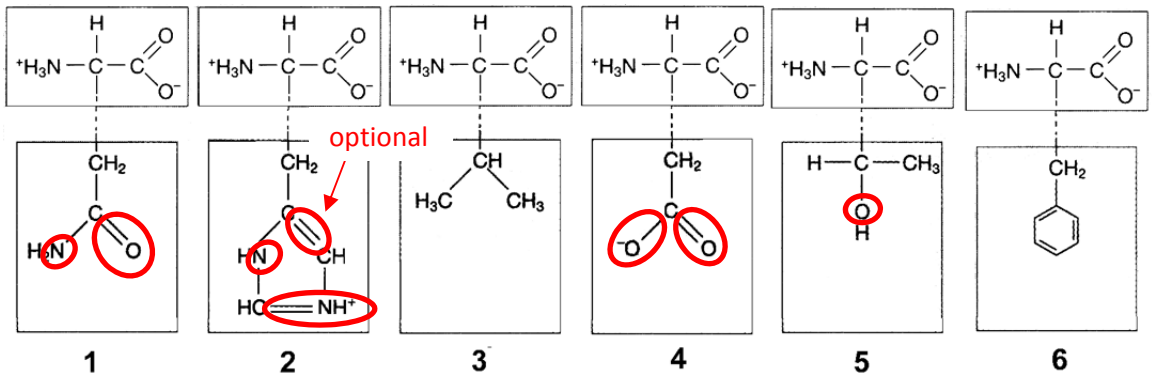
Association	True (T) or False (F)	Justify briefly your answer if false
Microfilaments and nuclear lamina	F	Intermediate filaments make up lamina
Microtubules and chromosome movement	T	
Intermediate filaments and dynein	F	IF are non oriented and do not interact with motor proteins / dynein is the motor protein for MT
Microfilaments and ciliary motion	F	MT are involved in ciliary motion

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

Structures	Sizes (write the letter corresponding to appropriately-sized structure)
A. Nucleus	___B___ 10 nm
B. Ribosome	___D___ 0.03 m
C. Eukaryote	___A___ 5000 nm
D. Goose egg	____C__ 0.05 mm

Section A - Student number: _____

9. Compare the following molecules; i) list below those that you have determined are polar AND ii) draw/label on the polar molecules what contributes to their polarity in order to justify your choice: (3 marks)



Answer: The following are the ones you determine to be polar:_1, 2, 4, 5 (award mark if completely correct)

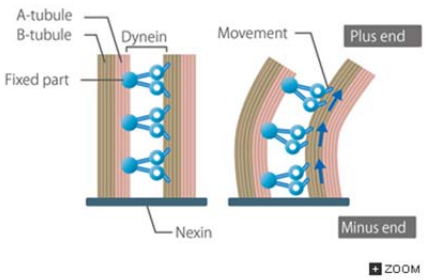
Areas of electronegativity in the functional groups or side chains should be highlighted clearly (not the entire functional group); N, O, charges, asymmetrical double bonds (0.5 marks for each correctly labelled polar amino acid)

Note: #2 has many elements contributing to polarity. These elements needed to be included for marks (except optional element, which went beyond the learning objectives of the course, but is not incorrect). A major issue for many students was denoting that H without a charge in OH, NH groups contributed to polarity. This is not the case.

Section A - Student number: _____

10. Flagella have a unique structure. Describe this structure briefly, and explain the relationship between this structure and how motion is achieved. (4 marks)

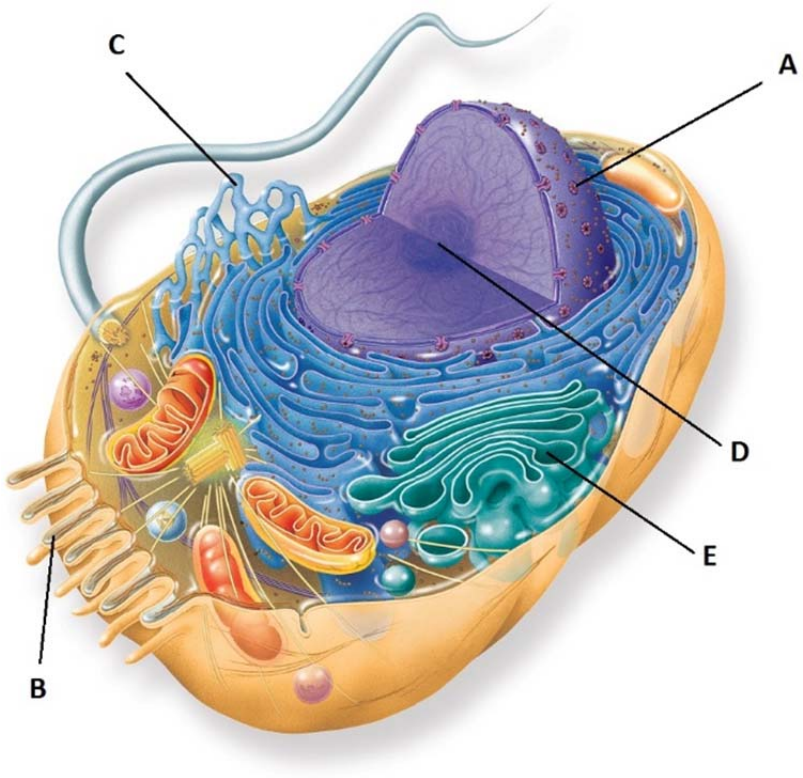
B)



- 9+2 structure consists of 9 doublets of microtubules, arranged in circular fashion, with a doublet of 2 single MTs in center). (1 mark)
- Doublets are held together by polymerizing or cross-linking protein (nexin). (1 mark)
- This prevents the doublets from sliding apart. (0.5 marks)
- Base is the basal body below the plasma membrane. (0.5 marks)
- Dynein walks on 1 doublet carrying the next doublet as its cargo, **toward the – end (the membrane)** imposing a bend in the ring. (1 mark)
- This achieves a **long s-wave motion** by the flagella, which in turn allows the cell to achieve **mobility** in its environment (1 mark)

Section A - Student number: _____

11. Complete the table below using the following figure : (Total 5 marks)



0.5 mark for each element; description of the structure has to match the structure to award mark

Label	Name the structure	Briefly describe the role of the structure
A	Nuclear pores (pore complex)	Structural gate to control exchanges between nucleus and cytoplasm
B	Microvilli / microfilaments	Membrane structures that maximize surface area for exchanges with extracellular environment.
C	Smooth endoplasmic reticulum (do not accept only ER or RER)	Lipid synthesis OR detoxification of cell, namely drugs and toxins
D	Nucleolus (do not accept nucleus)	Site of ribosome synthesis or rRNA synthesis
E	Golgi (Golgi body, complex or apparatus)	Site of post-translational modification (or maturation) of **proteins**

Section A - Student number: _____

12. Fatty acids can have different levels of saturation. Explain what this means and how this influences plasma membrane fluidity. (5 marks)

- Number of double bonds OR desaturase to introduce double bond (1 mark)
- Type of double bonds (cis vs trans – cis packs less tightly than trans) (kink is not as precise and worth 0.5)(1 mark)
- Alignment of double bonds on fatty acids (1 mark)
- Varying length on fatty acids (1 mark)
- All these elements contribute to how compact the phospholipids will be in a given layer of the membrane (1 mark)
- and in turn, influences the rigidity ie the fluidity of the membrane. (1 mark)

Section A - Student number: _____

13. You have just isolated a protein from liver cells. You want to determine where it is located within the cells, and what macromolecules it interacts with, to determine the function of this protein. You suspect it might be near or within the membrane. Propose 3 things that you could do **experimentally** and explain how the results would help you to better understand this protein. (6 marks)

There are many different possible answers – if the suggestions are plausible and can help identify the function of the protein, the answer will be accepted.

Each element must name a technique (1 mark) and provide an explanation as to how it contributes to get information (1 mark – award marks only if explanation matches technique):

- Microscopy (must be specific – eg fluorescence) – colocalization with a known protein, use a marker to label a structure or a known protein or the protein of interest
- Centrifugation (cell fractionation)
- FRAP
- Freeze fracture **AND** electron microscopy/fluorescence microscopy
- Membrane transport – inhibition, saturation, assess rate of diffusion
- Sequence analysis (secondary and tertiary structure – hydrophobic domains)
- Isolate proteins and examine their interactions

Well done! You have completed the first midterm exam.