BIO1140 Introduction to Cell Biology

Professor: Dr. Caroline Petit-Turcotte

Midterm Exam 1 – Version DD: Friday February 13th, 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 (BIO1140DD) 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 DD 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 designed the first single lens 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 are special lenses used to enhance the differences in density of a cell?

a) Bright field

b) Fluorescence

c) Nomarski (Differential interference contrast)

d) Electron microscopy

4. The best technique to study the fluidity of phospholipids within a lipid bilayer is:

a) Fluorescence Recovery after Photobleaching (FRAP)

b) Enzymatic degradation

c) Electron microscopy

d) Freeze fracture

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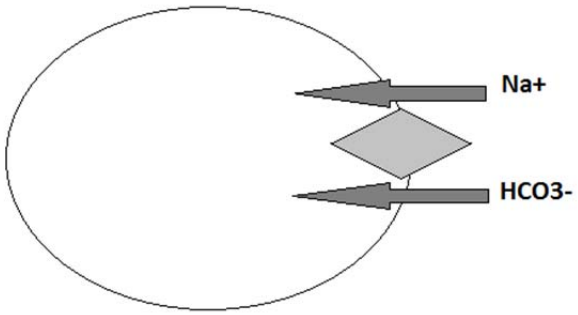
5. In the following figure, how is HCO_3^- transported across the membrane?



a) Secondary antiporter

b) Secondary symporter

c) Primary active transport

d) Facilitated diffusion

6. How could a trout adapt to a rapid increase 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. Which of these steroids is found in the membrane of fungi?

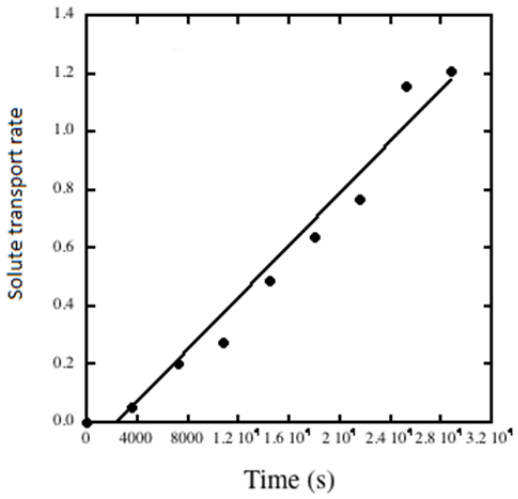
a) Ergosterol

b) Cholesterol

c) Phytosterol

d) Aldosterone

8. 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

9. Justify your answer to question 8:

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 does not saturate

d) Because the cell runs out of ATP

10. During cellular respiration in eukaryotes, which step is crucial to enter the mitochondria?

a) Oxidative phosphorylation

b) The citric acid cycle

c) Fatty acid oxidation

d) Pyruvate oxidation

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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) Nucleus

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 attaches cells together using intermediate filaments?

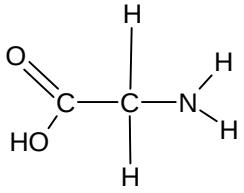
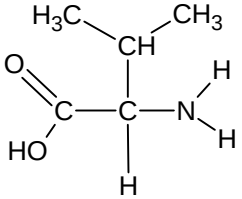
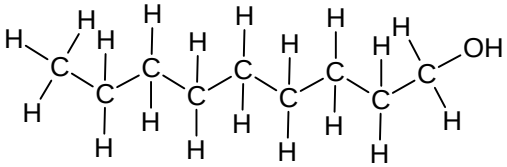
a) Tight junctions

b) Corner junctions

c) Gap junctions

d) Anchoring junction

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

		
A	B	C

16. Phagocytosis is possible thanks to what feature of the cytoskeleton?

a) Fluidity

b) Diversity

c) Dynamicity

d) Rigidity

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

a) Chemiosmosis occurs at the beginning of the process

b) The main products are oxygen and sugar

c) Is only present in plants

d) Chemiosmosis occurs at the end of the process

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 stromae?

___chloroplast_____

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. Phosphoglycerolipids are amphipathic. What does this mean?

A macromolecule that has both a hydrophobic - in this case, fatty acid chains linked to a glycerol backbone (0.5 marks)
and hydrophilic areas – in this case, a polar head group containing phosphate (0.5 marks)
Accept polar as hydrophilic and non polar as hydrophobic areas

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

The absence of ribosomes on the ER membrane makes it smooth (0.5 marks)
The smooth ER is responsible for lipid synthesis and detoxification (0.5 marks)

5. Which organelle is responsible for enzymatic degradation?

__Lysosome OR central vacuole)_____

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

1. Complete the following sentences using the most appropriate term: (12 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____ 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. Microtubules are formed by joining __dimers___ of tubulin in order to form a protofilament. These assemble together to form sheets that lead to the hollow tube structure; there are ___13_____ (number) of these in a sheet. Growth occurs mostly at the β (+) end because it presents ___GTP_____ more easily. The α (-) is anchored at the base called the _microtubule organisation center OR MTOC___.

c. ___Nucleotides____ are macromolecules formed by joining a __nitrogenous___ 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. You are engineering the perfect eukaryotic cell. What type of cellular junction must you include to allow free passage of small ions between 2 cells? (1 mark)

_____Gap junctions OR plasmodesmata_____

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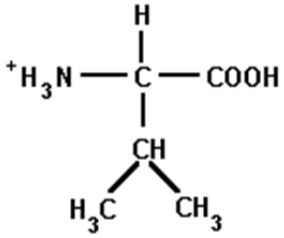
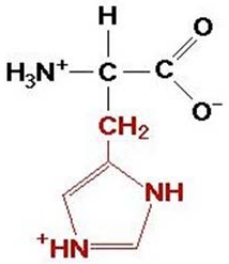
3. Compare the two following amino acids. Discuss their polarity and the impact they could have on the structure of a peptide. (4 marks)



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).

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

1 mark for each of the following elements. Max of 2 marks.

- Morphology (shape and size match with prokaryotes)
- Reproduction by binary fission
- Genome (circular cpDNA and mtDNA)
- Transcription and translation
- Electron transport within double membrane
- Sequence (coincides with bacterial domain)

5. Compare and contrast the structure and function of the cytoskeletal fibers, using the table below. Be sure to add the criteria you are using for your comparison: (6 marks)

0.5 for each element in table (excludes titles of rows and columns)

	Microfilaments	Microtubules	Intermediate filaments
Basic molecular structure	Small, flexible, helical filament G actin monomers	Large, tubular, hollow, rigid structure αß-tubulin dimers	Large, multiple filaments stacked as tetramers Various protein; cell type-specific (ex. Keratins)
Size	~7nm in diameter	~25nm in diameter	~10nm in diameter
Role in the cell	Transport (periphery of cell), structural, cytokinesis, mitosis/meiosis, amoeboid movement, structural	Transport (membrane to nucleus and vice-versa), mitosis/meiosis, flagellum/cilia movement, structural	Structural, mechanical strength and protection (nucleus)
Interact with proteins	Molecular motors (myosin),	Molecular motors (kinesin, dynein),	cell junctions – ex plektins, adherins, etc.

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

1 mark for each element

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
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
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.

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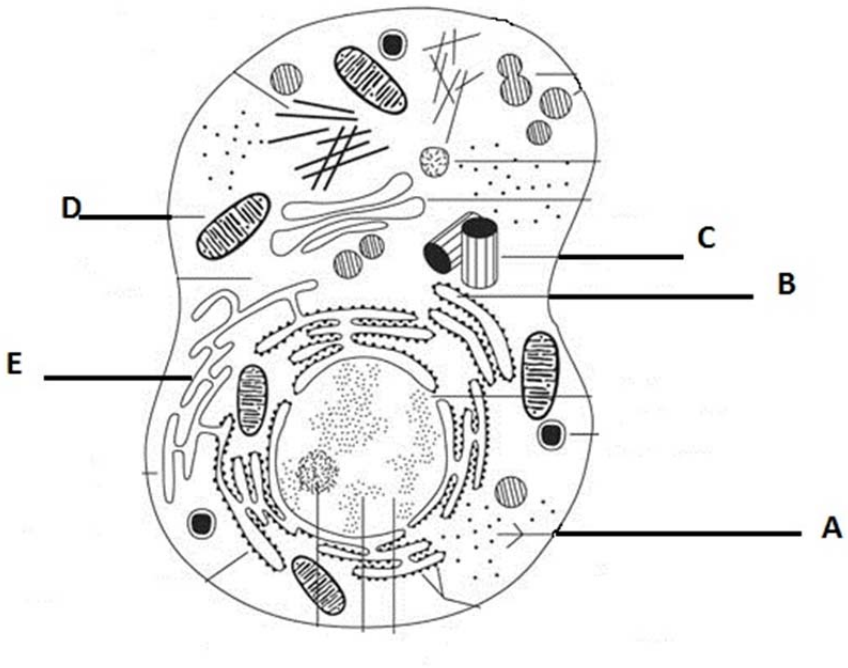
7. Associate the following structures with the given sizes: (2 marks)

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

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

1 mark for each element



A	Ribosomes
B	Rough ER
C	Centriole OR Centrosome
D	Mitochondria

E	Smooth ER

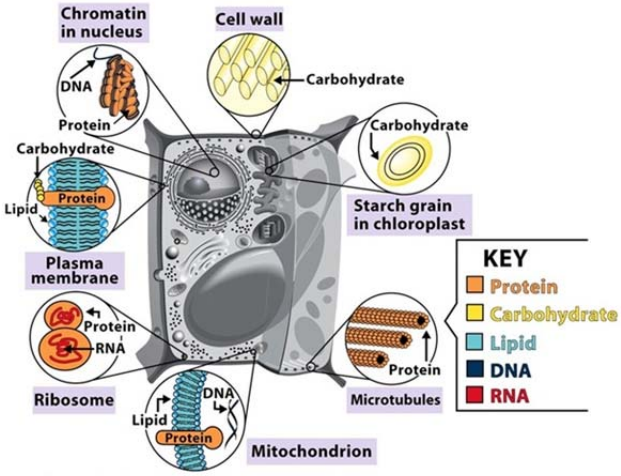
9. Complete the following table, identifying for each of these macromolecules, where they would be synthesized in the cell and in what location they accomplish their role: (5 marks)

0.5 marks for each element in table

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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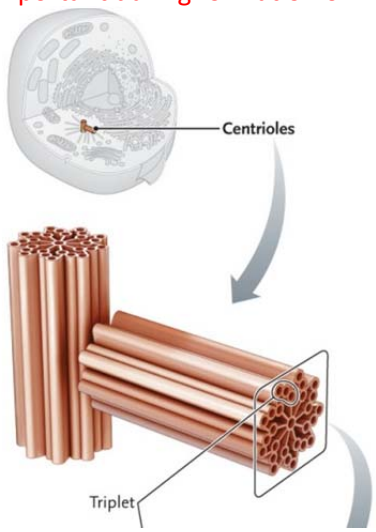
11. Discuss the structure and the role of centrosomes/centrioles. (6 marks)

Centrosome is made of 2 centrioles in a right angle or L shape arrangement (1)
They are made of 9 microtubule triplets (1) arranged in a circular conformation/ring (no central MT) (1)

Important for anchoring cilia and flagella (similar structure, called basal body) (1)
Serve as the MTOC (1)
Important during formation of mitotic spindle (1)



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Section D – Long answer questions (12 marks)

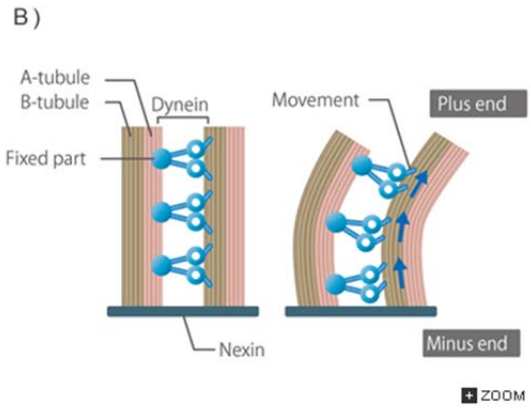
1. Explain the role of nexin in the movement of a flagellum or cilium. Make sure you include the structural aspects of flagellum or cilium in your answer. (9 marks)

9+2 complex arrangement of microtubules (1)
Anchored to basal body below plasma membrane (1) at – or alpha end (1)

Microtubule doublets are linked by motor protein dynein (1) – as it travels it imposes the motion of the flagella or cilia (1)
S wave versus whip types of movements for flagella and cilia respectively (1 each)

To avoid doublets separating during motion, they are held together by nexin (a protein) (1)

This will allow to impose the 'return' motion to the structure (1)



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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
- Centrifugation
- FRAP
- Freeze fracture and electron microscopy
- Membrane transport – inhibition, saturation, assess rate of diffusion
- Sequence analysis

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