BIO1140 Introduction to Cell Biology

Professor: Dr. Caroline Petit-Turcotte

Midterm Exam 2 – Version DD: Friday March 17th, 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 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 (37 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.

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: _____

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.

How would you rate your preparation level compared to the first midterm?

a) Less prepared

b) Somewhat the same

c) Slightly better

d) Much better

2. During cellular respiration in eukaryotes, which step takes place in the cytoplasm?

a) Oxidative phosphorylation

b) The citric acid cycle

c) Fatty acid oxidation

d) Glycolysis

e) None of the above

3. Which of these cellular events is **not** associated with necrosis?

a) Loss of electrochemical gradients

b) Dissolution of nuclear envelope

c) Dissolution of plasma membrane

d) Cellular lysis

e) None of the above

4. In a chloroplast, where does ATP synthesis (using the F-pump ATP synthase) take place?

a) The matrix

b) The outer membrane

c) The internal membrane

d) The stroma

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5. Unlike mitochondria, chloroplasts do not have a transporter to export ATP to the cytosol. How does the plant cell obtain the ATP it needs to survive?

a) The ATP produced in chloroplast is mostly used for carbon fixation

b) The ATP produced in chloroplast can diffuse across the thylakoid membrane

c) The orientation of the ATP-synthase produces ATP in the cytosol

d) There is no ATP production by chloroplast

6. Which of the following choices corresponds to a post-translational modification that does **not** occur in the Golgi?

a) Lipidation

b) Acetylation

c) Disulfide bond formation

d) Methylation

7. In order to obtain the following mRNA sequence; 5' ACUGCUAGCUAGCGCG 3', which of these template strands did the RNA polymerase use?

a) 5' ACTGCTAGCTAGCGCG 3'

b) 3' TGACGATCGATCGCGC 5'

c) 5' TGACGATCGATCGCGC 3'

d) 3' GCGCGATCGATCGTCA 5'

8. Which of the following statements best describes the role of apoptosomes :

a) Bind directly to transmembrane receptors and initiate apoptosis.

b) Activate executioner caspases.

c) Cleave essential proteins at a cysteine-aspartate site.

d) Release cytochrome c from the mitochondrion.

e) None of the above.

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9. You wish to design an experiment that will specifically prevent the G-protein-coupled receptor interaction with the α-subunit. Where would you direct your blocking agent?

a) The extracellular domain of the receptor

b) The transmembrane domain of the receptor

c) The intracellular domain of the receptor

d) The amino acid sequence in the binding site for the G protein

e) All of the above

10. Membrane proteins (and lipids) vital to the structure and function of the plasma membrane are typically delivered to the membrane via:

a) pinocytosis

b) the constitutive secretory pathway

c) the regulated secretory pathway

d) ubiquitination

e) both b and c

11. Which of the following statements about intracellular receptors is incorrect?

a) They mainly act by affecting gene expression

b) They preferably bind to lipophilic ligands

c) They are present in the cytosol or the nucleus

d) Once opened, they will activate an amplifier enzyme.

e) None, they are all correct

12. If a missense point mutation occurs in an intron, what will be the ultimate outcome for the organism?

a) The organism will not be able to survive

b) It will be of little consequence as the intron will be spliced

c) It will depend on the polarity of the new amino acid

d) It depends on what impact that intron corresponds to during translation

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13. Your experiments on cells in culture reveal that their DNA has become fragmented and a specific protein was released. Which of the following choices corresponds to the chronology of events for these cells?

a) IP3 releases Bak/Bax from the ER → Ca2+ rises in cytosol → PTP pore is opened → cytochrome C is secreted by mitochondria

b) Ca2+ enters the cell → mitochondria and ER increase their uptake of Ca2+ → Bad is released from mitochondria → cytochrome C is activated

c) Bad is dephosphorylated → BCl2 is inactivated → IP3-gated Ca2+ channel is opened → cytochrome C is released from mitochondria

d) Bad is activated → Ca2+ is released from the mitochondria → cytochrome C increases in cytoplasm → loss of cellular adhesion is observed

14. Which of the following statements best describes how transmembrane receptors depend on membrane structure for stability and efficiency:

a) The membrane does not influence transmembrane receptors

b) The receptors are located in areas with less fluidity to offer more structural support

c) The receptors are located in areas with similar fluidity but increased thickness

d) The receptors are located in areas with more fluidity to facilitate conformational changes

15. Because of the Wobble effect (oscillation), there is more than one possible _____ for phenylalanine.

a) DNA

b) tRNA

c) mRNA

d) rRNA

e) ribosome

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16. Binding of a signaling molecule to which of the following types of receptors will lead directly to a change in membrane potential?

a) Intracellular receptor

b) phosphorylated tyrosine kinase receptor

c) GPCR

d) ligand-gated ion channel

e) None of the above

17. Which of the following statements correctly describes how a steroid-derived messenger would act on its target cell:

a) Binding to a Trk monomer – dimerization and autophosphorylation – activation of MAPK and AP1

b) Binding to a GPCR – activation of $G\alpha_s$ and adenylate cyclase – activation of PKA – binding to CRE in promoter

c) Binding to an intracellular receptor – ligand-receptor complex goes to nucleus – binding to RE in promoter

d) Binding to transmembrane receptor – change in conformation – flow of ions and change in membrane potential

18. A mutation to Grb2's SH3 domain prevents it from interacting with Sos. What will be the most likely consequence to that cell?

a) The activation of Ras and the MAPK pathway will not be possible

b) The tyrosine kinase receptors will no longer be functional

c) The cell will not be able to respond to growth factors

d) Grb2 will directly activate Ras

19. Which of these statements best corresponds to gene regulation in prokaryotes?

a) A repressor binds to an operator sequence upstream of the +1 site

b) A silencer must be displaced from a distal regulatory element

c) A mature mRNA is produced regardless of the conditions prokaryotes are in

d) A specific arrangement of activator proteins needs to bind to the regulatory elements

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20. Which of the following choices does not correspond to a similarity between prokaryotes and eukaryotes regarding initiation of transcription?

a) It depends on protein recognizing consensus sequences in the promoter

b) Chromatin must be modified for the promoter to be accessible

c) Transcription is carried out by an RNA polymerase

d) The 3' to 5' DNA strand is the template strand

YOU HAVE COMPLETED SECTION A

PLEASE TURN TO THE NEXT PAGE FOR THE REMAINDER OF THE EXAM

Student number: _____

Section B – General knowledge (Total 12 marks)

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

1. Define *proton motive force* and provide an example of how the cell benefits from it. (2 marks)

The potential energy from a gradient of ions built up across a membrane (0.5)
is used to drive an energy-dependant process. (0.5)

For example: The H+ ion gradient in the mitochondrial intermembrane space powers the F1 ATPase to phosphorylate ADP to ATP in matrix (1)
Or
Same in thylakoid lumen of chloroplast to produce ATP in stroma (1)

2. Explain how protein kinase A is activated and deactivated. (2 marks)

Activation: 1 mark
cAMP binds to each of the 2 regulatory subunits, causing them to dissociate from the 2 now active catalytic subunits of PKA

Deactivation: 1 mark
Low intracellular concentration of cAMP causes cAMP to dissociate from regulatory subunits, which will reassemble with and deactivate the catalytic subunits

3. Chronologically describe how the transcription initiation complex is assembled. (2 marks)

0.5 marks each

- Transcription factor binds to TATA box in promoter
- TATA binding proteins recruited to promoter
- Additional transcription factors (OR Activators/repressors) bind to response elements (proximal or distal) OR Enhancer/silencer regions
- RNA polymerase II is recruited to promoter (transcription start site)

4. What makes the nematode *C. Elegans* a good model to study apoptosis? Provide two reasons. (2 marks)

1 mark each for a maximum of 2 marks

- Same number of cells in each organism
- Through development, the same cells die through apoptosis
- Genes and associated proteins identified
- Homologous gene sequences
- Observation of apoptotic events (ex. Blebbing)

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5. Briefly list the steps involved in mitophagy: (2 marks)

0.5 marks each:

- Expression of PINK on outer mitochondrial membrane and phosphorylation of MFN2
- Recruitment of Parkin
- Ubiquitination of mitochondria
- Autophagy/degradation by lysosomes

6. Briefly describe two different ways cells can terminate a signal transduction cascade: (2 marks)

1 mark each

- Ligand removed /endocytosed by neighbouring tissues or cells
- Ligand digested by extracellular enzymes
- Endocytosis of ligand-receptor complex
- Inactivation of receptor (for example by changing phosphorylation state)
- Inactivation of amplifier enzyme

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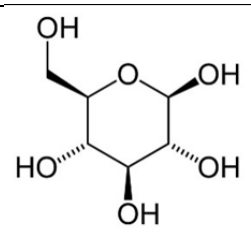
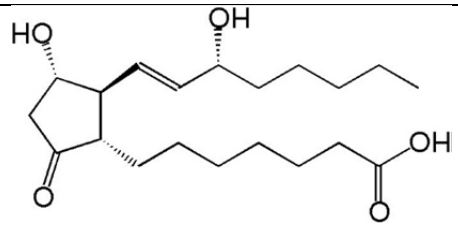
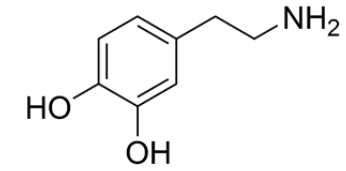
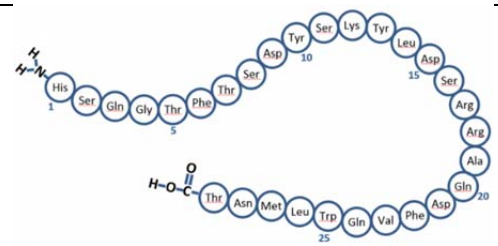
Section C –Associate (Total of 15 marks)

1. Associate the following messenger classes with their most likely communication path: (2 marks)

Messengers	Communication paths
A: 	1. Endocrine
B: 	2. Direct
C: 	3. Paracrine
D: 	4. Neuronal

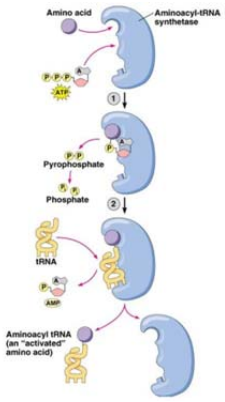
<u>Indicate the number of the corresponding communication path for each messenger:</u>

A: 2
B: 3
C: 1 OR 3 OR 4
D: 1

Student number: _____

2. Describe the molecular mechanism that is responsible for specific pairing between amino acids and tRNA. (4 marks)

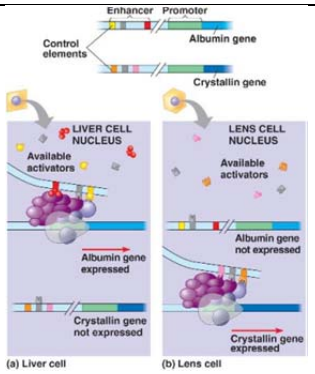
- Each of the 20 amino acids have a unique amino-acyl-tRNA synthetase (or aminoacyl transferase) that bind them (1 mark)
- ATP binds to the aa-enzyme complex and is hydrolyzed releasing PP (1 mark)
- Aminoacyl-amino acid-AMP complex recruits a tRNA that has one of the matching anticodons for that amino acid (not necessary to mention oscillation or Wobble effect) (1 mark)
- Aminoacyl-transferase covalently binds the amino acid and the tRNA (to the tRNA's 3' end) (1 mark)



3. While all cells carry the same DNA, they do not all express the same gene products in the same amounts. Using a specific example, provide an explanation for this type of regulation in eukaryotes. (4 marks)

- Combinations of activators / repressors that are expressed in specific cells, (1 mark)
- These are able to bind to the distal regulatory elements enhancers / silencers (1 mark)
- to contribute to initiation (or inhibition) of transcription of genes that are specific to those cells. (1 mark)

Any correct example of comparison between 2 cell types and their respective gene products is accepted (1 mark)



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4. Tyrosine kinase receptors are mostly monomeric, single pass transmembrane proteins that dimerize. Following transcription of the gene for such a receptor monomer, the mRNA will be translated in such a way that the monomer will be available, spanning the membrane, for incoming ligands. Name this process and describe the key steps. (5 marks)

- This process is called co-translation. (1 mark)

Maximum 4 marks within the elements below

- SRP – signal recognition particle binds to the signal sequence (or signal peptide) in polypeptide undergoing cytosolic translation (1 mark)
- Translation is halted and the ribosome is directed to the ER (1 mark)
- The SRP docks to the SRP receptor on ER membrane and aligns the ribosome with a translocator protein (translocon) (1 mark)
- The signal sequence is transferred to the signal peptidase which will cleave the signal peptide (1 mark)
- Translation resumes with the polypeptide extending in the ER lumen until a stop-transfer sequence is reached and recognized (1 mark)
- Translation continues until the stop codon is reached but translocation is interrupted, leaving the polypeptide as a transmembrane monomer. (1 mark)

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Section D – Long answer question (10 marks)

1. Following a sports injury, it is important to quickly reduce pain and inflammation. Non-steroidal anti-inflammatory drugs such as Naproxen act by blocking the cyclooxygenase pathway. Using your knowledge of the phospholipase C signal transduction cascade, explain how this drug can be efficient. (10 marks)

- Naproxen or similar drugs bind to the GPCR and activate it (1 mark)
- The activated GPCR recruits the heterotrimeric G protein (1 mark)
- The α-subunit exchanges GDP for GTP (1 mark)
- and once active releases from the other 2 g-proteins (beta and gamma) (1 mark)
- The GTP-α-subunit activates phospholipase C, which cleaves PIP2 into DAG and IP3 (1 mark)
- Phospholipase A2 cleaves DAG to Arachidonic acid (1 mark)
- Cyclooxygenase acts on arachidonic acid to produce prostaglandins, which are pain-mediating chemical messengers (1 mark)
- when released from cells they can act on same or neighbouring cells to illicit a pain response (autocrine or paracrine pathway) (1 mark)
- Prostaglandins bind to GPCRs that activate the phospholipase C pathway (1 mark)
- Naproxen is a drug that inhibits cyclooxygenase and thus prevents the formation of prostaglandins, and therefore the propagation of the message of pain (1 mark)

You have completed the second midterm exam!

Student number: _____

Remarking procedure: For a complete description of the remarking process, visit the BBLearn course website (Course syllabus, registrations and policies -> Asking for an exam to be remarked). All midterm/final exam remarking appeals must be handed in prior to the deadline specified to Marc Charette (GNN 281), without exception, and will be remarked by Marc Charette. Remarking can increase, decrease or result in no change to the mark originally awarded. Tips and tricks for enabling a quick and easy remark: 1. Please note that it is key to clearly identify your issue in your written statement and clearly identify the question that is to be remarked. 2. It is best achieved by referencing the statements you made on the exam with the contents of the marking scheme (e.g. I said this and the marking scheme says that). This clearly identifies your issue with the marking and generally leads to better results when remarking. Things to avoid when asking for a remark: 1. Please avoid making written statement that employs reasoning that is something to the effect of: "I feel I deserve/would like more marks", as these requests will be ignored.2. Not providing a rational for the remarking of a question or simply asking to have the question remarked. Again, these requests will be ignored. When the remarking process is complete, you will be notified via an announcement on the course website. Therefore, please do not contact us regarding the progress of the remarking process.

REMARKING REQUESTS: