BIO1140 Introduction to Cell Biology

Professor: Dr. Caroline Petit-Turcotte

Midterm Exam 2 – Version DD: Friday March 18th, 2016

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 20% 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 (44 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. Which of these cellular events is not associated with apoptosis?

a) Energy depletion

b) DNA fragmentation

c) Disruption of cell adhesion

d) Rearrangement of the cristae

e) None of the above

3. 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

e) None of the above

4. In plants, where does photosynthetic ATP synthesis, using the F-pump ATP synthase, take place?

a) The thylakoid membrane

b) The stroma

c) The thylakoid lumen

d) The cytoplasm

e) None of the above

Student number: _____

5. Enzymatic receptors, such as tyrosine kinase receptors, require a sequence of events to become active. Which of these statements is correct?

a) A ligand, such as a growth factor, binds to a receptor dimer; autophosphorylation of 6 tyrosine residues provides the kinase activity of the receptor

b) A ligand, such as a growth factor, binds to a ligand binding domain; a membrane bound effector is recruited; the kinase activity of the receptor is functional

c) A ligand, such as a growth factor, binds to 2 monomeric subunits; dimerization leads to autophosphorylation of 6 tyrosine residues; the kinase activity of the receptor is functional

d) A ligand, such as a growth factor, binds to 2 monomeric subunits; dimerization recruits a kinase that will phosphorylate 6 tyrosine residues; the kinase activity of the receptor is functional

e) None of the above

6. Even though plant cells carry out photosynthesis, they use mitochondria to oxidize pyruvate. When and where will this occur?

a) In photosynthetic cells in the light, while photosynthesis is ongoing

b) Only in nonphotosynthesizing cells

c) Only in cells storing glucose

d) In all cells, all the time

e) None of the above

7. Which of the following choices does not correspond to a post-translational modification that can occur in the Golgi?

a) Glycosylation

b) Acetylation

c) Disulfide bond formation

d) Lipidation

e) None of the above

Student number: _____

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

a) The constitutive secretory pathway

b) The regulated secretory pathway

c) Endocytosis

d) Ubiquitination

e) Both a and b

9. Using the following prokaryotic DNA sequence, choose which of the following would correspond to the result of transcription;

5' GCGATCTGA 3'
3' CGCTAGACT 5'

a) 5' UCAGAUCGC 3'

b) 3' GCGAUCUGA 5'

c) 5' GCGAUCUGA 3'

d) 3' AGUCUAGCG 5'

10. Caspases are known to:

a) Bind directly to transmembrane receptors and initiate apoptosis.

b) Deactivate other caspases.

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

d) Release cytochrome c from the mitochondrion.

e) None of the above.

Student number: _____

11. Which of the following statements about the ACh-gated ion channel receptor is incorrect?

a) It is composed of 5 transmembrane subunits, 2 of which are identical.

b) The receptor requires both binding sites to be filled to change to its open conformation

c) These channels are mostly permeable to Na^+ and Ca^{2+}.

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

e) None of the above

12. You have grown epithelial cells in culture, but a few of them appear to be dying. By using fluorescent microscopy, you have determined that before dying, the concentration of cytochrome C in the cytoplasm increases and their DNA is fragmented. Which of the following choices corresponds to the chronology of events for these cells?

a) Bax is released from the ER → Ca2+ rises → PTP pore is opened → cytochrome C is secreted by ER

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

c) BCl2 is activated → Ca2+ is released from the mitochondria → cytochrome C increases in cytoplasm → blebbing begins

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

13. 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 depend if the pre-mRNA is matured

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

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

Student number: _____

14. Consider the following pathway:

epinephrine → GPCR → G protein → adenylyl cyclase → cAMP → PKA. Identify the second messenger.

a) cAMP

b) G protein

c) adenylyl cyclase

d) GPCR

e) None of the above

15. A rodent is given an intramuscular injection of acetylcholine. Which of the following choices corresponds to the sequence of events that occurs after binding of the ligand molecule to its ionotropic receptor?

1) Calcium binds to troponin

2) Membrane depolarization

3) Sodium influx from extracellular fluid

4) Myosin binds actin

5) Calcium release from SR

6) Conformational change of tropomyosin to expose myosin binding sites

7) Muscle contraction

a) 2,5,4,3,6,1,7

b) 3,2,5,1,6,4,7

c) 2,5,1,6,4,3,7

d) 3,5,6,2,1,4,7

16. A cell releases a chemical messenger, and after a short time spent in the extracellular space, this messenger binds to a receptor on a nearby cell's surface. Which communication path is this an example of?

a) Paracrine

b) Endocrine

c) Exocrine

d) Autocrine

e) Direct (Gap)

Student number: _____

17. Beadle and Tatum discovered many categories of *Neurospora* mutants. Category I mutants could grow on medium with Arginine, Citrulline or Ornithine, while Category II mutants grew only on medium containing either Arginine or Citrulline, but not in the presence of Ornithine. The metabolic pathway for the synthesis of Arginine is as follows:

Precursor → Ornithine → Citrulline → Arginine

From these results, we can conclude that:

a) A single gene codes for the entire metabolic pathway

b) The genetic code is a triplet code

c) In Category I mutants, mutations occur later in the chain of nucleotides than in Category II mutants; Category I mutants have a greater number of functional enzymes

d) Category I mutants have a non-functional enzyme in the first step, while Category II mutants have a non-functional enzyme in the second step

e) Category I mutants have a non-functional enzyme at the second step, while Category II have a non-functional enzyme at the third step

18. Which of the following choices corresponds to a major difference between signal transduction cascades using intracellular receptors when compared to those using transmembrane receptors?

a) The ligand and receptor are both part of the transduction events

b) The ligand is irrelevant

c) The receptor does not have a ligand binding domain

d) The cascade does not lead to any changes in the cell

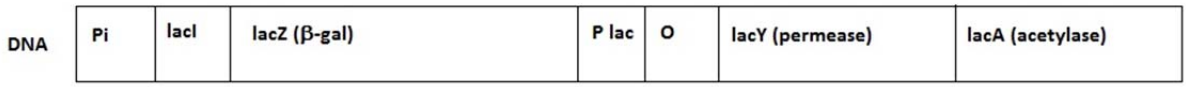
e) There is no difference

Student number: _____

19. You have recently designed a technique that allows you to move DNA sequences within a prokaryote's genome. You decide to move the promoter and operator for the *lac* operon, placing it between the β-galactosidase and permease genes.

Lac operon

Lac operon after modification



Which of the following choices is your best prediction for the outcome, when in the presence of lactose?

a) None of the genes will be transcribed
b) Only lac Z (β-galactosidase) will be transcribed
c) Only lacY (permease) and lacA (acetylase) will be transcribed
d) All three genes will be transcribed but with lac Z less than the other 2 genes
e) None of the genes will be transcribed

20. The amino acid proline has several possible codons, due to the degeneracy of the genetic code. This means that there is more than one possible _____ for proline.

a) DNA
b) tRNA
c) mRNA
d) rRNA
e) ribosome

YOU HAVE COMPLETED SECTION A

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

Student number: _____

Section B – General knowledge (Total 9 marks)

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

1. Explain what an adaptor protein does and provide an example. (2 marks)

A protein that facilitates (allows) the interaction between a receptor and the effector based on their structures (specific domains). (1 mark)
For example; Grb2-Sos (1 mark)

2. How does the cell manage the storage and release of calcium? (1 mark)

Based on the concentration gradients of calcium in the cytoplasm and the storage organelles (mitochondria and ER), using facilitated and active transport

3. Describe what mitophagy is and give an example of a situation where it is useful. (2 marks)

Mitophagy is the process by which damaged portions of, or entire, mitochondria can be directed to autophagy (lysosomal degradation). (1 mark)

Examples: (1 mark)
Following oxidative stress
Reduced energy requirements

4. How does the Na+/K+ ATPase pump contribute to membrane potential? (2 marks)

Because it exchanges 3 Na+ for 2 K+ (1 mark), against each ion's concentration gradient,
it maintains an uneven distribution of charge OR concentration of ions on both sides of the membrane (1 Mark)

Student number: _____

5. Name 2 of the 6 ways to terminate a signalling pathway. (2 marks)

Each worth 1 mark

- Removal of ligand by distant tissues;
- Removal of ligand by adjacent /neighbouring cells;
- Enzymatic degradation of ligand;
- receptor-ligand internalisation by endocytosis; (concept of receptor and ligand must be present)
- inactivation of receptor;
- inactivation of signal transduction pathway OR second messenger;

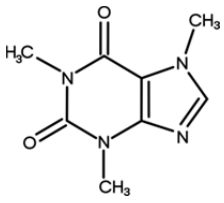
Section C –Associate (Total of 22 marks)

1. Place the following steps in the correct order to produce albumin, an endocrine transport protein: (1 mark – all answers must be correct, no partial marks)

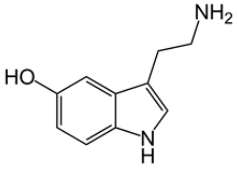
Order	Steps
1	a. Splicing
2	b. Elongation
3	c. Release factor lines up with stop codon
4	d. mRNA bound to small ribosomal subunit
5	e. Binding of large ribosomal subunit
6	f. mRNA passes through nucleoporin

Correct order: _____A-F-D-E-B- C OR B-A-F-D-E-C _____

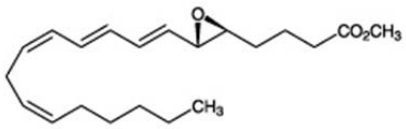
2. Identify the chemical messenger class the following molecular structures belong to (3 marks):

a) 

_____Purine _____

b) 

_____amine _____

c) 

_____eicosanoid (accept leukotrienes, Not prostaglandins)_____

Student number: _____

3. When considering RNA, what are three things that are different from DNA: (3 marks)

Each answer worth 1 mark

- Ribose (not deoxyribose)
- Uracil (not Thymidine)
- Single strand (not double strand) (single helix is acceptable)
- It can leave the nucleus
- It can act as an enzyme
- DNA more stable than RNA
- RNA does not have histones

4. Using the codon table provided, indicate what the peptide sequence would be for the following mRNA sequence: (1 mark)

mRNA: 5' AUGUCAAGCGGAGAGGUACUCUAA 3'

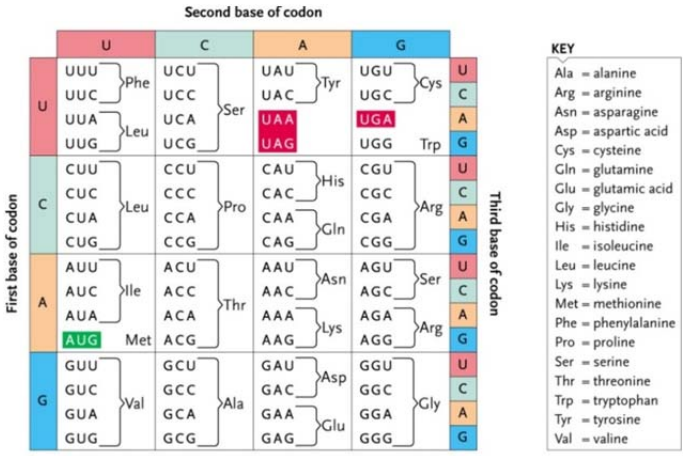


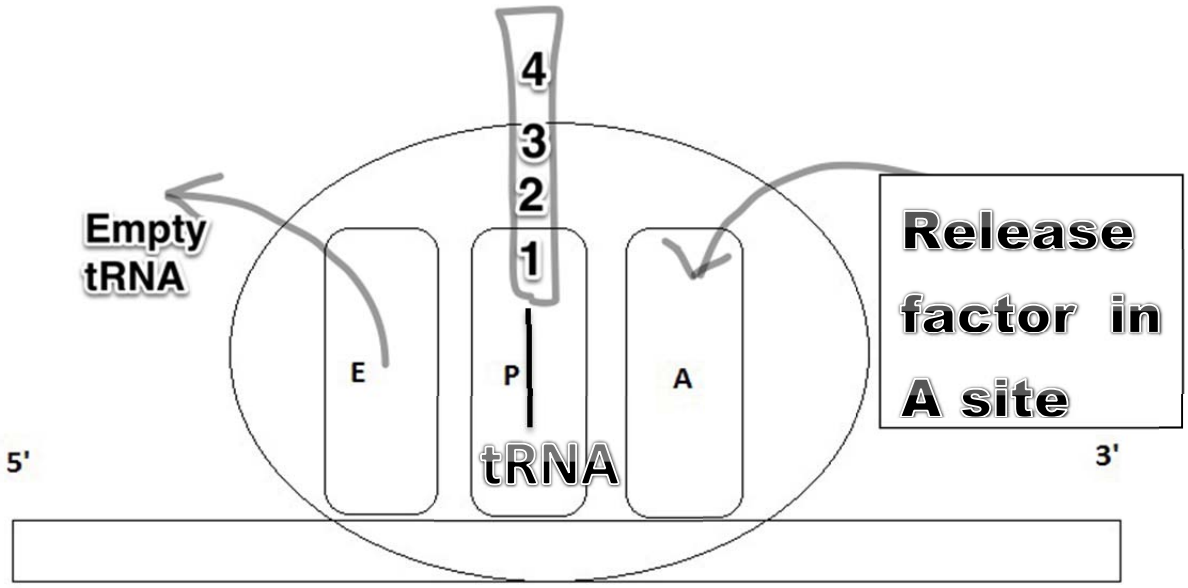
Figure 13.5
The genetic code, written as the codons appear in mRNA being read 5′ to 3′. The AUG initiator codon, which codes for methionine, is shown in green; the three terminator codons are boxed in red.

Answer: ____Met – Ser –Ser –Gly –Glu –Val –Leu

5. Complete the drawing below to represent **termination**. Include and **label** all the necessary elements in this step. (4 marks)

- Must clearly identify on drawing:
  - Empty tRNA leaving E site, (1 mark)
  - tRNA (1 mark) linked with growing polypeptide in P site (1 mark)
  - Release factor in A site (1 mark)

Student number: _____



Student number: _____

6. What would be the consequence if the IP_3-gated channel of the endoplasmic reticulum became insensitive to IP_3 which is produced following activation of the phospholipase C pathway? Use the key steps of the transduction pathway to support your answer. (4 marks)

1 mark each

- Activated PLC cleaves PIP2 into DAG and IP3
- IP3 is directed to the IP3-gated Ca2+ channel on ER
- If that channel is insensitive to IP3 then Ca2+ is not released
- Therefore unable to activate PKC along with DAG, DAG will be the main second messenger

7. Acetylcholine is a common neurotransmitter that can act in a stimulatory or inhibitory fashion. Explain how one ligand can result in multiple responses and why this is advantageous. (6 marks)

Same ligand binding to different receptors (1 mark)–
ACh can bind to a ligand gated ion channel which leads to muscle contraction (1 mark) AND
it can bind to GPCR that interact with stimulatory or inhibitory alpha subunits of the G-protein which will in turn activate or inhibit the amplifier enzyme (1 mark)

This is advantageous because with a limited number of ligands and signal transduction pathways (1 mark), we can illicit a wide range of cellular responses, in different cell types (1 mark), while keeping the number of genes to transcribe and translate to a lesser number than if each different response required a specific ligand and receptor (1 mark)

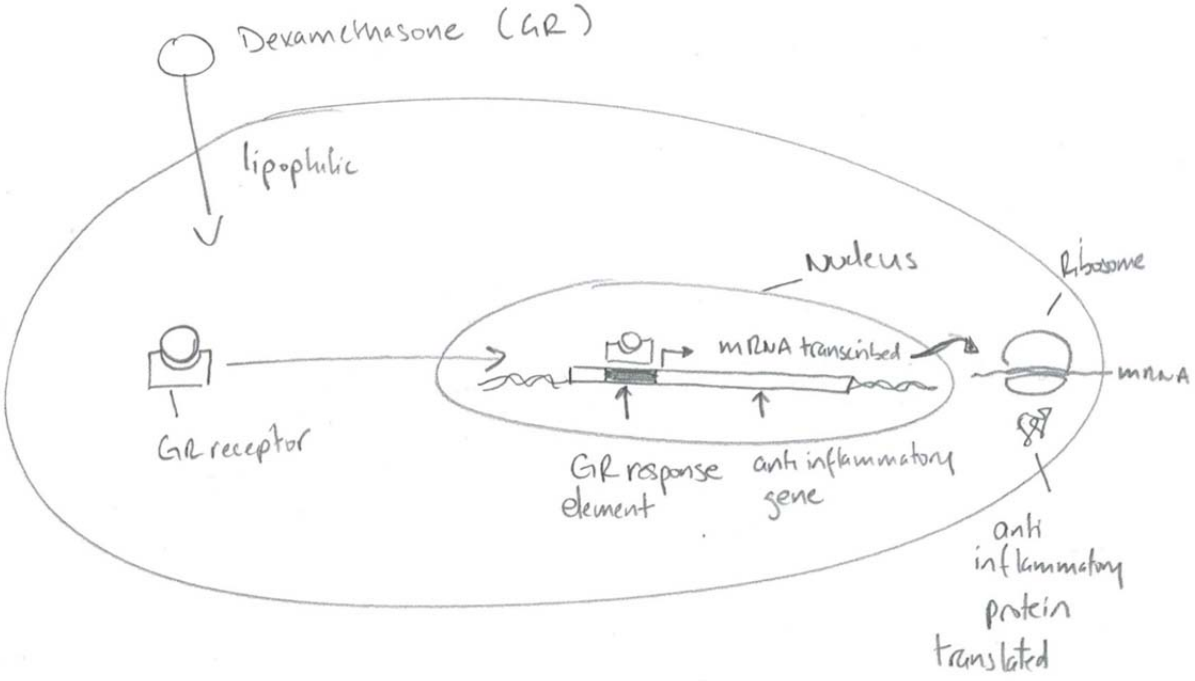
Student number: _____

Section D – Long answer question (10 marks)

1. Dexamethasone is a glucocorticoid used for treatment of inflammatory conditions. Using a **drawing** of a cell, explain how dexamethasone's message is transduced by the cell to reduce inflammation. (10 marks)

Drawing – explanation must include:

All elements clearly labelled (1 mark)
Cell with nucleus (1 mark)
Dexamethasone crossing the membrane by itself (1 mark)
Intracellular receptor (in cytoplasm or nucleus) (1 mark)
Binding of dex to intracellular receptor (1 mark)
Receptor-dex complex goes to nucleus and binds to a response element (RE) in regulatory region of a gene (1 mark)
Transcription is initiated OR increased (1 mark)
mRNA leaving nucleus (1 mark)
to be translated to protein (ribosome) (1 mark)
Indication that gene transcribed is an anti-inflammatory protein (1 mark)



You have completed the second midterm exam!