UNIVERSITY OF TORONTO
Faculty of Arts and Science

December Final Exam
Tuesday December 13th, 2011

BIO230H1F
From 9:00– 11:00 am
DURATION: 120 minutes

No Test Aids Allowed

Number of pages: 12 (not including this one) **Number of questions: 53 multiple choice**

This final exam is worth **40%** of your final mark.

INSTRUCTIONS: Please read carefully!

1. All questions are based on lecture material of Section I. You are to choose the BEST answer; there is ONE and only one correct answer per question (multiple answers for a question will be marked wrong). There is no additional penalty for incorrect answers, so **do NOT leave any questions unanswered (blank)** on your answer sheet. **Write your name on your test question paper.**

2. **Green Computer Answer Sheet: SCANTRON** (See sample on the back of this page) Transfer your answers to the computer scantron answer sheet using a soft lead pencil and darken inside one box ONLY as multiple answers will be marked wrong. Erase all corrections completely. *ONLY your answer sheet will be marked.* On the left side of your computer answer sheet:

    a) **Print your last name** in the boxes provided, and darken the appropriate letters in each column. Print your first name initial(s) in the far right columns and darken the appropriate letters.

    b) **Print your student number** and carefully darken the appropriate numbers. Do not leave this section blank.

    c) **Print the exam version in "CODE"** and darken in the appropriate numbers. The test version is at the bottom of every page of this test.

Hand in BOTH your COMPUTER ANSWER SHEET and your Test PAPER

TEST VERSION 11

COURSE: BIO230H1F DATE: Dec 13th, 2011

SIGNATURE: A. STUDENT

University of Toronto • Departments of Bota

IMPORTANT:

- Use **HB pencil** only
- Fill box completely
- Erase clearly any
- Make no stray m

LAST NAME	INT
STUDENT	A

STUDENT ID#	CODE
999999999	11

1. If a chemical that inhibits PI 3-kinase were added to cells, which of the following would occur?

   a. Specific proteins would dissociate from the cytosolic face of cell membranes.
   b. The concentrations of PIP2 species would be affected.
   c. Rab activities would be affected.
   d. All of the above.

2. In a cell with a clathrin mutation, which of the following would most likely be affected?

   a. Endocytosis.
   b. Transport of molecules from the endoplasmic reticulum to the golgi apparatus.
   c. Transport of molecules from the golgi apparatus to the endoplasmic reticulum.
   d. Transport of molecules between golgi cisternae.

3. Which of the following statements concerning vesicle regulation is **incorrect**?

   a. Inositol phospholipids are phosphorylated.
   b. Rab5-GDP is converted to Rab5-GTP by Rab5-GEF.
   c. Rab5A is localized on late endosomes.
   d. The presence of Rab5-GTP and PI(3)P forms a coincidence detector.

4. How many of the following complexes/proteins draw two lipid bilayers into direct contact?

   - Clathrin
   - Dynamin
   - SNARE proteins
   - Rab small GTPases

   a. 1
   b. 2
   c. 3
   d. 4

5. An artificial membrane-bound container is filled with purified tubulin subunits, a purfied centrosome, purified Dynein complexes and the necessary small molecules for protein activities. Over time, where would the Dynein complexes accumulate?

   a. Near the centre of the compartment.
   b. Near the outer membrane of the compartment.
   c. On microtubules throughout the compartment.
   d. Homogenously throughout the compartment.

6. How many of the following statements are true?

   - Actin subunits and tubulin subunits are both asymmetric.
   - Actin subunits and tubulin subunits both bind ATP.
   - Actin subunits and tubulin subunits are both monomeric.
   - Actin and tubulin filaments are both formed from multiple protofilaments.

   a. 1
   b. 2
   c. 3
   d. 4

7. Which of the following cells use diffusible extracellular signals as their primary mechanism to position themselves in space?

   a. Re-associating Xenopus germ layer cells and developing fly sensory bristle cells.
   b. Re-associating Xenopus germ layer cells and pathfinding commissural neurons.
   c. Pathfinding commissural neurons and migrating immune cells.
   d. Migrating immune cells and migrating neuronal cell bodies in the cerebral cortex.

8. Which of the following is least likely to be structurally supported by an actin network?

   a. The adherens junction.
   b. The growth cone.
   c. The cytokinetic ring.
   d. The Golgi apparatus.

9. An occludin mutation in _____ cells will directly affect _____.

   a. intestinal epithelial; glucose transport.
   b. *Drosophila* embryonic; movement of the outer epithelium.
   c. *Drosophila* embryonic; segmentation of the outer epithelium.
   d. epithelial; adherens junction formation.

10. How many of the following statements regarding connective tissue are **incorrect**?

    - Cells use treadmilling actin networks and integrins to move through the tissue.
    - The tissue is primarily supported by direct connections between cells.
    - The tissue forms our skin.
    - Connective tissue cells include muscle cells.

    a. 1
    b. 2
    c. 3
    d. 4

11. Which of the following statements concerning cell polarity cues/landmarks is correct?

    a. In *C. elegans*, the area where the sperm enters the egg is the area that develops anterior cues.
    b. Landmarks only induce apical cues since basal membrane properties are simply the absence of apical molecules.
    c. Complexes at the adherens junction signal regions nearby to develop apical cues.
    d. The high expression of adherens junctions serve as landmarks for tumor development.

12. Which of the following statements concerning sea urchin gastrulation is correct?

    a. Initially, epithelial cells break loose and crawl over the inner face of the wall of the blastula, becoming the endoderm.
    b. Three germ layers are created: the endoderm, mesoderm and epidermis.
    c. The mesoderm develops into the muscles and nervous system.
    d. The endoderm develops into the gut and lungs.

13. What two processes are primarily responsible for plant tissue morphogenesis?

    a. Cell division and cell shape change.
    b. Cell shape change and cell sorting.
    c. Cell sorting and cell migration.
    d. Cell migration and cell division.

14. Which of the following statements makes the best argument for a common evolutionary origin for animals?

    a. Specific germ layers are positioned inside embryos using the same morphogenesis mechanisms in different animals.
    b. Specific Homeotic selector genes are expressed in the same sequence along the body axis of different animals.
    c. Specific neuronal connections are made between the same cells in different animals.
    d. All of these statements are true and make equally strong arguments.

15. Sonic hedgehog (Shh) acts mainly via what type of signaling?

    a. Synaptic.
    b. Endocrine.
    c. Contact-dependent.
    d. Paracrine.

16. You perform a transplant experiment, and find that the transplanted tissue only affects cells of the host that are in direct contact with the transplant. Which source materials would be the best to purify the core signalling molecules involved?

a. Secreted molecules of the transplant tissue and plasma membranes of the host tissue.
b. Secreted molecules of the transplant tissue and secreted molecules of the host tissue.
c. Plasma membranes of the transplant tissue and plasma membranes of the host tissue.
d. Plasma membranes of the transplant tissue and secreted molecules of the host tissue.

17. How many of the following statements concerning cell differentiation are correct?

- Morphogens specify multiple and different body parts across a field of cells.
- Regulatory hierarchies specify a single important body part.
- Hox genes initiate embryo segmentation.
- Notch signalling directly promotes the differentiation of isolated cells.

a. 1
b. 2
c. 3
d. 4

18. Which of the following statements concerning somatic cell nuclear transfer is correct?

a. A nucleus from a terminally differentiated cell cannot be used to make a stem cell.
b. No male cells are directly necessary for reproductive cloning.
c. Only certain animal tissues can be created for therapeutic use.
d. Fluorescence-Activated Cell Sorting must be used in this process.

19. You develop a new technique to label the DNA of single cells in human adults. For which of the following cells would the initial labelling of one cell remain in that one cell?

a. A transit amplifying cell and a basal skin cell.
b. A basal skin cell and a photoreceptor cell.
c. A photoreceptor cell and an outer hair cell.
d. An outer hair cell and most cells of the crypt.

20. Which of the following form stem cell niches?

a. Osteoclast cells in the bone and osteoblast cells in the bone.
b. Osteoblast cells in the bone and basal lamina in the skin.
c. Basal lamina in the skin and macrophage cells in the bone.
d. Macrophage cells in the bone and squames in the skin.

21. Which of the following statements about signalling is true?

a. Negative feedback allows cells to detect changes in signalling.
b. Positive feedback leads to oscillations in signalling.
c. Effective signalling depends on continual uninhibited signalling activity.
d. Intercellular signalling only occurs in multicellular organisms.

22. In signalling via GTP-binding proteins, inhibition of GAP activity will result in which of the following?

a. Slower GEF activity, resulting in a longer inactive signal.
b. Slower GTPase activity and a longer active signal.
c. Faster GEF activity, resulting in a longer active signal.
d. Faster GTPase activity and a longer inactive signal.

23. Which of the following does not travel into the cell for cell signaling?

a. Vitamin D.
b. A product of nitroglycerine used to treat heart pain.
c. Molecules we detect as odours.
d. Steroid hormones.

24. If cells were treated with a chemical that directly inhibits PKA, which of the following would also be inhibited?

a. GPCR activation.
b. Adenylyl cyclase activation.
c. Cyclic AMP production.
d. CREB-mediated gene transcription.

25. What is the correct order for the following signalling steps, from first to last?

I. Sevenless activation
II. Activation of MAP kinase kinase kinase
III. Ras-GTP binding
IV. Ras-GEF activation
V. Phosphorylation of MAP kinase

a. I, IV, III, II, V
b. I, IV, III, V, II
c. IV, III, I, II, V
d. IV, III, I, V, II

26. Which of the following changes would stop bacterial tumbling?

a. Increasing CheA phosphorylation.
b. Increasing CheZ activity.
c. Increasing CheY phosphorylation.
d. Increasing repellent concentration.

27. Which of the following statements regarding signalling is **incorrect**?

a. Signal relays do not change the basic form of the signal.
b. Distinct protein domains are connected by peptide binds to form complex signalling proteins.
c. When one molecule impacts another in a signalling pathway, the upstream molecule is called the effector.
d. Building multi-protein complexes helps insulate signalling pathways from each other.

28. Which of the following would be the slowest overall signalling process?

a. Altered cytoplasmic protein function in response to synaptic signalling.
b. Altered gene expression in response to synaptic signalling.
c. Altered cytoplasmic protein function in response to endocrine signalling.
d. Altered gene expression in response to endocrine signalling.

29. For a synaptic signalling event between two cells, place the following steps in the correct order.

1. Exocytosis leads to depolarization of the membrane.
2. Depolarization of the membrane opens sodium channels.
3. Sodium channels create an action potential.
4. The action potential triggers exocytosis.
5. The action potential opens sodium channels.

a. 2, 3, 5, 3, 5, 3, 4, 1
b. 2, 3, 4, 1, 2, 3, 4, 1, 5
c. 1, 2, 3, 5, 3, 5, 3, 4
d. a or c

30. How are Notch signalling and Hedgehog signalling similar?

a. They are both initiated by interactions between receptors from neighbouring cells.
b. In both cases, initial receptor activation involves immediate protein cleavage events.
c. In both cases, protein cleavage creates a functional molecule.
d. In both cases, initial receptor activation involves immediate phosphorylation.

31. Which of the following might produce a cellular effect that resembles the loss of p53?

a. X-ray-induced DNA damage.
b. Deletion of p21.
c. Deletion of Mdm2.
d. Proteasome inhibition.

32. How many of the following statements about the cell cycle are **incorrect**?

- Cdc25 counteracts CAK activity.
- Cdc25 counteracts Wee1 activity.
- Wee1 activity counteracts CAK activity.
- CAK activity counteracts M-Cdk activity.

a. 1
b. 2
c. 3
d. 4

33. Which statement comparing cyclins and Cdks in vertebrates versus budding yeast is most accurate?

a. The downstream effects of yeast cyclin-Cdk complexes must be specified solely by the cyclin present.
b. The downstream effects of yeast cyclin-Cdk complexes must be specified solely by the Cdk present.
c. The downstream effects of vertebrate cyclin-Cdk complexes must be specified solely by the cyclin present.
d. The downstream effects of vertebrate cyclin-Cdk complexes must be specified solely by the Cdk present.

34. Which of the following might trigger apoptosis?

a. A mutation inactivating the Fas receptor.
b. The movement of cytochrome c from the cytosol to the mitochondria.
c. The inhibition of Bcl-2.
d. IAP overexpression.

35. Using FACS, you isolate a population of cells (population 1) **with** phosphatidylserine in the outer leaflet of their plasma membranes and a second population (population 2) **without** phosphatidylserine in the outer leaflet of their plasma membranes. You analyze the DNA from both populations after electrophoresis through an agarose gel. What difference do you expect to see from this gel?

a. Population 1 will display smaller fragments of DNA compared with population 2.
b. Population 1 will display less gene expression compared with population 2.
c. Population 1 will show more chromosome translocations than population 2.
d. The DNA in populations 1 and 2 should be fairly similar because the phosphatidylserine is on the outside of the cells.

36. How many of the following statements accurately describe extrinsic and intrinsic mechanisms of caspase cascade activation?

- The signal from the triggering molecule crosses a membrane in each case.
- The first proteins recruited are not caspases in either case.
- The initiator caspase has an additional protein domain in each case.
- The complex formed for extrinsic activation is different from the one formed for intrinsic activation.

a. 1
b. 2
c. 3
d. 4

37. Which of the following is an oncogene?

a. Myc.
b. Bcl-2.
c. Rb.
d. Cytochrome c.

38. Which of the following is **NOT** a hallmark of cancer?

a. Increased cell proliferation.
b. Inhibition of differentiation.
c. Inhibition of cell death.
d. Increased cell adhesion.

39. What is a mechanism by which Gleevec-treated cancer cells could become resistant?

a. A mutation in the Bcr-Abl ATP-binding site that allows kinase activity.
b. Loss-of-function mutations in Bcr-Abl substrate proteins.
c. Fusion of the *Bcr* and *Abl* genes.
d. Down-regulation of fused *Bcr/Abl* mRNA.

40. Which of the following statements concerning p53 is **incorrect**?

a. p53 is a transcriptional regulator.
b. p53 activity leads to Cdk inhibitor protein activity.
c. Loss of p53 is sufficient for cancer development.
d. p53 activity increases via the ubiquitination and destruction of an inhibitor.

41. Which of the following concerning the ribosomal RNA operon in prokaryotes is CORRECT?

a. An RNA operon has several binding sites along its length that bind to sigma factors.
b. The RNA operon contains sequences that code for both rRNA and tRNA.
c. There is one copy of the RNA operon in the bacterial genome.
d. The ratio of 16S rRNA to 23S rRNA to 5S rRNA found in cells is 1:2:1.

42. You have three linear double-stranded fragments of DNA obtained by digestion with *Hae*III, which produces blunt ended fragments. Fragment 'A' is 4 kb long, fragment 'B' is 5 kb long and fragment 'C' is 6 kb long. Each fragment has a single *Bam*HI restriction site located exactly in the middle of the fragment.
You would like to ligate (covalently join) these fragments together so that they are in the following orientation:

B-C-A

Following ligation, you isolate only the linear 15 kb fragments. However, you are not sure whether the 15 kb fragments have fragments A, B and C in the desired orientation. You decide to digest these 15 kb fragments with *Bam*HI and separate the resultant fragments on an agarose gel. If many of the 15 kb fragments contain the desired B-C-A orientation, what size fragments would you hope to see on the gel?

a. 2 kb, 2.5 kb, 3 kb, 4.5 kb
b. 2.5 kb, 3 kb, 4.5 kb, 5 kb
c. 2 kb, 2.5 kb, 5 kb, 5.5 kb
d. 2 kb, 3 kb, 4.5 kb, 5.5 kb

43. Which of the following statements regarding the expected results of your RNA agarose gel in Lab 1 is CORRECT?

a. The 16S and 23S rRNA formed the brightest bands because they are twice as long as most mRNA.
b. The tRNA migrated the shortest distance from the well because it is smaller than most rRNA or mRNA.
c. The 16S, 23S, and 5S rRNA species formed the brightest bands because rRNA is the most abundant RNA in cells.
d. The mRNA was not visible because SybrSafe stain does not efficiently intercalate between the bases of mRNA.

44. Which of the following would be an essential control during a PCR assay of ancient DNA?

A PCR tube:

a. without *Taq* DNA polymerase.
b. without template DNA.
c. with amino acids that were well-preserved in the original sample.
d. with depurinated DNA molecules from the original sample.

45. Which of the following is the BEST way to determine the size of a particular transcript in a specific cell type?

a. Perform a microarray analysis.
b. Perform a PCR assay.
c. Perform a northern blot.
d. Perform a Gel-Mobility Shift Assay (or EMSA).

46. Imagine that you are a researcher wishing to study the length of time a protein stays within an organelle before the protein is degraded. You already know that once the protein arrives in the organelle it does not leave until it is degraded. Which of the following techniques would be the BEST for this study?

a. Photoactivation.
b. Fluorescence Recovery after Photobleaching.
c. Fluorescence Loss in Photobleaching.
d. Fluorescence Correlation Spectroscopy.

47. You have digested a plasmid with *Eco*RI and expect to obtain fragments 5000 bp, 3000 bp, and 2000 bp in length. Given that you used 5.0 µl of plasmid DNA at a concentration of 1.0 µg/µl, how many µg of the 2000 bp fragment would you expect to be present in your *Eco*RI digest?

a. 2.0 µg
b. 5.0 µg
c. 1.25 µg
d. 1.0 µg

48. Which of the following regarding kinesin in wild-type *Drosophila* oogenesis is **CORRECT**?

a. It is a ß-galactosidase fusion protein.
b. It is a minus-end directed microtubule motor protein.
c. It may be used to transport mRNAs or proteins in the oocyte.
d. It requires ß-galactosidase in order to be translocated to the posterior part of the oocyte.

49. When you extracted RNA in Lab 1 you used potassium acetate in one of the steps. Which of the following is the BEST description of the function of potassium acetate in Lab 1?

a. It reacts with lysozyme, and is required to rupture the cell wall of procaryotes.
b. It reacts with SDS, forming an insoluble precipitate that permits the removal of protein and large fragments of DNA.
c. It selectively precipitates organellar membranes so the DNA can be separated from the RNA.
d. It is required to chelate Mg^{2+} ions so RNAses can be precipitated and removed.

50. Imagine that you wanted to be able to be able to visualize a protein that in a developing organism tends to be transported relatively quickly around the cell. You have tagged this protein with a fluorescent marker and want to be able to track its movement through the cell in a three-dimensional space. Which of the following microscopy techniques would be the best for your study?

a. Phase contrast microscopy.
b. Confocal microscopy.
c. Bright-field microscopy.
d. Fluorescence microscopy.

51. Imagine that your plant cells in Lab 4 do not show any fluorescence after you correctly followed the protocol for FDA staining. Which of the following is NOT a possible explanation for your findings?

a. The plant cells are dead.
b. The esterases in your plant cells are inactive.
c. The pH in your plant cells was not optimal.
d. The fluorescein could not diffuse across the cell membrane into the cell.

52. With respect to Lab 3, which of the following describes a CORRECT relationship between the distance that digested lambda DNA fragments migrated in the gel during electrophoresis, and the size of those fragments?

    a. Linear DNA fragments migrate at rates that are inversely proportional to the $\log_{10}$ of their molecular weights.
    b. Linear DNA fragments migrate at rates that are inversely proportional to the percentage of agarose in the gel.
    c. Circular DNA fragments migrate at rates that are inversely proportional to the $\log_{10}$ of their molecular weights.
    d. Circular DNA fragments migrate at rates that are inversely proportional to the percentage of agarose in the gel.

53. Which of the following statements about *Drosophila* is **TRUE**?

    a. mRNA and proteins in stage 10 follicles are distributed with bilateral symmetry.
    b. Embryonic germ cells give rise to the head of the adult fly.
    c. Peroxisomes transport mRNA and proteins to different areas of the oocyte.
    d. The polarity of the oocyte determines the polarity of the embryo.

THE END