MULTIPLE CHOICE QUESTIONS

1. It is advantageous for cells to be small because:
   A. a small cell size prevents a cell from weighing too much.
   B. a small cell size occupies less space in nature where space is limited.
   C. a small cell has a small volume relative to surface area, thereby increasing efficient transport.
   D. a small cell has a small surface area relative to volume, thereby facilitating ion balance.
   E. a small cell is better able to conserve energy than a larger cell.

2. One strategy that allows larger cells to have an effective surface area to volume ratio is:
   A. having a completely spherical shape.
   B. being short and fat.
   C. having thin, finger-like projections.
   D. having a thinner plasma membrane.
   E. locomotion.

3. You want to determine the location of a specific protein in a cell using a colored stain. Which of the following is the best technique for this purpose?
   A. electron microscopy
   B. phase contrast microscopy
   C. bright-field microscopy
   D. fluorescence microscopy
   E. dark-field microscopy

4. Electron microscopes have a much higher resolution than either the human eye or any light microscope because:
   A. of their higher magnification.
   B. the lenses used are of much higher quality.
   C. of the very short (nanometer) wavelengths of electrons.
   D. the images are viewed on screens, rather than directly using an eyepiece or ocular lens.
   E. All of these.

5. The scanning electron microscope differs from the transmission electron microscope in that the scanning electron microscope:
   A. can view a live specimen.
   B. relies on the detection of electrons from the beam after contact with the specimens.
   C. can view the internal structure of a cell.
   D. utilizes a beam of light that passes through the specimen.
   E. gives a three dimensional image of the object being studied.

6. Differential centrifugation is a process that:
   A. separates different components of the cell that function differently.
   B. separates components of the cell that have a different chemical makeup.
   C. analyzes the chemical components of the cell.
   D. separates components of the cell that have different densities.
   E. allows researchers to view the contents of the cells.
7. Which of the following structures or activities is NOT directly part of the endomembrane system?
   A. ER
   B. lysosomes
   C. ribosomes
   D. peroxisomes
   E. Golgi complex

8. DNA is associated with proteins, forming a complex called:
   A. chromosomes.
   B. nucleoli.
   C. nucleus.
   D. genes.
   E. chromatin.

9. Nucleoli contain chromosomal regions that specialize in making:
   A. proteins.
   B. RNA.
   C. ribosomes.
   D. lipids.
   E. hormones.

10. A single cell in a smoker’s lung has become cancerous. It doubles its DNA and divides much faster than a normal lung cell. The most likely change that would have caused this condition took place in the:
    A. nucleus.
    B. nucleolus.
    C. microtubule.
    D. mitochondria.
    E. lysosome.

11. If a toxin, such as a bacterial toxin, destroys ribosomes, what cellular activity will be affected first?
    A. protein synthesis
    B. DNA synthesis
    C. movement
    D. energy storage
    E. active transport

12. The smooth endoplasmic reticulum:
    A. is absent in most plant cells.
    B. synthesizes proteins.
    C. provides structural support.
    D. synthesizes lipids.
    E. is required for ribosome synthesis.

13. Proteins made on ribosomes may be further modified within the:
    A. lysosomes.
    B. nucleus.
    C. mitochondria.
    D. Golgi complex.
    E. peroxisomes.
14. The **cis face** of the Golgi complex is most directly involved in which of the following?

A. packaging molecules in vesicles  
B. accepting vesicles from the ER  
C. synthesizing proteins  
D. transporting molecules out of the Golgi  
E. catalyzing the efficient folding of proteins

15. A glycoprotein destined for secretion from the cell would move through the Golgi complex in this sequence:

A. **cis face** to **medial region** to **trans face**  
B. **trans face** to **cis face** to **medial region**  
C. **trans face** to **medial region** to **cis face**  
D. **cis face** to **trans face** to **medial region**  
E. **medial face** to **trans face** to **cis face**

16. During an infection, white blood cells travel to the infected site and phagocytize the pathogens. After phagocytosis, primary lysosomes fuse with the phagocytic vesicle to form a larger vesicle called a secondary lysosome. The reason for this is:

A. to introduce antibodies to the phagocytic vesicles.  
B. to wrap the pathogen in additional membrane, rendering them harmless.  
C. to coat the bacteria in lipids derived from the Golgi complex, which cover and smother them.  
D. to mix the pathogens with strong hydrolytic enzymes and destroy them.  
E. to prepare the bacteria for export from the body.

17. All of the following functions are performed by plant vacuoles EXCEPT:

A. maintaining hydrostatic (turgor) pressure.  
B. waste storage and recycling.  
C. storage of proteins.  
D. breakdown of unneeded cellular materials.  
E. storage of nucleic acids.

18. One function of peroxisomes involves the process of:

A. cell death.  
B. water storage.  
C. protein synthesis.  
D. DNA replication.  
E. detoxification.

19. The theory that chloroplasts and mitochondria had their evolutionary beginnings in eukaryotic cells as endosymbionts is supported by all of the following EXCEPT:

A. chloroplasts and mitochondria are completely autonomous within eukaryotic cells.  
B. chloroplasts and mitochondria have DNA.  
C. chloroplasts and mitochondria have small ribosomes for protein synthesis.  
D. chloroplasts and mitochondria are approximately the same size as prokaryotic cells.  
E. chloroplasts and mitochondria have the same shape as prokaryotic cells.
20. Which of the following organelles plays an important role in apoptosis, or programmed cell death?
A. ribosomes
B. mitochondria
C. chloroplasts
D. vacuoles
E. peroxisomes

21, 22. Use the figure to answer the corresponding questions.

21. If you treated this organelle to remove ONLY the chlorophyll, which label indicates the portion of the organelle that would be most directly affected by this treatment?
A. A
B. B
C. C
D. D
E. E

22. The formation of carbohydrates from carbon dioxide and water occurs in the portion of this figure labeled:
A. A
B. B
C. C
D. D
E. E

23. Which of the following is a key component of the cytoskeleton?
A. centrosome
B. microtubules
C. DNA
D. ribosomes
E. endoplasmic reticulum

24. You isolate a cellular structure and determine that it is composed of α-tubulin and β-tubulin. Based on this evidence, you correctly identify this structure as:
A. a structural MAP.
B. a microfilament.
C. a microtubule.
D. an actin filament.
E. a myosin filament.
25. Which of the following pairs is correctly matched?
   A. chloroplast—storage of enzymes
   B. lysosome—powerhouse of the cell
   C. centrosome (MTOC)—cell division
   D. plastids—structural support of the cell
   E. Golgi complex—production of energy

26. The force necessary to cause microtubules of cilia and flagella to slide alongside one another is provided through the action of _______ proteins, which derive the energy to perform their work directly from ______ molecules.
   A. kinesin; ADP
   B. kinesin; glucose
   C. tubulin; ATP
   D. dynein; ATP
   E. dynein; ADP

27. A basal body is most closely related to a:
   A. ribosome.
   B. thylakoid.
   C. centriole.
   D. centrosome.
   E. lysosome.

28. As a result of testing an experimental drip on a vertebrate cell, you notice that the cell cortex becomes more fluid, and although the cell remains strong, it loses its ability to move. Based on this evidence, you correctly conclude that the drug most directly affected:
   A. α-tubulin.
   B. β-tubulin.
   C. actin filaments.
   D. myosin.
   E. intermediate filaments.

29. The structures in the micrograph are:
   A. chloroplasts.
   B. cilia.
   C. rough ER
   D. flagella.
   E. B and D
30. Intermediate filaments are most closely associated with which of the following?
   A. actin.
   B. microvilli.
   C. pseudopodia.
   D. keratins.
   E. myosin.

31. Which of the following pairs is correctly matched?
   A. middle lamella—cellulose
   B. integrins—receptors
   C. primary cell wall—pectin
   D. fibronectins—wood
   E. secondary cell wall—glycoproteins

32. Which of the following is NOT a cell covering or part of a cell covering?
   A. glycocalyx
   B. extracellular matrix
   C. cristae
   D. cell wall
   E. integrins

33. Which of the following is/are located between the primary walls of adjacent cells?
   A. intermediate filaments
   B. myosin
   C. actin filaments
   D. middle lamella
   E. secondary wall

34. Quorum sensing would most likely occur when:
   A. *Dictyostelium* senses cyclic AMP.
   B. tobacco plants are attacked by insects.
   C. bacteria reach a certain critical concentration.
   D. predator insects eat herbivorous insects.
   E. insulin binds to target cells.

35. Which of the following lists the correct sequence of events involved in cell signaling?
   A. amplifying, signal transducing, receiving, responding
   B. signal transducing, sending, receiving, terminating
   C. sending, signal transducing, receiving, amplifying
   D. receiving, sending, signal transducing, responding
   E. sending, receiving, signal transducing, responding

36. Paracrine signaling is different from other types of signaling in that the signaling molecule:
   A. is produced by endocrine glands.
   B. binds to a receptor.
   C. is secreted by neurons.
   D. is transported in the blood.  E. acts on nearby cells.
37. Which of the following is stored in cells of the immune system and released during an allergic reaction?
   A. nitric oxide  
   B. a growth factor  
   C. histamine  
   D. a prostaglandin  
   E. a neurotransmitter

38. Which of the following is released by cells lining blood vessels and causes an increase in blood pressure?
   A. histamine  
   B. acetylcholine  
   C. cyclic AMP  
   D. nitric oxide  
   E. prostaglandin

39. Which of the following would most likely diffuse across a synapse?
   A. insulin  
   B. NO  
   C. histamine  
   D. acetylcholine  
   E. prostaglandins

40. Which of the following statements concerning receptors is FALSE?
   A. They are found inside the cell and on the cell surface.  
   B. They are proteins or glycoproteins.  
   C. They are also called ligands.  
   D. They are highly selective.  
   E. They are activated by binding to a signaling molecule.

41. A receptor on the cell surface usually has several domains. The function of the external domain is:
   A. transmitting the signal to the inside of the cell.  
   B. holding the receptor within the membrane.  
   C. attaching the receptor to the DNA.  
   D. functioning as an enzyme.  
   E. binding the signaling molecule.

42. A receptor in plant cells that responds to red light is:
   A. brassinolide.  
   B. diacylglycerol.  
   C. rhodopsin.  
   D. cryptochrome.  
   E. phytochrome.
43. Under which of the following situations would receptor down-regulation most likely occur?
   A. The concentration of a neurotransmitter is too low.
   B. The concentration of a hormone is too high.
   C. The number of receptors in the plasma membrane is too low.
   D. The number of G proteins is too high.
   E. The cell is unable to manufacture cyclic AMP.

44. As a result of receptor up-regulation:
   A. the number of genes that code for a receptor increases.
   B. the sensitivity of a cell to a hormone decreases.
   C. the number of receptors decreases.
   D. the concentration of hormone molecules in the blood increases.
   E. a hormone's signal is amplified.

45. In contrast to a G protein-linked receptor and an enzyme-linked receptor, a channel-linked receptor:
   A. is located on the cell surface.
   B. is composed of seven alpha helices.
   C. couples signaling molecules to signal transduction pathways.
   D. is a ligand-gated channel.
   E. functions as a tyrosine kinase.

46. When acetylcholine binds its receptor on the surface of a muscle cell, which of the following happens next?
   A. G protein is activated.
   B. Tyrosine kinase is activated.
   C. Tyrosine is phosphorylated.
   D. A neurotransmitter crosses the synapse.
   E. A sodium gate opens.

47. The outer part of a G protein receptor binds _____, and its inner part binds _____.
   A. the signaling molecule; tyrosine kinase
   B. the signaling molecule; a G protein
   C. G protein; tyrosine kinase
   D. G protein; an ion channel
   E. an ion channel; a G protein

48. An example of a signaling molecule that binds with a receptor on the cell surface is:
   A. insulin.
   B. ecdysone.
   C. Vitamin D.
   D. Vitamin A.
   E. nitric oxide.
49. Which of the following statements concerning intracellular receptors is FALSE?
   A. Their ligands are hydrophobic.
   B. Most are transcription factors.
   C. Some are located in the cytosol.
   D. After binding their ligand, they move out of the cell.
   E. Some are bound to DNA.

50. One difference between the ion channel-linked receptors for GABA and acetylcholine is that when GABA binds its receptor:
   A. muscle contraction is inhibited.
   B. sodium ions enter the cell.
   C. muscle contraction is stimulated.
   D. neural signaling is inhibited.
   E. chloride ions rush out of the neuron.

51. An example of a neurotransmitter that opens ligand-gated sodium channels is:
   A. GABA.
   B. acetylcholine.
   C. ecdysone.
   D. NO.
   E. cortisol.

52. When a receptor binds to its G protein, which of the following happens next?
   A. The signaling molecule binds to the receptor.
   B. The G protein activates an enzyme.
   C. The three G protein subunits come together.
   D. GTP is replaced by GDP.
   E. GDP is replaced by GTP.

53. Which of the following statements concerning G protein is FALSE?
   A. Its subunits can separate.
   B. One subunit is a GTPase.
   C. One subunit binds GTP.
   D. One subunit binds GDP.
   E. One subunit binds ATP.

54. A molecule that is a first messenger but not a second messenger is:
   A. cyclic AMP.
   B. G protein.
   C. adenylyl cyclase.
   D. protein kinase.
   E. acetylcholine.

55. An example of a second messenger is:
   A. protein kinase A.
   B. an ion channel.
   C. cyclic AMP.
   D. GABA.
   E. insulin.
56. Adenylyl cyclase catalyzes the reaction in which:
   A. a protein is phosphorylated.
   B. ATP is converted to cAMP.
   C. GTP is converted to GDP.
   D. PIP₂ is split.
   E. calcium ions bind calmodulin.

57. In the signal transduction pathway involving cAMP, once cAMP is formed, it then activates:
   A. protein kinase A.
   B. adenylyl cyclase.
   C. G protein.
   D. protein kinase C.
   E. IP₃.

58. A protein kinase catalyzes the reaction in which:
   A. a protein loses a phosphate group.
   B. a protein is phosphorylated.
   C. G protein is activated.
   D. ATP is converted to cAMP.
   E. GTP is converted to GDP.

59. In the cAMP signal transduction pathway, once a protein kinase is activated, which of the following happens next?
   A. G protein is activated.
   B. Adenylyl cyclase is activated.
   C. GDP is replaced by GTP.
   D. cAMP is converted to ATP.
   E. The protein kinase activates a cellular response.

60. Phospholipase C catalyzes the reaction in which:
   A. IP₃ is converted to DAG.
   B. PIP₂ is split.
   C. a protein kinase is activated.
   D. calcium ions are released from the ER.
   E. DAG is converted to PIP₂.

61. In the phospholipase C signal transduction pathway, which are second messengers?
   A. phospholipase C and G protein
   B. PIP₂ and IP₃
   C. cAMP and IP₃
   D. phospholipase C and protein kinase A
   E. IP₃ and DAG

62. What activates protein kinase C?
   A. IP₃
   B. DAG
   C. cAMP
   D. PIP₂
   E. calcium ions
63. In the IP₃ pathway, what is the function of IP₃?
   A. activate protein kinase C
   B. activate phospholipase C
   C. phosphorylate a protein
   D. bind calcium channels in the ER
   E. activate adenylyl cyclase

64. Calmodulin is a:
   A. hormone.
   B. calcium-binding protein.
   C. phosphatase.
   D. protein kinase.
   E. phospholipase.

65. Which of the following statements concerning calmodulin is FALSE?
   A. It activates protein kinases.
   B. It activates phosphatases.
   C. It is a protein.
   D. It is found in all eukaryotic cells studied.
   E. It binds a maximum of three calcium ions.

66. Most enzyme-linked receptors are:
   A. phospholipases.
   B. adenylyl cyclases.
   C. tyrosine kinases.
   D. G proteins.
   E. ion channels.

67. Which of the following statements concerning Ras proteins is FALSE?
   A. They are inactivated when phosphorylated.
   B. They are G proteins.
   C. They are active when bound to GTP.
   D. They are activated by tyrosine kinase receptors.
   E. They include MAP kinases.

68. The main signaling cascade for cell division and differentiation is the _______ cascade.
   A. phospholipase C
   B. MAP kinase
   C. phosphoinositol
   D. cAMP
   E. calcium-calmodulin
69. You conduct an experiment in which you inactivate Ras proteins in fibroblast cells. Which of the following is the most immediate consequence of this procedure?

A. The fibroblasts synthesized excess G protein.
B. The fibroblasts synthesized excess DAG.
C. The fibroblasts no longer responded to calmodulin.
D. The fibroblasts no longer synthesized DNA in response to growth factors.
E. The fibroblasts divided uncontrollably.

70. The function of scaffolding proteins is to:

A. phosphorylate proteins in a cascade.
B. dephosphorylate proteins in a cascade.
C. convert ATP and GTP to cAMP and cGMP, respectively.
D. regulate the MAP kinase pathway.
E. stimulate the release of calcium ions from the ER.

71. When *Arabidopsis thaliana* is exposed to drought conditions, the concentration of abscisic acid concentration ______ which leads to the _______.

A. increases; opening of stomata
B. increases; closing of stomata
C. decreases; opening of stomata
D. decreases; closing of stomata
E. decreases; further dehydration of the plant

72. The cholera toxin causes a(n) ______ of chloride channels in cells of the intestine and the resulting _______.

A. closing; loss of blood
B. closing; movement of neutrophils toward the bacterium
C. opening; assembly of microtubules
D. opening; gain of water
E. opening; loss of water

73. Choanoflagellates have been important for the study of cell communication evolution because choanoflagellates have:

A. signal transduction pathways unlike those in other bacteria.
B. signaling molecules similar to those of other protists.
C. signal transduction pathways that interfere with the cells they infect.
D. protein kinases similar to those in animals.
E. G proteins different from those in prokaryotes.

Please complete the short answers on the next page and have a super-duper weekend.
Short Answer Questions

Please type on a separate sheet of paper.

1. Pick one of the following medical conditions. Describe the likely cellular organelle or structure that has been affected in such a way as to cause the condition (note: There may be more than one organelle or structure involved):

   A. The sperm of a man cannot swim, thus rendering him infertile.
   B. A child experiences kidney failure due to Fabry’s disease where the cells lining the inside of the kidney tubule accumulate abnormally large amounts of glycolipids that are usually degraded by enzymes.
   C. A person dies within minutes after ingesting cyanide because ATP is no longer being synthesized.

2. Explain the differences between receptor up-regulation and down-regulation including the conditions under which a cell would use one rather than the other.