

These review questions are for Bio 1 Signal transduction topic. The questions were adapted from several sources, including the textbook's review questions.

1) Which of the following is characterized by a cell releasing a signal molecule which diffuses into the local environment, followed by nearby cells responding?

- A) hormonal signaling
- B) autocrine signaling
- C) paracrine signaling
- D) endocrine signaling
- E) synaptic signaling

2) You are doing an experiment to track the movement of signal molecules inside the body of a particular species of mammal, from the point in the body where the molecules are secreted to the point where the molecules bind their receptors. You find that signal molecule A travels 20X faster than signal molecule B. What might explain these results?

- A) Molecule A is a hormone and molecule B is a paracrine.
- B) Molecule B travels by osmosis.
- C) Molecule A is a paracrine and molecule B is a hormone.
- D) Molecule A is much larger than molecule B.

3) The final change in a cell's activity as a result of binding a signal molecule is called the...

- A) cellular output response
- B) signal transduction
- C) allosteric resgulation
- D) phosphorylation cascade
- E) positive feedback loop

4) Because most receptors are membrane proteins, which of the following is usually true?

- A) They lead to changes in intracellular ion concentration.
- B) They open and close channels in response to protein signals.
- C) They are only attached to one membrane surface: exterior or interior.
- D) They preferentially bind with lipid or glycolipid signal molecules.
- E) Their intracellular region changes its conformation when signal molecule binds.

5) When a signal transduction pathway operates via phosphorylation of a series of relay proteins, the phosphorylation of each relay protein...

- A) causes a shape change to that relay protein.
- B) requires binding of a hormone to a receptor in the cytoplasm.
- C) requires GTP because it is the source of phosphates used in signal transduction.
- D) requires cAMP because it is the source of phosphates used in signal transduction.

E) requires target cells to move within the body to activate other cells.

6) An enzyme that adds a phosphate functional group to amino acids is called a...

- A) ATPase
- B) kinase
- C) cyclase
- D) amino phosphotase
- E) ATP synthase

7) Which of the following amino acids are frequently phosphorylated by protein kinases in the cytoplasm during signal transduction?

- A) tyrosine, glycine, and histidine
- B) glycine, histidine, and serine
- C) serine, threonine, and tyrosine
- D) glycine and glutamic acid
- E) Any of the 20 amino acids are equally phosphorylated.

8) One of the major categories of receptors in the plasma membrane reacts to signal molecule by forming dimers, adding phosphate groups to themselves, and then activating relay proteins. Which type does this?

- A) G protein-coupled receptors
- B) ligand-gated ion channels
- C) steroid receptors
- D) tyrosine kinase receptors

9) Signal transduction through tyrosine kinase receptors often

- A) Leads to production of the second messenger cAMP
- B) Leads to production of the second messenger IP_3
- C) Stimulates gene expression by the receptor binding to a promoter
- D) Leads to the activation of a cascade of kinase enzymes
- E) Increases the amount of calcium ion in the cytoplasm

10) The phosphates that tyrosine kinase receptors add to their own amino acids activate relay proteins in this way:

- A) The phosphates on the receptor stay on the receptor but cause relay proteins to dimerize.
- B) The phosphates on the receptor are transferred to relay proteins, activating the relay proteins.
- C) The phosphates on the receptor stay on the receptor but act as allosteric activators of relay proteins.
- D) The phosphates on the receptor are transferred to ADP, forming ATP to act as an

energy source for the cellular response enzymes.

E) The phosphates on the receptor cause relay proteins to trimerize.

11) When a G protein-linked receptor binds signal molecule, the first relay protein to be activated is...

A) adenylyl cyclase.

B) phospholipase C.

C) G-protein

D) tyrosine kinase.

E) serine/threonine kinase.

12) When a G protein becomes activated, it moves...

A) laterally in the plasma membrane.

B) deeper into the cytoplasm.

C) outward through the plasma membrane (exocytosis/secretion).

D) into the nucleus to promote gene transcription.

E) to the receptor's signal molecule binding site.

13) What is the first event that occurs when a signal molecule binds to a G protein linked receptor?

A) The G protein releases a GDP and binds a GTP

B) The G protein dissociates (moves away from) the receptor

C) The G protein interacts with the next relay protein

D) The receptor dimerizes with a second G protein linked receptor

14) After a signal molecule has bound to a G protein-linked receptor and signal transduction has successfully occurred, eventually the cell needs to stop the signal transduction pathway (otherwise the cell would be forever stuck doing the cellular output response to the signal molecule). An enzyme that the cell could use to halt the signal transduction pathway described above might be an enzyme that...

A) increases the available concentration of phosphate.

B) increases the amount of IP₃ in the cell.

C) converts GTP to GDP.

D) converts cGMP to GTP.

E) phosphorylates protein kinases.

15) A major group of G protein-linked receptors contains seven transmembrane alpha helices. The amine end of the protein lies at the exterior of the plasma membrane. Loops of amino acids connect the helices either at the exterior face or on the cytoplasmic face of the membrane. The loop on the cytoplasmic side between helices 5 and 6 is usually substantially longer than the others. Considering all the information given above, where

would you expect to find the carboxyl end of the receptor protein?

- A) at the exterior surface
- B) at the cytoplasmic surface
- C) connected with the loop at H5 and H6
- D) between the membrane layers

16) A major group of G protein-linked receptors contains seven transmembrane alpha helices. The amine end of the protein lies at the exterior of the plasma membrane. Loops of amino acids connect the helices either at the exterior face or on the cytoplasmic face of the membrane. The loop on the cytoplasmic side between helices 5 and 6 is usually substantially longer than the others.

Considering all the information given in the problem above, the G protein that is activated by this receptor most likely interacts with this receptor...

- A) at the amine end.
- B) at the carboxylic acid end.
- C) at the signal molecule binding site.
- D) along its hydrophobic transmembrane domains.
- E) at the loop between helix 5 and helix 6.

17) If you wish to alter a G protein-linked receptor such that it still could bind its signal molecule but it was unable to carry out any signal transduction, you should change which region of the receptor?

- A) the exterior (extracellular) end of the receptor
- B) the binding site for signal molecule
- C) the transmembrane domains
- D) the amino acid sequence in the receptor's binding site for the G protein
- E) the amino acid sequence in the receptor's binding site for the adenylyl cyclase or phospholipase C

18) Epinephrine hormone causes liver cells to secrete glucose into the blood. If you were researching the signal transduction pathway involved in this process, you would suspect that the epinephrine receptor is a G protein-linked receptor if you found that...

- A) liver cells secrete epinephrine into the blood.
- B) liver cells have receptors for epinephrine in the blood.
- C) liver cells secrete GTP into the blood.
- D) the epinephrine receptors dimerize when epinephrine binds to them.
- E) epinephrine causes an increase in cAMP in the liver cells.

19) The binding of a certain hormone to its receptor results in the activation of the enzyme adenylyl cyclase. The receptor is...

- A) a G protein-linked receptor.

- B) an ion channel.
- C) phospholipase C.
- D) a tyrosine kinase receptor.

20) The binding of a certain hormone to its receptor results in the activation of the enzyme adenylyl cyclase. A secondary messenger in this signal transduction pathway is...

- A) Ca^{2+}
- B) phosphate ion
- C) cAMP
- D) tyrosine kinase
- E) paracrines.

21) What is the substrate molecule of adenylyl cyclase?

- A) GTP
- B) GDP
- C) CIA
- D) cAMP
- E) ATP

22) Consider this pathway: epinephrine \rightarrow G protein-linked receptor \rightarrow G protein \rightarrow adenylyl cyclase \rightarrow cAMP. Which part of the pathway is not a membrane protein?

- A) cAMP
- B) G protein
- C) G protein-linked receptor
- D) adenylyl cyclase

23) How exactly does cAMP activate the subsequent parts of the signal transduction pathway?

- A) It causes GTP to bind to the G-protein linked receptor.
- B) It causes GTP to bind to the G-protein.
- C) It is the substrate for increased ATP synthesis to power the cellular output response.
- D) It releases Ca^{2+} ions into the cytoplasm.
- E) It is an allosteric activator of the next relay protein.

24) Which membrane enzyme can be activated by G-proteins?

- A) Tyrosine kinase receptors.
- B) Phospholipase C.
- C) Serine kinase receptors.
- D) ATP synthase.
- E) G-protein linked receptors.

25) Activated phospholipase C directly makes this secondary messenger:

- A) cAMP
- B) Ca^{2+}
- C) Inositol triphosphate
- D) Na^+
- E) GTP

26) Activated phospholipase C directly makes a secondary messenger from...

- A) ATP
- B) Ca^{2+} stored in the endoplasmic reticulum
- C) membrane phospholipids
- D) extracellular ions
- E) G-protein linked receptors

27) Why do cells store Ca^{2+} in their endoplasmic reticulum?

- A) as a building block for the cytoskeleton
- B) to neutralize negative ions that enter the cell through ion channels
- C) For use as a secondary messengers
- D) to neutralize the phosphate ions used in signal transduction
- E) as a hormone

28) An inhibitor of which of the following could be used to block the release of calcium from the endoplasmic reticulum?

- A) tyrosine kinases
- B) serine kinases
- C) threonine kinases
- D) phospholipase C
- E) adenylyl cyclase

29) Which of the following would be inhibited by a drug that specifically blocks the addition of phosphate groups to proteins?

- A) G protein-coupled receptor signaling
- B) ligand-gated ion channel signaling
- C) adenylyl cyclase activity
- D) Ca^{2+} activity
- E) tyrosine kinase receptor activity

30) Which one of the following statements is true of signal molecules?

- A) When signal molecules first bind to receptor tyrosine kinases, the receptors phosphorylate a number of nearby molecules.

- B) In response to some G protein-mediated signals, a special type of lipid molecule associated with the endoplasmic reticulum is cleaved.
- C) In most cases, signal molecules cause their effects by entering the cell and binding to allosteric sites on the relay proteins they activate.
- D) A drug that interfered with the ability of G proteins to hydrolyze GTP to GDP would block the ability of cells to respond to signal molecules that use G protein-linked receptors.
- E) Phospholipase C activation is one possible result of signal molecules binding to G protein-linked receptors.

31) Binding of a signaling molecule to which type of receptor leads directly to an increase in the passage of ions through the cell membrane?

- A) receptor tyrosine kinase
- B) G protein-coupled receptor
- C) phosphorylated receptor tyrosine kinase dimer
- D) ion channel receptors
- E) intracellular receptor

32) Protein phosphorylation is commonly involved with all of the following *except*...

- A) activation of protein kinase molecules.
- B) enzyme activation.
- C) activation of G protein-coupled receptors.
- D) activation of receptor tyrosine kinases.

33) Which of the following is the best explanation for the fact that most transduction pathways have multiple steps?

- A) Each step can be activated by several G proteins simultaneously.
- B) Multiple steps in a pathway require the least amount of ATP.
- C) Multiple steps provide for greater possible amplification of a signal.
- D) Each individual step can remove excess phosphate groups from the cytoplasm.

34) Phosphorylation cascades involving a series of protein kinases are useful for cellular signal transduction because

- A) they are species specific.
- B) they always lead to the same cellular response.
- C) they amplify the original signal.
- D) they counter the harmful effects of phosphatases.
- E) the number of molecules used is small and fixed.

35) Neurons communicate with one another by releasing molecules called neurotransmitters which diffuse to other very nearby neurons. What type of receptors do

neurons have for neurotransmitters?

- A) receptor tyrosine kinases
- B) G protein-coupled receptors
- C) phosphorylated receptor tyrosine kinase dimers
- D) ion channel receptors
- E) intracellular receptors

36) Neurons communicate with one another by releasing molecules called neurotransmitters which diffuse to other very nearby neurons. When a neuron responds to a neurotransmitter by opening gated ion channels, the neurotransmitter is serving as which part of the signal pathway?

- A) receptor
- B) relay molecule
- C) transducer
- D) signal molecule
- E) endocrine molecule

37) On neurons (nerve cells), what usually enters the cell when signal molecules bind their receptors?

- A) Na^+
- B) phosphate ions
- C) cAMP
- D) neurotransmitters
- E) paracrines

Answers to review questions:

- 1) C
- 2) A
- 3) A
- 4) E
- 5) A
- 6) B
- 7) C
- 8) D
- 9) D
- 10) C
- 11) C
- 12) A
- 13) A
- 14) C
- 15) B

- 16) E
- 17) D
- 18) E
- 19) A
- 20) C
- 21) E
- 22) A
- 23) E
- 24) B
- 25) C
- 26) C
- 27) C
- 28) D
- 29) E
- 30) E
- 31) D
- 32) C
- 33) C
- 34) C
- 35) D
- 36) D
- 37) A