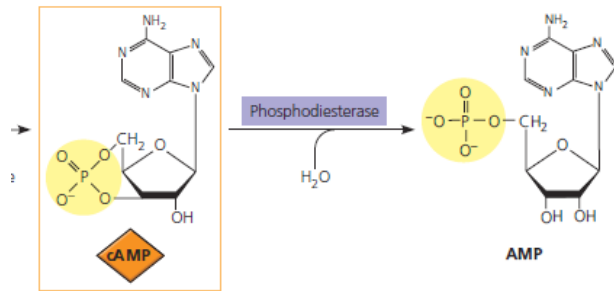
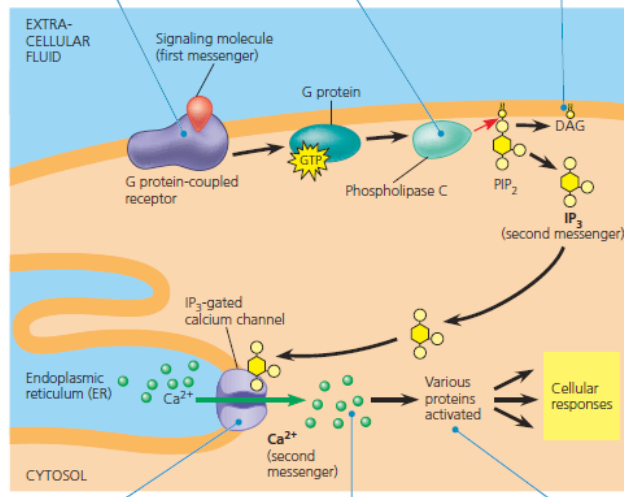


Cheat Sheet

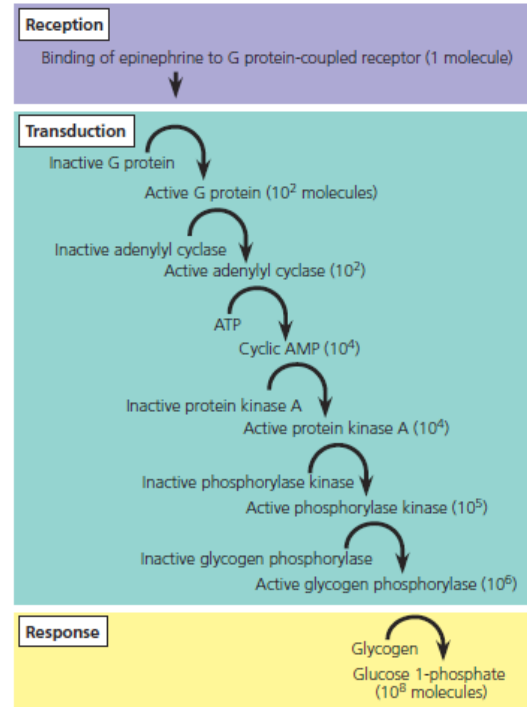


cAMP (cAMP) is made from ATP by adenyl cyclase

- 1 A signaling molecule binds to a receptor, leading to activation of phospholipase C.
- 2 Phospholipase C cleaves a plasma membrane phospholipid called PIP_2 into DAG and IP_3 .
- 3 DAG functions as a second messenger in other pathways.



- 4 IP_3 quickly diffuses through the cytosol and binds to an IP_3 -gated calcium channel in the ER membrane, causing it to open.
- 5 Calcium ions flow out of the ER (down their concentration gradient), raising the Ca^{2+} level in the cytosol.
- 6 The calcium ions activate the next protein in one or more signaling pathways.



Chapter 11 Questions

1. What is *Saccharomyces cerevisiae*? What are the two mating types and how do they communicate?
2. **Where do scientists think that signaling mechanisms first evolved?**
3. **What is monitoring of local cell density by bacteria called and how does it occur?**
4. **What are myxobacteria and what is one of their interesting capabilities?**
5. **What is MRSA and why is it dangerous?**
6. **What is an aggregation of bacterial cells adhered to a surface called?**
7. **Name and describe the three types of communication and their subtypes.**
8. **What is the plant hormone that promotes fruit ripening and helps regulate growth?**
9. **What is type of molecule is insulin?**
10. **What is adrenaline?**
11. **What are the three stages of cellular communication?**
12. **What is a ligand?**
13. **What are some results of ligand binding?**
14. **What is the largest family of human cell surface receptors?**
15. **How does the drug maraviroc work?**
16. **What are the 3 types of cell-surface transmembrane receptors?**
17. **What are GPCRs, what are their structure, and how are they involved in disease?**
18. **Draw the four stages of GPCR signaling.**
19. **What are RTKs?**
20. **What are the four stages of RTK signaling?**
21. **What are ligand-gated ion channels?**
22. **What percent of human proteins do cell-surface receptors represent?**
23. **Why is it hard to determine the structures of cell-surface receptors?**
24. **What is HER2 and what protein do scientists use to bind to it?**
25. **What are intracellular receptors and give examples of molecules that bind them.**
26. **What is aldosterone?**
27. **What is a transcription factor?**
28. **What are protein kinases?**
29. **What is the process in which protein kinases phosphorylate other protein kinases in a signal transduction pathway?**
30. **What percent of genes code for protein kinases?**
31. **What are protein phosphatases?**
32. **What are second messengers and what are the two most widely used?**
33. **What is cAMP?**
34. **What is the pathway that epinephrine signal goes through (not picture)?**
35. **What occurs in cholera?**
36. **What is cGMP?**
37. **Where are calcium ions used?**
38. **What are IP₃ and DAG?**

39. What are the 6 steps of Ca^{2+} and IP_3 pathways?
40. Draw the epinephrine signal transduction.
41. What are scaffolding proteins?
42. What is Wiskott-Aldrich syndrome (WAS)?
43. What is apoptosis?
44. How many cells does *Caenorhabditis elegans* have?
45. How often does cell suicide occur in *C. elegans*?
46. What are the three key apoptosis genes in *C. elegans*?
47. What enzymes cut up proteins and DNA of cell, and what are the main ones in apoptosis?
48. What is a major cell death pathway involving mitochondria?
49. What diseases are linked to faulty apoptosis?

Chapter 11 Answers

1. Unicellular yeast used to make bread, wine, beer, and alpha. Each secretes specific factor that binds only to receptors on the other type of cell. When exposed to other's factors, change shape and grow towards each other and fuse.
2. Ancient prokaryotes and single-celled eukaryotes
3. Quorum sensing, occurs by sensing concentration of molecules secreted by other cells
4. Soil-dwelling "slime bacteria", secrete signaling molecule when food is scarce that causes cells to aggregate and form a fruiting body that produces spores (thick-walled cells capable of surviving until the environment improves (i.e. *Myxococcus xanthus*)
5. MRSA is methicillin resistant *Staphylococcus aureus*, resistant to many antibiotics, start to secrete toxin once inside body, killing body cells and cause inflammation and damage (1 in 100 people carry a strain of *S. aureus* that is resistant to common antibiotics)
6. Biofilm
7. Direct contact: cell junctions that allow molecules (e.g. signalling molecules) to pass readily between adjacent cells, cell-cell recognition where two cells communicate by interactions between protruding molecules
Local Signaling: Paracrine signaling where signaling cell secretes molecules of local regulator (i.e. growth factor that causes cells to grow and divide) to act on nearby cells, synaptic signaling where nerve cell releases neurotransmitter molecules into synapse, stimulating target cell, such as muscle or another nerve cell
Long-distance signaling: Endocrine (hormonal signaling) where specialized endocrine cells secrete hormones into body fluids that affect only some cells
8. Ethylene (C_2H_4) gas, small enough to pass through cell walls
9. Protein hormone of thousands of atoms
10. Hormone epinephrine that triggers "fight-or-flight" response, stimulates breakdown of glycogen within liver cells and skeletal muscle cells, releasing glucose 1-phosphate, which is converted to glucose 6-phosphate (early intermediate in glycolysis), used for energy production by liver or muscle cell. Glucose 1-phosphate can be stripped of phosphate and released into blood as glucose. Epinephrine stimulates glycogen breakdown by activating cytosolic enzyme glycogen phosphorylase, but does not directly interact with enzyme
11. Reception: target cell's detection of signaling molecule when molecule binds to receptor protein
Transduction: Binding of signaling molecule changes receptor to initiate transduction, converting signal to form that can bring about specific cellular response, often requires changes in series of different "relay molecules" (signal transduction pathway)
Response: Transduced signal triggers cellular response
12. Molecule that specifically binds to another molecule
13. Ligand-binding causes protein to undergo shape change, activating receptor or causing receptors to aggregate
14. G protein-coupled receptors (GPCRs), more than 800

15. It treats AIDS by targeting co-receptors that are hijacked by HIV to enter immune cells
16. GPCRs, RTKs, and ligand-gated ion channels
17. G protein-coupled receptors, cell-surface transmembrane receptors that works with help of G protein (protein that binds to GTP). Yeast mating factors, neurotransmitters, and epinephrine (+ many hormones) use GPCRs. Vary in binding sites for ligands and G proteins. Secondary structure in which single polypeptide has seven transmembrane alpha helices that form binding sites for signaling molecules outside cell, G proteins on inside. Vision, smell, and taste depend on GPCRs. Bacteria that cause cholera, pertussis (whooping cough), and botulism make victims ill by producing toxins that interfere with G protein function.
18. G protein inactive when bound to GDP, phosphorylated when signaling molecule binds to receptor, which binds to G protein and activates it. G protein diffuses to bind with enzyme that is activated, and G protein hydrolyzes bond in GTP to form GDP (GTPase)
19. Receptor tyrosine kinases, have enzymatic activity (protein kinase, so catalyzes transfer of phosphate groups from ATP to another protein). Pair of RTK in cytoplasm functions as tyrosine kinase, adds phosphate to tyrosine of substrate protein. Can activate ten or more different transduction pathways (several at once), help cell regulate growth and reproduction. Abnormal RTKs that function w/o signaling molecules cause many cancers
20. Two RTKs separate before binding with alpha helix spanning membrane, intracellular tail with tyrosines. Binding signaling molecule causes two RTKs to associate, forming dimer in dimerization. Dimerization activates kinase, adding phosphate group to tyrosine. RElay proteins recognize and bind with tyrosine, undergo structural change that activates bound relay protein.
21. Membrane channel receptor containing region that can act as gate; binding of ligand opens channel, channel closes when ligand dissociates
22. 30%
23. Flexible and inherently unstable, so are difficult to crystalize for X-ray crystallography
24. It is a RTK in breast cancer cells, scientists use Herceptin to bind it, reducing cell division
25. receptors found in cytoplasm or nucleus of cell, signaling molecule passes through plasma membrane, hydrophobic and small signaling molecules such as steroid hormones and thyroid hormones and nitric oxide (NO) gas, aldosterone
26. Steroid hormone secreted by adrenal gland (lies above kidney), travels through blood, causes response only in kidney cells, were hormone activates receptors protein that enter nucleus to control genes that control water and sodium flow in kidney cells
27. Special proteins that control which genes are turned on
28. Proteins that phosphorylates another protein, usually phosphorylates serine or threonine
29. Phosphorylation cascade
30. 2%
31. Enzymes that rapidly remove phosphate groups from proteins (called dephosphorylation), turn off signal transduction pathway when initial signal is no longer present
32. Small, water soluble molecules, readily spread through cytosol by diffusion (cyclic AMP and more used Ca^{2+})

33. cyclic adenosine monophosphate (levels elevated by epinephrine binding in liver cell)
34. GPCR that epinephrine binds to activates adenylyl cyclase, which synthesizes cAMP from ATP by removing a pyrophosphate, cAMP converted back to AMP by phosphodiesterase. cAMP levels cause protein kinase A (serine/threonine kinase) to get activated, which phosphorylates various other proteins
35. Bacteria *Vibrio cholerae*, acquired by drinking contaminated water, form biofilm on lining of small intestine and produces toxin that locks G protein for regulating salt and water secretion in activated state, causing cell to secrete large amounts of salts into intestines (water follows)
36. Second messenger produced by muscle cell in response to NO released by neighboring cell, causes relaxation of muscles
37. Increased concentration causes muscle cell contraction, exocytosis, and cell division, or greening in response to light. Can function as messenger because concentration in cytosol is usually lower than that outside cell (10,000 fold). Actively transport out of cell or into ER/mitochondria/chloroplasts
38. Inositol trisphosphate and diacylglycerol, second messengers produced by cleavage of certain phospholipid in membrane
39. Look at picture.
40. Picture
41. Large relay proteins to which several other relay proteins are simultaneously attached, in brain cells some permanently hold together networks of signaling pathway proteins at synapses
42. Inherited disorder where absence of single relay protein leads to abnormal bleeding, eczema, and predisposition to infections/leukemia (WAS protein located just beneath immune cell surface, absence disrupts many signaling pathways)
43. Controlled cellular suicide where cellular agents chop up DNA and fragment cytoplasmic components, cell shrinks and becomes lobed (change called "blebbing") and cell parts packaged in vesicles that are engulfed and digested by scavenger cells
44. the nematode has 1,000 cells
45. 131 times during normal development
46. ced-3 and ced-4 (for cell death), encode proteins essential for apoptosis (Ced-3 and Ced-4). ced-9 programs Ced-9 (protein in outer mitochondrial membrane, serves as master regulator of apoptosis)
47. proteases and nucleases, main proteases are called caspases (Ced-3 is main caspase in nematode)
48. Proteins triggered to form pores in outer membrane of mito, causing it to leak (release proteins that promote apoptosis). Cytochrome c is an apoptosis promoting protein.
49. Parkinson's disease. Alzheimer's disease where accumulation of proteins in neuronal cells activates enzyme that triggers apoptosis, resulting in loss of brain function. Cancer can result from failure, i.e. melanoma linked to faulty forms of human Ced-4 protein