CHAPTER 2.1 CELL STRUCTURE
EXAMINATION QUESTIONS

1. The concentration of solutes in the cytoplasm of most cells follows which of the following order, from greatest to least:

   A. Na>K>ATP>Ca
   B. K>Na>ATP>Ca
   C. Na>K>Ca>ATP
   D. Na>ATP>K>Ca
   E. ATP>Na>K>Ca

2. The boundary between the inside and outside of a cell is provided by the

   A. Cell membrane
   B. Endoplasmic reticulum membrane
   C. Mitochondrial membrane
   D. Nuclear Envelope
   E. Cytoskeleton

3. Kinesin and dynein move vesicles and other cargo along tracts composed of

   A. Myosin
   B. Desmin
   C. Actin
   D. Tubulin
   E. Intermediate filaments

4. Intermediate filaments differ from the other cytoskeletal filaments in that

   A. Intermediate filaments have a polarity (+ and - ends)
   B. Intermediate filaments are dynamic along their entire length, not just the ends
   C. They are approximately 100 nm in diameter
   D. Intermediate filaments are polymers of globular monomeric proteins
   E. Intermediate filaments do not differ from the other cytoskeletal elements except in size

5. Proteasomes degrade proteins that are “tagged” by

   A. Myristoylation
   B. Palmitoylation
   C. Formation of disulfide bonds
   D. Farnesylation
   E. Ubiquitinylation

6. All of the following organelles of the cell have membranes that enclose a space except

A. Mitochondria
B. Peroxisomes
C. Cytoskeleton
D. Lysosomes
E. Nucleus

7. Cells adhere to each other through all of the following junctions EXCEPT

A. Desmosomes
B. Gap junctions
C. Zonula adherens
D. Zonula occludens
E. Zonula cadhera

8. Most of the oxygen consumption of human cells occurs in the

A. Cytosol
B. Peroxisomes
C. Lysosomes
D. Nucleus
E. Mitochondria

9. Purified subcellular organelles are most often isolated by

A. Electron microscopy
B. Differential centrifugation
C. Free zone electrophoresis
D. Light microscopy
E. Bouyant density centrifugation

10. The relative centrifugal force is given as

A. kT/D
B. $6\pi\eta a$
C. $\omega^2 r / g$
D. $(dr/dt) / \omega^2 r$
E. $-\beta v$

11. The Svedberg is defined as

A. kT/D
B. $6\pi\eta a$
C. $\omega^2 r / g$
D. $(dr/dt) / \omega^2 r$
E. $-\beta v$

12. The *endosymbiotic hypothesis* proposes that

A. Lysosomes fuse with endocytotic vesicles to form secondary lysosomes
B. Phagocytosis was a precursor to the gastrointestinal system
C. Secondary active transport is necessary for life
D. Mitochondria originated from engulfment of aerobic bacteria
E. The nucleus was once a separate cell

13. Which of the following supports the endosymbiotic hypothesis

A. Mitochondria contain circular DNA separate from nuclear DNA
B. Mitochondria consume oxygen
C. Lysosomes contain hydrolytic enzymes
D. Mitochondria import proteins from the cytoplasm
E. Ribosomes contain RNA

14. Of the following, the organelle most involved in the synthesis of lipids is the

A. Rough endoplasmic reticulum
B. Smooth endoplasmic reticulum
C. Golgi apparatus
D. Peroxisome
E. Endosome

15. Gap junctions are formed by

A. Integrins
B. Cadherins
C. Desmoplakin
D. Connexin
E. Plakophilin

16. Which are NOT one of the ways that cells connect to each other?

A. Gap junction
B. Adherens junction
C. Desmosome
D. Zonula occludens
E. Connectosome

17. Of the following, the organelle most involved with packaging and processing of secreted proteins is the

A. Endoplasmic reticulum
B. Peroxisome
C. Golgi apparatus
D. Nucleus
E. Mitochondria

18. Double membranes are part of the structure of

A. The endoplasmic reticulum
B. The mitochondria
C. The peroxisome
D. The Golgi apparaturs
E. The cytoskeleton

CHAPTER 2.2 DNA AND PROTEIN SYNTHESIS
EXAMINATION QUESTIONS

1. The outward appearance or behavior of an organism is called its

   A. Genotype
   B. Somatotype
   C. Phenotype
   D. Proteome
   E. Genome

2. The set of alleles of a particular person is called the person's

   A. Genotype
   B. Somatotype
   C. Phenotype
   D. Proteome
   E. Genome

3. **Alleles** are

   A. Alternate forms of proteins expressed by cells
   B. Protein formed by alternate splicing of DNA
   C. Alternate forms of somatic cells
   D. Alternate forms of germ cells
   E. Alternate forms of genes

4. Which of the following is NOT a building block of a nucleotide?

   A. A base such as adenine, guanine, thymine or cytosine
   B. Phosphate
   C. Deoxyribose
   D. 2-deoxy Glucose
   E. All of the above are components of nucleotides

5. Nucleotides consist of

   A. Deoxyribose, phosphate and a base such as adenine
   B. Glycerol, fatty acid and a polar head group such as choline
   C. Glycerol, phosphate and a base such as adenine
   D. Glycerol, fatty acid and a polar head group such as phosphate
   E. Deoxyribose, choline and a base such as adenine

6. The “backbone” of a single DNA nucleotide chain consists of

A. Deoxyribose units bonded together with phosphate groups hanging off one side and bases hanging off the other side
B. Alternate phosphate and deoxyribose parts bonded covalently
C. Phosphate chains to which deoxyribose units with bases are attached
D. Nucleotides attached by hydrogen bonds
E. Nucleotides attached to each other by covalent bonds

7. Adenine on one strand of DNA forms

A. Three hydrogen bonds with guanosine on tRNA
B. Covalent bonds with rRNA
C. Two hydrogen bonds with thymine on tRNA
D. Two hydrogen bonds with cytosine on tRNA
E. Two hydrogen bonds with uracil on tRNA

8. Guanine on one strand of DNA forms

A. Three hydrogen bonds with thymine on the opposite DNA strand
B. Three hydrogen bonds with thymine on tRNA
C. Three hydrogen bonds with cytosine on the opposite DNA strand
D. Two hydrogen bonds with thymine on the opposite DNA strand
E. Two hydrogen bonds with cytosine on the opposite DNA strand

9. Which of the following are NOT differences between RNA and DNA?

A. DNA has deoxyribose, RNA has ribose
B. DNA uses thymine, RNA uses uracil to pair with guanine
C. DNA is double-stranded, RNA is single-stranded
D. DNA is replicated from DNA, but RNA is not replicated from RNA
E. All of the above are true differences between RNA and DNA

10. The 3' to 5' direction on one DNA strand being opposite to the 5' to 3' direction in the opposing strand is called

A. Antiparallel
B. Double helix
C. Reverse strands
D. Helicase
E. Okazaki fragments

11. DNA polymerase

A. Adds nucleotides only to the 3' end of deoxyribose
B. Uses the base on the existing strand as a guide to which nucleotide to add
C. Uses nucleotide triphosphates as substrates
D. Adds nucleotides to the complementary strands of both halves of unwound DNA
E. All of the above are true

12. The unwinding of DNA is accomplished by

A. DNA polymerase
B. DNA unwinding enzyme
C. Helicase
D. DNA ligase
E. DNA primase

13. The only RNA that is not made from DNA is

A. messenger RNA
B. ribosomal RNA
C. transfer RNA
D. small nuclear RNA
E. None of the above

14. "Transcription" refers to the

A. Synthesis of proteins in the cytosol
B. Synthesis of proteins in the mitochondria
C. Synthesis of proteins on the ER membrane
D. Synthesis of mRNA from DNA in the nucleus
E. The formation of aminoacyl tRNA

15. RNA Polymerase III

A. Makes mRNA from a DNA template
B. Makes mRNA from an RNA template
C. Makes pre t-RNA from a DNA template
D. Makes ribosomal RNA in the nucleolus
E. Makes snRNA

16. mRNA is made by

A. RNA polymerase I acting on DNA
B. RNA polymerase II acting on DNA
D. RNA polymerase III acting on DNA
E. RNA polymerase III acting on RNA
E. RNA polymerase I acting on RNA

17. The "codon" refers to a triplet sequence of nucleotides in

A. DNA
B. mRNA
C. tRNA
D. complementary DNA
E. rRNA

18. The function of t-RNA is to

A. Covalently link to an amino acid and also recognize and bind the codon on mRNA
B. Structurally stabilize ribosomes
C. Bind mRNA to the ribosome
D. Elongate the amino acid chain by creating the peptide bond
E. Transfer proteins into the ER

19. The genetic code is located

A. On the mRNA
B. On the tRNA
C. On the DNA
D. On the amino acyl transferases
E. None of the above; it is a system property

20. The sequential order of binding of tRNA to the ribosome is

A. A site, P site, E site
B. A site, E site, P site
C. E site, P site, A site
D. E site, A site, P site
E. P site, A site, E site

21. An exon is a region of DNA that is

A. At the end of the response element
B. In between response elements
C. Expressed
D. Excised in the making of mRNA
E. Promotes expression of the DNA

22. A region of the DNA that is expressed is called

A. An intron
B. A response element
C. A promoter
D. An exon
E. A spliceosome

23. Regions of DNA that bind receptors for steroid hormones, for example, are called

A. Exons
B. Introns
C. Splices
D. Response elements
E. Promoters

24. Histones are

A. Proteins that bind DNA and make it inaccessible to transcription
B. Proteins that prevent DNA from being translated
C. Enzymes that mark cells for histology
D. Enzymes that ubiquinylate DNA
E. Enzymes that methylate DNA

25. Which reaction is NOT part of the "histone code"

A. Histone acetylation
B. Histone methylation
C. Histone phosphorylation
D. Histone proteolysis
E. Histone ubiquitinylation

26. Transcription requires

A. Unraveling of DNA from the histones
B. Activation of DNA polymerase
C. Activation of RNA polymerase I
D. Duplication of DNA
E. Nucleosome formation

27. The codon on mRNA 5' to 3' is UCA, which codes for serine. The amino acid sequence complementary to the codon on the tRNA, 5' to 3' is what sequence of nucleotides?

UGA

28. If the DNA sequence in a gene is 5' to 3' is TGA, what is the sequence in the codon, 5' to 3'?

UCA

29. How many possible codons are there? How many different amino acids are there? From this, what can you conclude about the genetic code?

There are 4 possibilities for nucleotides in the first position, 4 in the second, and 4 in the third, giving a total of 64 possible codons. Since there are only 20 amino acids, the genetic code is redundant: several different codons may specify a given amino acid.

CHAPTER 2.3 PROTEIN STRUCTURE
EXAMINATION QUESTIONS

1. All amino acids contain

   A. An amino group ($-NH_2$)
   B. An asymmetric carbon
   C. A carboxyl group (-COOH)
   D. A, B and C
   E. A and C

2. In a naturally occurring amino acid at neutral pH

   A. The amino group is $-NH_3^+$ and the carboxyl group is -COOH
   B. The amino group is $-NH_2$ and the carboxyl group is $-COO^-$
   C. The amino group is $-NH_3^+$ and the carboxyl group is $-COO^-$
   D. The amino group is $-NH_2$ and the carboxyl group is COOH
   E It is impossible to say the ionization of the groups because they vary among the differeent amino acids

3. Arginine is an example of a

   A. Acidic amino acid
   B. Basic amino acid
   C. Non-polar amino acid
   D. Polar amino acid
   E. Aromatic amino acid

4. An example of a polar amino acid is

   A. Tryptophan
   B. Arginine
   C. Aspartic acid
   D. Serine
   E. Phenylalanine

5. An example of a non-polar amino acid is

   A. Tyrosine
   B. Histidine
   C. Threonine
   D. Glutamic acid
   E. Leucine

6. Non-polar amino acids include all of the following EXCEPT

A. Tryptophan
B. Phenylalanine
C. Leucine
D. Lysine
E. Valine

7. "Hydrophobicity" of an amino acid describes

A. The number of hydrocarbons in its R group
B. Its ability to dissolve in water
C. Its preference for non-polar solvents over water
D. The number of polar groups on the amino acid
E. The number of charged groups on the amino acid

8. Which of the following amino acids is most hydrophobic?

A. Lysine
B. Aspartic acid
C. Serine
D. Tyrosine
E. Isoleucine

9. Peptide bonds form on the ribosome between

A. The amino group of a lysine R chain and the carboxyl group of an aspartic R chain
B. The carboxyl group on the carboxyl terminus of the growing chain and the amino group of the next amino acid
C. The amino group on the amino terminus of the growing chain and the carboxyl group of the next amino acid
D. Amino and carboxyl groups of adjacent amino acids in the interior of the polypeptide
E. The alpha carbon and the R group

10. The linear sequence of amino acids that make up a single polypeptide chain is called its

A. Primary structure
B. Secondary structure
C. Tertiary structure
D. Quarternary structure
E. Code

11. Which of the following is NOT one of the non-covalent interactions that stabilize protein structure?

A. Hydrogen bonding
B. Electrostatic attraction/repulsion
C. Hydrophobic interactions
D. Quantum tunneling
E. Steric hindrance

12. The final three-dimensional structure of proteins is important because

A. The pictures are awesome
B. Protein function occurs through interactions on the surfaces of the proteins
C. They are not two-dimensional structures
D. Amino acids nearby in the 3D structure are usually not adjacent in the primary structure
E. The structure is dictated by the function

13. Post-translational modifications of proteins includes

A. Elongation
B. Replication
C. Transcription
D. Proteolytic cleavage
E. Initiation

14. Chemical post-translational modifications include all of the following EXCEPT

A. Phosphorylation
B. Methylation
C. Ubiquitinylation
D. Acetylation
E. Transesterification

15. Phosphorylation of proteins typically occurs at which of the following amino acids?

A. Aspartic acid
B. Serine
C. Tryptophan
D. Phenylalanine
E. Proline

16. N-linked glycosylation occurs when carbohydrate groups are added to

A. The side chain NH_2 of asparagine
B. The side chain NH_2 of lysine
C. The side chain N of histidine
D. The side chain N of N-acetylglucosamine
E. The side chain NH_2 of serine

17. O-linked glycosylation occurs when carbohydrate groups are added to

A. The hydroxyl group of threonine
B. The hydroxyl group of hydroxyproline
C. The hydroxyl group of serine
D. The hydroxyl group of tyrosine
E. Both A and C are correct

18. Proteins can be anchored to membranes by

A. Covalent attachment of the protein to GPI (glycosyl phosphatidyl inositol)
B. Covalent attachment to retinal in membranes
C. Linkage to myristic acid through the carboxyl terminal COOH
D. Linkage to myristic acid through cysteine
E. Linkage to farnesyl through the N-terminus

19. After the amino acid sequence of a protein is assembled, the protein often undergoes a number of post-translational modifications. There are four major classes of post-translational modifications. List three of these.

A. **Proteolytic cleavage**

B. **Disulfide bond formation**

C. **Chemical modification**

D. **Protein folding**

20. The ratio of the concentration of an unknown amino acid in octanol compared to its concentration in water was 10:1. Calculate the free energy of transfer from the water to the octanol phase. Use T = 310°K and R = 8.314 joule mol^{-1} K^{-1}.

ΔG^0_T = - RT ln $[X]_{octanol}$ / $[X]_{H2O}$ = - 8.314 joule mol^{-1} K^{-1} x 310°K x ln 10

= 5.93 kj mol^{-1}

21. Briefly describe the difference between integral and peripheral proteins.

Integral proteins are tightly bound to membranes and can be removed only by using drastic means.

Peripheral proteins are loosely bound to membranes and can be extracted relatively easily.

CHAPTER 2.4 BIOLOGICAL MEMBRANES
EXAMINATION QUESTIONS

1. Fatty acids consist of

   A. A hydrocarbon chain and an alcohol group on one end
   B. A hydrocarbon chain and an ester bond at the far end
   C. A hydrocarbon chain and an ether bond at the far end
   D. A hydrocarbon chain and an carboxylic acid group at the far end
   E. A hydrocarbon chain and an SH group at the far end

2. Kinks are formed in hydrocarbon chains that

   A. Bind proline
   B. Have a trans double bond in the hydrocarbon chain
   C. Have a cis double bond in the hydrocarbon chain
   D. Are saturated
   E. Are esterified to cholesterol

3. Which of the following is not a constituent of a phospholipid?

   A. Fatty acid
   B. Glycerol
   C. Phosphate
   D. Choline
   E. Cholesterol

4. In phospholipids, the phosphate is generally bonded between

   A. Fatty acid and glycerol
   B. Glycerol and hydrophilic group such as choline
   C. Fatty acid and serine
   D. Glycerol and glucose
   E. Fatty acids and glucose

5. The major hydrophobic part of a phospholipid is its

   A. Glycerol
   B. Phosphate
   C. Fatty acid
   D. Inositol
   E. Choline

6. The major hydrophilic part of a phosphatidylinositol is its

A. Glycerol
B. Phosphate
C. Cis Fatty acid
D. Inositol
E. Trans fatty acid

7. Which of the following is NOT a polar group used in phospholipids?

A. Serine
B. Inositol
C. Choline
D. Ethanolamine
E. Alanine

8. The main ingredient of the lipid bilayer in most biological membranes is

A. Phospholipids
B. Cholesterol
C. Free fatty acids
D. Triglycerides
E. Cardiolipin

9. Cardiolipin consists of

A. Sphingomyelin with attached carbohydrate molecules
B. Two sphingosine molecules linked by a glycerol
C. Two phosphatidyl choline molecules linked by a phosphate
D. Two phosphatidic acid molecules linked by a glycerol
E. Two ceramide molecules linked by a phosphate

10. Surface tension is best described as

A. The surface energy per unit area
B. The surface energy per unit length
C. The force or tension per unit area
D. The force per unit volume
E. The surface energy per unit volume

11. Consider a spherical cell with surface area $4\pi r^2$ with surface tension γ. If we increase r by 5%, what would be the **change** in **surface energy**?

A. + 1.050 γ
B. + 1.050 r γ
C. - 1.050 r γ
D. + 1.288 r^2 γ
E. + 0.628 r^2 γ

12. The origin of the surface tension of water at the water-air interface is

A. Air pressure pushing on the water surface
B. Water molecules attracting other water molecules more than the air attracts them
C. Water in the bulk phase being at a higher energy than water at the surface
D. Attractive forces of air molecules that tend to exclude the water
E. The hydrophilic nature of air molecules

13. Amphipathic molecules

A. Prefer organic solvents such as chloroform or CCl_4 as a solvent
B. Prefer water as a solvent
C. Have spatially separated lipophilic and hydrophilic regions
D. Have spatially separated positive and negative charges on their surface
E. Are soluble in neither water nor lipid solvents

14. Molecules having a lipophilic part spatially separated from a hydrophilic part are called

A. Ambivalent
B. Amphipathic
C. Zwitterionic
D. Integral
E. Peripheral

15. The surface tension of pure water is 72 dyne cm^{-1}. Addition of surfactant lowers the surface tension to 60 dyne cm^{-1}. With the surfactant, the surface pressure is

A. 12 dyne cm^{-1}
B. 132 dyne cm^{-1}
C. 0.166 dyne cm^{-2}
D. 0.20 dyne cm^{-2}
E. Cannot be determined from the information given

16. Integral proteins

A. Have irreducible functions
B. Are loosely bound to membranes
C. Are constituents of ribosomes
D. Are tightly bound to membranes
E. Require high salt for removal from membranes

17. Motion of lipids in a biological membrane is

A. Slow in all directions
B. Slow across the membrane, but fast in the plane of the membrane
C. Rapid in all directions
D. Fast across the membrane, but slow in the plane of the membrane
E. Restricted except in lipid rafts

18. The thickness of biological membranes is about

A. 10 µm
B. 1 µm
C. 100 nm
D. 10 nm
E. 1 nm

19. The first part of a secreted protein to be translated is called its

A. Initiation sequence
B. Origin
C. Signal sequence
D. Target sequence
E. Recognition sequence

20. Secreted proteins cross the membrane of the ER

A. By diffusion
B. By active transport
C. Through a channel provided by a translocon
D. By osmosis
E. Through a channel made by the SRP

21. The signal recognition peptide

A. Binds to the signal sequence and to the SRP receptor
B. Binds to the signal sequence and to the translocon
C. Binds to the SRP and to the translocon
D. Binds to the signal sequence inside the ER lumen
E. Helps fold up proteins inside the ER

22. Name three ways that proteins can be anchored into membranes:

A. Hydrophobic interactions of amino acids with the lipid interior

B. Covalently attachment of palmitic or myristic acid

C. Covalent attachment of a farnesyl group

D. Covalent attachment to glycosylphosphatidylinositol

23. Briefly describe the difference between integral and peripheral proteins.

Integral proteins are tightly bound to membranes and their release requires drastic measures such as detergents. Peripheral proteins are loosely bound to membranes and can be released by washing in salt solutions or other relatively mild treatments.

CHAPTER 2.5 PASSIVE TRANSPORT AND FACILITATED DIFFUSION EXAMINATION QUESTIONS

1. In the microporous model of a membrane, solutes diffuse across the membrane by

   A. Dissolving in the lipid and diffusing across the lipid phase
   B. Diffusing through water-filled channels, or pores
   C. Being bound to carriers that diffuse across the membrane
   D. Obtaining enough energy through splitting of ATP
   E. Riding down the electrochemical gradient of Na^+

2. In the microporous membrane model, transport flux is increased by

   A. Increasing the thickness of the membrane
   B. Increasing the length of each pore
   C. Decreasing the difference in concentration across the membrane
   D. Increasing the size of the solute
   E. Increasing the number of pores per unit area of membrane

3. Permeability is best defined for any membrane as

   A. $n \pi a^2 D / \delta$
   B. $J / \Delta C$
   C. $k_s D_{lipid} / \delta$
   D. D / δ
   E. $(n \pi a^2 D + k_s D_{lipid}) / \delta$

4. When a solute penetrates through a membrane by dissolving in the lipid, the permeability is directly proportional to the

   A. Size of the solute
   B. Partition coefficient
   C. Temperature
   D. Thickness of the membrane
   E. Concentration difference across the membrane

5. In the lipid-dissolution model of passive transport, the rate-limiting step in the permeation is

   A. Dissolution of the solute in the lipid phase on the source side of the membrane
   B. Dissolution of the solute in the aqueous phase on the sink side of the membrane
   C. Diffusion of the solute through the lipid interior of the membrane
   D. Conformational changes in the carrier
   E. The number of pores in the membrane.

6. Permeability through the lipid bilayer

A. Requires an input of metabolic energy
B. Saturates with higher concentration of solute
C. Always involves movement of solute from low to high osmotic pressure
D. Depends directly on the partition coefficient
E. Is increased by ionization of the solute

7. A membrane separates a solution with a concentration C_L on the left and C_R on the right. The free energy change for movement of solute to the right is zero when

A. $C_L < C_R$
B. $C_L = RT \text{ Ln } C_L / C_R$
C. $C_R = RT \text{ Ln } C_L / C_R$
D. $C_L = C_R$
E. $p = 0$

8. A facilitated diffusion carrier has a K_m = 5 mM and a maximum transport rate of Q_{max}. At a solute concentration of 10 mM, its transport rate is about

A. $0.25\ Q_{max}$
B. $0.5\ Q_{max}$
C. $0.67\ Q_{max}$
D. $2\ Q_{max}$
E. Q_{max}

9. You have the ability to measure the transport rate, Q, across a membrane as a function of the concentration of transported solute on the source side, S. How would you experimentally determine the K_m for transport?

A. It is the solute concentration at one-half the maximum transport rate
B. It is the X-intercept on a plot of 1 /Q against 1 / S
C. It is the Y-intercept on a plot of 1/Q against 1/ S
D. It is the solute concentration when $Q = Q_{max}$
E. It is -R times the slope of the plot of ln Q vs 1/T

10. Facilitated diffusion differs from simple passive permeability in all of the following EXCEPT

A. Facilitated diffusion is saturable, passive permeability is not
B. Facilitated diffusion uses metabolic energy, passive permeability does not
C. Facilitated diffusion is specific, passive permeability is not
D. Facilitated diffusion displays competitive inhibition, passive permeability does not
E. Facilitated diffusion uses a carrier, passive permeability does not

11. In carrier kinetics, saturation means that

A. All of the carriers are busy and transport is limited by the number of carriers
B. No more transport is possible
C. Equilibrium has been reached
D. The membrane can hold no more solute
E. There are no free C=C double bonds

12. An ionophore is a substance that

A. Increases the permeability of a membrane to glucose
B. Separates proteins on the basis of their charge and size
C. Carries water across membranes
D. Increases the permeability of a membrane to ions
E. Enlarges the size of water pores

13. Which of the following is NOT a characteristic of biological ion channels?

A. They display specificity
B. They often display gating
C. They are passive
D. They are integral proteins
E. They are carriers

14. Gating of ion channels means that the

A. Specificity of ion conductance is determined by a gate
B. Channels appear to have gates that are opened sometimes, and closed at other times
C. Channels behave like sieves
D. Channels are like circular pipes with pressure-operated valves
E. Opening of the channels is metabolically controlled

15. Voltage-gated channels change their open probability in response to

A. Chemicals that bind to the channel
B. Current that flows through the channel
C. The local electrical field
D. Binding of ions to the channel
E. Phosphorylation of the channel

16. A membrane separates two solutions of glucose. The outside concentration of 5 mM and the inside has a concentration of 20 mM. Consider that there is an efflux of 1 pmol of glucose to the outside of the cell . How much energy does the transport of 1 pmol of glucose involve? Is the free energy change positive or negative? R = 8.314 joule mol^{-1} $^oK^{-1}$, T = 37^{o}C

The free energy of transport per mole is given as

$\mu_{final} - \mu_{initial} = \mu^0_{outside} + RT \ln C_{outside} - \mu^0_{inside} - RT \ln C_{inside} = RT \ln C_{outside} / C_{inside} =$

8.314 joule mol^{-1} $^oK^{-1}$ x 310 ^oK ln [5 x 10^{-3}M / 20 x 10^{-3} M] = - 3.57 kJ mol^{-1}

The free energy is $\Delta G = n \Delta\mu = 1 \times 10^{-12}$ mol x -3.57×10^3 joule mol^{-1} = -3.57×10^{-9} joules

Where does the energy for passive transport come from?

It comes from the solutions themselves.

17. The concentration of solute on the left side of a membrane was 5 μM and the concentration on the other side was 0. The flux across the membrane was determined to be 0.2 pmol $cm^{-2}s^{-1}$.

A. What is the permeability of the membrane to the solute?

Permeability is determined as $p = J / \Delta C = 0.2 \times 10^{-12}$ mol cm^{-2} s^{-1} / 5×10^{-9} mol cm^{-3}

$p = 4 \times 10^{-5}$ cm s^{-1}

B. The thickness of the membrane is 10 μm, and the free water diffusion coefficient of the solute is 1×10^{-5} cm^2s^{-1}. We want to find out if transport across the membrane is faster than it would be across water. What would the diffusive flux be for a water barrier the thickness of the membrane? Is the flux through the membrane faster or slower than for simple diffusion through water?

The diffusive flux across a water barrier this thick would be given by Fick's First Law of Diffusion:

$J = - D \Delta C/\Delta x = - 1 \times 10^{-5}$ cm^2s^{-1} x [$(5 \times 10^{-9} - 0)$ mol cm^{-3}] / [$0 - 10 \times 10^{-4}$ cm] =

$J = 5 \times 10^{-11}$ mol cm^{-2} s^{-1}

This is much faster than the flux across the membrane, 0.2×10^{-12} mol cm^{-2} s^{-1}

18. Explain why at steady-state the concentration gradient in a pore must be constant.

Because if the concentration gradient were not constant in time, then the concentrations would be changing with time, and the flux would be changing with time, and there would not be a steady-state.