1

2 **5.1 Cells**

- Cell theory
  1. All organisms are composed of one or more cells
  2. Cell are the smallest living things
  3. Cells arise only by division of previously existing cells

3 **5.1 Cells**

- Cellular structure is organized
  - plasma membrane forms the boundary of the cell
    - also controls the permeability of the cell to water and dissolved substances
  - cytoplasm fills the interior of the cell

4 **5.2 The Plasma Membrane**

- A phospholipid has a polar head and two non-polar tails
- polar region: phosphate chemical group and is water-soluble
- non-polar region: fatty acids and is water-insoluble

5

Interior of lipid bilayer is NONPOLAR: no water soluble molecules can cross

- cholesterol is also found in the interior
  - affects the fluid nature of the membrane
  - accumulation in walls of bld vessels » plaques
  - plaques lead to cardiovascular disease

6 **Plasma membrane proteins: embedded within the lipid bilayer**

- transmembrane proteins: form channels that span the membrane
- other proteins are integrated into the structure of the

membrane
- Ie: cell surface proteins: attached to outer surface of the membrane/ act as markers

7 **5.3 Prokaryotic Cells**
- There are two major types of cells
  - prokaryotic
    - lacks a nucleus/ No extensive system of internal membranes
    - all bacteria and archea have this cell type
  - eukaryotic
    - has a nucleus and has internal membrane-bound compartments
    - all organisms other than bacteria or archae have this cell type

8 **5.3 Prokaryotic Cells**
- the simplest cellular organisms
  - have a plasma membrane surrounding a cytoplasm without interior compartments
    - some bacteria have additional outer layers to the plasma membrane
      - cell wall comprised of carbohydrates to confer rigid structure
      - capsule may surround the cell wall

9 **Prokaryotic Interior: simple, uniform cytoplasm,**
- ribosomes (protein synthesis) are scattered t/o the cytoplasm
- nucleoid region (where DNA is localized)
- flagellum (plural, flagellae) is a collection of protein fibers that extends from the cell surface
  - aids in attaching to substrates and in exchanging genetic information between cells
    - may be one or many
    - aids in locomotion and feeding
- pilus (plural, pili) is a short flagellum

10 **5.4 Eukaryotic Cells larger and more complex**
- have a plasma membrane encasing a cytoplasm
  - internal membranes form organelles
    - cytoplasm is semi-fluid & has a network of protein fibers that form a scaffold called a cytoskeleton
  - Nucleus: a membrane-bound compartment for DNA
  - endomembrane system: gives rise to the internal membranes found in the cell
    - each compartment can provide specific conditions favoring a particular process

11 **5.4 Eukaryotic Cells**
- not all eukaryotic cells are alike
  - the cells of plants, fungi, and many protists have a cell wall beyond the plasma membrane
  - all plants and many protists contain organelles called chloroplasts
  - plants contain a central vacuole
  - only animal cells contain centrioles

12 **Animal versus Plant Cell**

13 **5.5 The Nucleus: The Cell's Control Center**
- stores hereditary information

- The nuclear surface is bounded by a double-membrane called the nuclear envelope
  - groups of proteins form openings called nuclear pores that permit proteins and RNA to pass in and out of the nucleus

14 **Inside the nucleus**
- Chromosomes: Segments of DNA packaged w/ protein
  - the proteins enable the DNA to be wound tightly so it appears condensed
    - the condensed or chromosome form of DNA occurs during cell division
  - When cell is not dividing DNA is stored as chromatin (hard to see)

- protein synthesis occurs when the DNA is in the chromatin form

15 **What else is in the nucleus?**

- nucleus is the site for the subunits of the ribosome to be synthesized
  - Nucleolus: dark-staining region of nucleus
    - it contains the genes that code for the rRNA (ribosomal RNA) that makes up the ribosomal subunits
    - the subunits leave the nucleus via the nuclear pores and the final ribosome is assembled in the cytoplasm

16 **Figure 5.12 The nucleus**

17 **5.6 The Endomembrane System: an extensive system of internal membranes**

some of the membranes form channels and interconnections

- other portions become isolated spaces enclosed by membranes (vesicles)

18 **5.6 The Endomembrane System**

- RER: protein synthesis
  - the surface of this region looks pebbly
  - the rough spots are due to embedded ribosomes
- SER: carbohydrate & lipid synthesis
  - the surface of this region looks smooth because it contains no embedded ribosomes

19 **5.6 The Endomembrane System**

- After synthesis in ER, the newly-made molecules are passed to Golgi bodies
  - GB flattened membranes that form collective stacks called the Golgi complex
  - their numbers vary depending on the cell
  - collect, package, and distribute molecules manufactured in the cell

20 **5.6 The Endomembrane System**

- The ER and Golgi complex function together as a transport system in the cell

21 **The Golgi complex also gives rise to**

1 ○lysosomes
- ●contain enzymes that the cell uses to break down macromolecules
  - ○worn-out cell parts are broken down & recycled to form new parts
  - ○particles that the cell has ingested are also digested

2 ○Peroxisomes
- ●the chemical reactions in peroxisomes
  1. detoxify harmful byproducts of metabolism
  2. convert fats to carbohydrates in plants seeds for growth

22 **5.7 Organelles That Contain DNA: nucleus, mitochondria, chloroplasts**

23 **The Theory of Endosymbiosis**

- ○some organelles evolved from a symbiosis in which one cell of a prokaryotic species was engulfed by and lived inside of a cell of another species of prokaryote

- ●the engulfed species provided their hosts with advantages because of special metabolic activities

- ●the modern organelles of mitochondria and chloroplasts are believed to be found in the eukaryotic descendants of these endosymbiotic prokaryotes

24 **Figure 5.18 Endosymbiosis**

25 **Evidence supporting endosymbiotic theory**

- ●Mitochondria: ~same size as modern bacteria
- ●the cristae in mitochondria resemble folded membranes in modern bacteria
- ●mitochondrial ribosomes are similar to modern, bacterial ribosomes in size and structure
- ●mitochondria divide by fission, just like modern bacteria

26 **5.8 The Cytoskeleton: Interior Framework of the Cell**

- internal framework of protein fibers that
  - anchor organelles to fixed locations
  - support the shape of the cell
  - helps organize ribosomes and enzymes needed for synthesis activities

- The cytoskeleton is dynamic and its components are continually being rearranged

27 **Three different types of protein fibers comprise the cytoskeleton**

- intermediate filaments
  - thick ropes of intertwined protein
- microtubules
  - hollow tubes made up of the protein tubulin
- microfilaments
  - long, slender microfilaments made up of the protein actin

28 **Centrioles are complex structures**

- assemble microtubules in animal cells and the cells of most protists
- anchor organelles such as flagella/cilia
- assemble microtubules near nuclear envelope
- they might also have an endosymbiotic origin

29 **5.8 The Cytoskeleton: Interior Framework of the Cell**

- Microtubules provide a means to transport material inside the cell efficiently over long distances

30 **5.8 The Cytoskeleton: Interior Framework of the Cell**

- The cytoskeleton also anchors storage compartments
  - Vacuoles:membrane-bound storage centers
    - central vacuole: lrg space inside a plant cell filled w/ water/ dissolved substances
    - contractile vacuole is found near the cell surface of some protists and accumulates excess water from inside the cell that it then pumps out

31 **5.9 Outside the Plasma Membrane**

- Cell walls
  - found in plants, fungi, and many protists
  - comprised of different components than prokaryotic cell walls
  - provides protection, maintains cell shape, prevents excessive water loss/uptake

32 **5.9 Outside the Plasma Membrane**

- Extracellular matrix (ECM)
  - comprised by a mixture of proteins secreted by cell
  - collagen and elastin proteins form a protective layer over the cell surface
  - fibronectin protein connects the ECM to the plasma membrane
  - ECM influences cellular behavior and coordinates groups of cells functioning as tissues

33 **Figure 5.25 The extracellular matrix**

34 **5.10 Diffusion and Osmosis**

- Movement of water and nutrients into a cell or elimination of wastes out of cell is is essential for survival
- This movement occurs across a biological membrane in one of three ways
  - diffusion
  - membrane folding
  - protein transport

35 **5.10 Diffusion**

- The net movement of molecules from an area of higher

concentration to an area of lower concentration is termed diffusion

- Molecules diffuse down a concentration gradient from higher to lower concentrations
  - diffusion ends when equilibrium is reached

36 **5.10 Diffusion**

- Only certain substances undergo diffusion across the plasma membrane
  - Ie: oxygen, carbon dioxide, and nonpolar lipids
  - ions and polar molecules cannot cross the interior of the membrane

- Water, although polar, is able to diffuse freely across the plasma membrane
  - aquaporins are selective channels that permit water to cross

37 **5.10 Osmosis**

- Water moves down its concentration gradient moving into/out of a cell
- the movement of water is dependent on the concentration of other substances in a solution
  - the greater the amount of solutes that are dissolved in a solution, then the lesser the amount of water molecules that are free to move

38 **5.10 Diffusion and Osmosis**

- The concentration of all molecules dissolved in a solution is called the osmotic concentration of the solution

- Osmotic concentrations of different solutions can be compared relative to each other

39 **5.10 Osmosis**

- Consider two solutions with unequal osmotic concentrations

- the solution with the higher concentration is called hypertonic

- The solution with the lower concentration is called hypotonic

40 **5.10 Osmosis**

- Consider two solutions with equal osmotic concentrations

- The solutions are each called isotonic

41 **5.10 Osmosis**

- Movement of water by osmosis into a cell causes pressure called osmotic pressure
  - Too much: may cause a cell to swell and burst
  - explains why so many cell types are reinforced by cell walls

42 **5.11 Bulk Passage into and out of Cells**

- Bulky substances are contained within vesicles as they are moved into and out of a cell
  - Endocytosis: transport into the cell
    - Phagocytosis:
    - Pinocytosis:
    - RME:
  - Exocytosis: transport out of the cell

43 **Figure 5.29(a) Exocytosis**

44 **Receptor Mediated Endocytosis: transport of specific molecules INTO**

molecules bind to specific receptors in plasma membrane. A portion of the receptor extends into the membrane in an indented pit coated with protein clathrin

when a molecule binds to its specific receptor, the cell reacts immediately by initiating endocytosis of a now clathrin-coated vesicle

45 **5.12 Selective Permeability**

- Selective permeability allows cells to control specifically what enters and leaves
  - involves using proteins in the membrane for transporting substances across

46 **5.12 Selective Permeability**

- Selective diffusion
  - proteins act as open channels for whatever is small enough to fit inside the channel
  - common in ion transport

- Facilitated diffusion
  - proteins act as carriers that can bind only to specific molecules to transport
  - transport is limited by the availability of carriers
  - if there are not enough carriers, then the transport is saturated

47 **Active transport**

- utilizes protein channels that open only when energy is supplied
- pump substances against or up their concentration gradients
- allows cells to maintain high or low concentration of certain molecules
  - *diffusion always ends in equilibrium*

- There are two kinds of channels that perform active transport in cells
  - sodium-potassium pump
  - proton pump

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Sodium-potassium (Na^+-K^+) pump

- uses energy, in the form of ATP, to pump three Na^+ out of the cell and to pump two K^+ into the cell

- nearly 1/3 of the energy expended by the body's cells is given over to driving these pumps

49 **Figure 5.32 How the sodium-potassium pump works**

50 **Summary of Transport Mechanisms**
http://www2.visalia.k12.ca.us/eldiamante/science/biology/taters/cell_membrane_mc.htm

1 PASSIVE
- No energy
- Down a gradient
- Diffusion
- Osmosis

- Facilitated Diffusion

2 ○ACTIVE

- Requires energy
- UP a gradient
- Uses up to 40% of a cells ATP
- Na-K pump
- Endocytosis
- Exocytosis
- Proton pump

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