## **Ch 4 A Tour of the Cell**

**Concept 4.1 Biologists use Microscopes & The tools of biochemistry to study cells**

# **Cell Fractionation**

## **Cell fractionation** breaks up cells and separates the components, using centrifugation

## Cell components separate based on theirrelative size

## Cell fractionation enables scientists to determine the functions of organelles

# **Concept 4.2: Eukaryotic cells have internal membranes that compartmentalize their functions**

## The basic structural and functional unit of every organism is one of two types of cells: prokaryotic or eukaryotic

# **Comparing Prokaryotic and Eukaryotic Cells**

## Basic features of all cells

### Plasma membrane

### Semifluid substance called **cytosol**

### Chromosomes (carry genes)

### Ribosomes (make proteins)

# **Comparing Prokaryotic and Eukaryotic Cells**

# **Eukaryotic Cells: Plant vs. Animal**


# **The Plasma Membrane**

# **Figure 4.5**

* The plasma membrane is a selective barrier that allows sufficient passage of oxygen, nutrients, and waste to service the volume of every cell
* The general structure of a biological membrane is a double layer of phospholipids

# **Surface Area:Volume Ratio**

## **Figure 4.6: Surface Area:Volume Ratio**

## Metabolic requirements set upper limits on the size of cells

## The ratio of surface area to volume of a cell is critical

### Higher S:V ratio allows more diffusion

## To successfully support the metabolic requirements a cell needs to be SMALL

# **A Panoramic View of the Eukaryotic Cell**

## A eukaryotic cell has internal membranes that divide the cell into compartments—organelles

## The plasma membrane and organelle membranes participate directly in the cell’s metabolism

# **Concept 4.3: The eukaryotic cell’s genetic instructions are housed in the nucleus and carried out by the ribosomes**

## The nucleus contains most of the DNA in a eukaryotic cell

## Ribosomes use the information from the DNA to make proteins

## **Figure 4.8**

## **Figure 4.9**

# **Concept 4.4: The endomembrane system regulates protein traffic and performs metabolic functions in the cell**

## Components of the **endomembrane system**

### Nuclear envelope

### Endoplasmic reticulum

### Golgi apparatus

### Lysosomes

### Vacuoles

### Plasma membrane

## These components are either continuous or connected through transfer by **vesicles**

# **The Endoplasmic Reticulum: Biosynthetic Factory**

## The **endoplasmic reticulum (ER)** accounts for more than half of the total membrane in many eukaryotic cells

## The ER consists of a network of sacs and tubules

* ER lumen is the internal compartment of the ER
* Cisternae fluid filled membranous sacs and tubules

## There are two distinct regions of ER

### **Smooth ER**: lacks ribosomes

* Synthesizes lipids & steroids (ie: steroid hormones lots in ovaries & testies)
* Metabolizes carbohydrates
* Detoxifies drugs and poisons
* Stores calcium ions

### **Rough ER**: surface is studded with ribosomes

* Polypeptide (proteins) made in bound ribosomes, thread into inside of the rough ER
* These dpolypeptides get folded into their 3D shape (2nd-ary & Tertiary structure
* Has bound ribosomes, which secrete glycoproteins
* Distributes transport vesicles, proteins surrounded by membranes
* Is a membrane factory for the cell

### **Figure 4.10**

### **The Golgi Apparatus: Shipping & Receiving Center**

* The Golgi apparatus consists of flattened membranous sacs called cisternae
* Cis- vs Trans face
* Functions of the Golgi apparatus
* Modifies (attaches ID tags that act like “zip codes” on mailing labels) on to products of the ER
* Manufactures certain macromolecules
* Sorts and packages materials into transport vesicles
* Not just a wharehouse for receiving, sorting and shipping but also dynamic modification of cargo (cisternal maturation model)

### **Figure 4.11**

# **Lysosome Formation**

# The hydrolytic enzemes and lysosome membranes are made by the rough ER and Golgi apparatus

# A lysosome is a membranous sac of hydrolytic enzymes that can digest macromolecules for food or recycling old organelles

# Lysosomal enzymes can hydrolyze proteins, fats, polysaccharides, and nucleic acids

# Lysosomal enzymes work best in the acidic environment inside the lysosome

# **Figure 4.12**

# Some types of cell (macrophage – type of WBC) (amoebas) can engulf another cell by phagocytosis; this forms a food vacuole

# A lysosome fuses with the food vacuole and digests the molecules

# **Figure 4.13 pg 80**

# Lysosomes also use enzymes to recycle the cell’s own organelles and macromolecules, a process called autophagy

# This helps cell to renew themselves (ie: Liver cells)

# **Vacuoles: Diverse Maintenance Compartments**

# Vacuoles are large vesicles derived from the endoplasmic reticulum and Golgi apparatus

# Membrane bound storage organelle

# There are several types:

# Food vacuoles are formed by phagocytosis

# Contractile vacuoles, found in many freshwater protists, pump excess water out of cells

# Central vacuoles, found in many mature plant cells, hold organic compounds (waste products, pigments & chemical compounds that could be poisonous) and water

# Certain vacuoles in plants and fungi carry out enzymatic hydrolysis like lysosomes

# **Figure 4.14 pg 80**

# **The Endomembrane System: *A Review***

## The endomembrane system is a complex and dynamic player in the cell’s compartmental organization

## **Figure 4.15**

# **The Evolutionary Origins of Mitochondria and Chloroplasts**

## Mitochondria and chloroplasts have similarities with bacteria

### Enveloped by a double membrane

### Contain free ribosomes and circular DNA molecules

### Grow and reproduce somewhat independently in cells

### The endosymbiont theory

### An early ancestor of eukaryotic cells engulfed a non-photosynthetic prokaryotic cell, which formed an endosymbiont relationship with its host

### The host cell and endosymbiont merged into a single organism, a eukaryotic cell with a mitochondrion

### At least one of these cells may have taken up a photosynthetic prokaryote, becoming the ancestor of cells that contain chloroplasts

### **Figure 4.16 pg 82**

# **Mitochondria: Chemical Energy Conversion**

# Mitochondria are in nearly all eukaryotic cells & are the energy producers

# They have a smooth outer membrane and an inner membrane folded into cristae

# Cristae allow for grater surface area for cell respiration

# The inner membrane creates two compartments:

# intermembrane space and

# mitochondrial matrix = liquidy inside inner membrane

# Mito has own DNA & ribosomes

# Some metabolic steps of cellular respiration are catalyzed in the mitochondrial matrix

# Break down sugars to produce energy in the form of ATP (Adenasine TriPhophate)

# Cristae present a large surface area for enzymes that synthesize ATP

# In cells with a lot of metabolic activity there are a lot (1000s) of mitochondria

# **Figure 4.17**

# **Chloroplasts: Capture of Light Energy**

# Chloroplasts are energy producers

# Chloroplasts contain the green pigment chlorophyll, as well as enzymes and other molecules that function in photosynthesis

# Chloroplast structure includes

# 2 membranes (inner & outer)

# Thylakoids, membranous sacs, stacked to form a granum (grana=plural)

# Stroma, the internal fluid

# The chloroplast is one of a group of plant organelles called plastids

# Plastids store starch, have pigments to give flowers colors

# Chloroplastss have own DNA and

# **Figure 4.18a**

# **Peroxisomes: Oxidation**

# Peroxisomes are specialized metabolic compartments bounded by a single membrane

# Peroxisomes contain enzymes that remove hydrogen from certain molecules and transfer them to Oxygen producing hydrogen peroxide (as a byproduct) which is toxic but they can break down H2O2 & convert it to water

# Peroxisomes perform reactions with many different functions

# Ie: Liver peroxisomes detoxify alcohol by transferring the Hydrogen from the alcohol and other harmful compounds to oxygen

# **Figure 4.19 pg, 84**

# **Concept 4.6: The Cytoskeleton is a network of fibers that organizes structures & activities in the cell**

# The cytoskeleton is a network of fibers extending throughout the cytoplasm

# It organizes the cell’s structures and activities, anchoring many organelles

# **Figure 4.20 pg. 84**

# Three main types of fibers make up the cytoskeleton

# Microtubules are the thickest of the three components of the cytoskeleton

# Microfilaments, also called actin filaments, are the thinnest components

# Intermediate filaments are fibers with diameters in a middle range

# **Table 4.1 pg 86**

# **Centrosomes and Centrioles**

# In animal cells, microtubules grow out from a centrosome near the nucleus

# The centrosome is a “microtubule-organizing center”

# The centrosome has a pair of centrioles, each with nine triplets of microtubules arranged in a ring

# **Figure 4.22**

# **Cilia and Flagella**

# Microtubules control the beating of cilia and flagella, microtubule-containing extensions projecting from some cells

# Flagella are limited to one or a few per cell, while cilia occur in large numbers on cell surfaces

# Cilia and flagella also differ in their b eating patterns

# Cilia like row boat oars stroking back & forth

# Flagella undulate or “S-wave” pattern

# Cilia and flagella share a common structure

# A core of microtubules sheathed by the plasma membrane (cytoskeleton) w/9+2 pattern

# With 9 + 2 pattern: 9 pairs(doublets) around central pair

# A basal body that anchors the cilium or flagellum

# A motor protein called dynein, which drives the bending movements of a cilium or flagellum, uses ATP

# **Cell Walls of Plants**

# The cell wall is an extracellular structure that distinguishes plant cells from animal cells

# The cell wall protects the plant cell, maintains its shape, and prevents excessive uptake of water

# Plant cell walls are made of cellulose fibers embedded in other polysaccharides and protein

# **Figure 4.25**

**The Extracellular Matrix (ECM) of Animal Cells**

# Animal cells lack cell walls but are covered by an elaborate extracellular matrix (ECM)

# ECM helps:

#  support,

#  move,

# regulate cell behavior &

# Adhere cells to other cells

# **Figure 4.26 pg 89**

# The ECM is made up of glycoproteins such as collagen, proteoglycans, and fibronectin

# ECM proteins bind to receptor proteins in the plasma membrane called integrins

# **Cell Junctions**

# Neighboring cells in an animal or plant often adhere, interact, and communicate through direct physical contact

# There are several types of intercellular junctions that facilitate this

# Plasmodesmata

# Tight junctions

# Desmosomes

# Gap junctions

# Plasmodesmata are channels that perforate plant cell walls

# Through plasmodesmata, water and small solutes (and sometimes proteins and RNA) can pass from cell to cell

# Animal cells have three main types of cell junctions:

# Tight junctions

# Membranes of adjacent cells are fused, forming continuous belts around cells;

# Prevent fluids from leaking in/out

# Ie: TJs between skin cells make us water tight by preventing leakage btwn cells in our sweat glands

# Desmosomes

# Anchoring junctions like “Rivets”

# Fasten cells together into strong sheets

# Ie: Desmosomes attach muscle cells

# Gap junctions

# Communicating junctions

# Allows cystoplasm, ions, sugars, amino acids, & other small molecules to move between adjacent animal cells

# Ie: heart muscle, brain cells

# All are especially common in epithelial tissue

# **Figure 4.27 pg 90**