

Cell Structure – Human

cell is basic unit of all life; structural and functional

if its alive, must contain at least a single cell

the function of an organism is the summation of functions of its individual cells

cell first described 300 years ago by Robert Hook

in human body

single fertilized egg → 75–100 trillion cells (adult)
[>10x's more bacterial cells in body]

There are about 200 different kinds of cells in the human body with a variety of sizes and shapes

The “Microbiome” or “Normal Flora”

in addition to the human cells we're made of, we are beginning to appreciate that the bacteria that inhabit us are just as important as our own cells:

our bodies normally contain 3-5 lbs of bacteria

~10x's more bacterial cells than human cells

(400 microbial genes for each human gene)

“you are born 100% human, but die 90% microbial”

Microscopy , Cells, Tissues: Cell Structure – Animals/Humans; Ziser Lecture Notes, 2014.4

1

bacterial are essential for a healthy body

eg. skin bacteria protect us from pathogens and unchecked inflammation triggered by injury and bacterial pathogens

widespread use of antibacterial hand gels may exacerbate such skin inflammation

which species you have on your skin determine whether you get acne or not

eg. gut bacteria

→help break down hard to digest fibers and starches

→make essential vitamins & additional nutrients

→protect us from pathogens

→metabolize & remove plant toxins and some carcinogens

→activate our immune systems to better resist infections

we are beginning to see that our symbiotic microorganisms play an essential role in our survival, adaptation and even evolution

our microbiome is strongly correlated with our genetic makeup

→ may be as distinctive as our fingerprints; eg. bacteria found on a keyboard can identify the user as well as fingerprints

the abundance of certain bacteria in your feces correlates with your age, gender, body mass index, and nationality

Microscopy , Cells, Tissues: Cell Structure – Animals/Humans; Ziser Lecture Notes, 2014.4

2

Human Cells - Anatomy

human cells range in **size** from:

eg. sperm cells are some of the smallest human cells

eg. human eggs & fat cells are some of the largest, barely visible to naked eye

eg. some nerve cells are 3 ft long (humans)

while there is a great diversity in size and shape
→less diversity in function

in most:

Structure

Basic Components of Cell:

a. cell membrane - boundary

b. cytoplasm (=cytosol)
- includes everything except cell membrane

c. nucleus -genetic material

d. organelles & inclusions
internal structures - highly organized, specialized structures

1. Cell Membrane

Microscopy , Cells, Tissues: Cell Structure – Animals/Humans; Ziser Lecture Notes, 2014.4

3

defines boundary

→phospholipids, proteins, cholesterol

phospholipids have polar and nonpolar ends
tend to arrange themselves into double layered films

framework for all membranes of cells

help to provide a high capacity for self repair

proteins “float” randomly in this bilayer

= “fluid mosaic”
some membrane protein functions:

eg. **receptors** (ie. docking sites) for specific substances

eg. **carriers:** move specific solutes across membrane

eg. **enzymes:** energy transforming enzymes

the cell membrane is **selectively permeable**

some things enter freely, some things cannot cross or cross only with “help”

2. Cytoplasm (=Cytosol)

contains mostly water, ions, organic molecules etc

Microscopy , Cells, Tissues: Cell Structure – Animals/Humans; Ziser Lecture Notes, 2014.4

4

variety of enzymes eg. glycolysis

3. Nucleus

largest of internal cell structures

number varies: one to many

in humans

most cells have one nucleus

RBC's have none

a few cells are multinucleate (2-50 nuclei)

surrounded by nuclear envelope

same structure and cell membrane

contains genetic material:

genetic material

=chromosomes

100's times length of cell

humans ~3' of DNA/cell

4. Nucleolus

densely packed chromosome region within nucleus

with proteins and ribosome precursors

site of RNA synthesis

important in formation of ribosomes

5. Mitochondria:

about size of small bacterial cell

contain their own set of DNA (genes):

passed only from mother to child

mtDNA remains unchanged generation after generation except by slow random mutation

→ used as molecular clock to trace evolution of groups

eg. all humans today descended from a single woman of about 200,000 years ago = mitochondrial EVE

power plants of cells:

contain enzymes for **respiration** and ATP synthesis

produces most of cells ATP (=energy)

→use oxygen gas in energy releasing reactions

the oxygen dependent energy releasing reactions = **aerobic respiration** occur in mitochondria

typical cell has dozens to 100,000's

→number related to cells activity

eg: muscle & nerve cells	100,000's/cell
liver cells	1000's/cell
sperm cells	~25/cell

6. Ribosomes

workbenches for protein synthesis

→protein factories (**translation**)

up to 1000's per cell

># ribosomes = > amount of protein synthesis

7. Endoplasmic Reticulum

(= "little network within the cytoplasm")

a single highly branched membranous tube, with sacs and flattened channels = cisternae

two types:

most cells contain both types
(in different proportions)

Rough ER:

lots of ribosomes attached to surface

protein synthesis and transport

esp those that are secreted or those found in lysosomes

especially in protein exporting cells

eg. liver and pancreas

Smooth ER:

no ribosomes

lipid metabolism

transports lipids & proteins thru cell

most cells have only a small amt of smooth ER

most common in lipid synthesizing cells

eg. liver cells

and detox cells of liver

long term abuse of alcohol, barbiturates and other drugs leads to tolerance partly because smooth ER proliferates and detoxifies the drugs more quickly

ER highly modified in skeletal muscle cells

=**sarcoplasmic reticulum**

→ Ca⁺⁺ storage

8. Golgi Bodies, Golgi Apparatus

usually near nucleus

stack of membranes (flattened sacs)

functions in "packing & shipping"

encloses chemicals in vesicles and takes them to the cell membrane for **secretion**

usually 1 to several 100 golgi bodies in a cell

but may be up to 25,000/cell

→highest in secretory cells

9. Lysosomes

membrane bound package of digestive enzymes

several 100/cell

size and shape changes

"digestive system" of cell:

contains at least 50 different enzymes

→capable of breaking almost every kind of large organic molecule

a. destroys unwanted materials, cellular debris, worn out organelles

eg. mitochondria

b. also used by WBC's and neuroglia cells to destroy invading pathogens

c. gets rid of worn out cells = **suicide bags**

= **apoptosis** (programmed cell death)

eg. during development, removes "webs" from between fingers and toes

eg. restores original size of uterus after delivery

at full term weighs ~30 oz (900g)
shrinks to 2 oz (60 g) within 5 or 6 weeks after delivery

10. Peroxisomes

resemble lysosomes but with a different set of enzymes

→ contains oxidases

removes poisons from cells = detox

eg. free radicals

eg. alcohol and other drugs

several 100 per cell

→ esp in liver and kidney cells

Functions:

detoxification of alcohol and other drugs

neutralize free radicals
digests large fatty acids and amino acids into fragments that can be used to produce ATP
help destroy bacteria

named for the H₂O₂ they produce while detoxifying chemicals and killing bacteria

11. Cytoskeleton

microfilaments and microtubules

some are contractile

responsible for the overall shape & rigidity of each kind of cell

nonrigid, contractile

Functions:

cell movement
phagocytosis
holds organelles in place
helps move things around in the cell
plays a role in cell division and growth

12. Centrioles (Centrosome)

each cell has a pair – at right angles to each other

made of microtubules
9 bundles of 3 tubules

functions in cell division: **mitosis & meiosis**

→ helps to form spindle

Structures found on the surface of some cells

13. microvilli

extensions of cell membrane that greatly increase its surface area
for absorption (intestine) or reabsorption (kidney)

best developed in cells specialized for absorption

- intestinal lining
- nephric tubule (PCT)

1000's/cell in intestine

- give cells 15 – 40 times more surface area

microvilli on taste cells and cells in inner ear have sensory rather than absorptive function

14. Membrane Junctions

formed by some of the membrane proteins

allows cells to attach to each other in different ways

eg. tight junctions

form impermeable barriers

esp in epithelial layers of membranes

- any passage through membrane must be

through cells, cant squeeze between adjacent cells

eg: keep digestive enzymes in intestine from leaking into blood

eg. prevents intestinal bacteria from invading tissues

eg. desmosomes

rivet-like couplings of "linked proteins"

"guy wires" throughout sheet of cells

especially in tissues subjected to stretching

- prevents sheets of cells from tearing

eg. skin, neck of uterus, heart muscle

eg. gap junctions

allows direct passage of small molecules and ions between cells

eg. intercalated discs in cardiac muscle cells

15. cilia

cilia are hairlike processes found in most body cells

mainly in respiratory tract and uterine tubes

beat in waves moving mucus or egg cells along tubes

16. flagella

is essentially a long, solitary cilium

flagella found only in sperm cells

17. membrane receptors

sites at which cells recognize and bind to specific molecules

eg. hormones, neurotransmitters, etc

the binding activates the cell in some way:

eg. changes metabolism

eg. triggers secretion

eg. triggers cell division