Anatomy & Physiology

Cells: The Living Units

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Cells: The Living Units



Fundamental unit of life is the Cell Humans are multicellular organisms An adult human is composed of about 75 trillion cells

Sizes of Human Cells



Cell Type and Functions: Examples



"Typical" Human Cell



Extracellular Materials

- Body Fluids (interstitial fluid; blood plasma, cerebrospinal fluid)
 - FYI: Interstitial fluid is found in the spaces between tissue cells, constituting on average about 16% of human body or about 11 liters (2.42 gallons) of interstitial fluid in an adult providing the cells of the body with nutrients and a means of waste removal.
- Cellular Secretions (gastric fluids, saliva, mucus)
- Extracellular Matrix (organized mesh of proteins and polysaccharides secreted by cells into the extracellular space)

The Cell or Plasma Membrane

The Cell or Plasma Membrane



The Cell or Plasma Membrane



Cytoplasm – material between plasma membrane and the nucleus

Three major elements:

- Cytosol largely water with dissolved protein, salts, sugars, and other solutes
- Cytoplasmic organelles metabolic machinery of the cell
- Inclusions chemical substances such as glycosomes, glycogen granules, and pigment

Protoplasm – living matter – cytoplasm and nucleus

Cytoplasmic Organelles - specialized cellular compartments with specific functions

Some (membranous) are bounded by a membrane similar to the cell membrane Mitochondria, Peroxisomes, Lysosomes, Endoplasmic Reticulum, Nucleus, Golgi Bodies, Vesicles

Others (nonmembranous) lack a membrane Cytoskeleton, Centrioles, and Ribosomes

The Cell Cycle



<u>Interphase</u>

 G_0 – no cell division G_1 – gap1, metabolism and growth S Phase – DNA synthesis G_2 – gap 2, growth and preparation for division

<u>Mitosis</u> (Nuclear division – Karyokinesis)

<u>Cytokinesis</u> (Cytoplasmic Division)

Cell Cycle



DNA Replication

•Each free nucleotide strand is a template for building a new complementary strand (semiconservative replication) •DNA + Protein = chromatin (uncondensed) or chromosomes (condensed) •Chromatin or chromosomes consist of about 40% DNA and

60% protein



Karyotype – a preparation of metaphase chromosomes



DNA Fingerprinting or Profiling

•DNA is extracted from cells and cut into fragments of various sizes by restriction enzymes. •Gel electrophoresis separates the fragments by size. •Separated fragments are transferred to a nylon membrane (Southern blot). •Some of the sequences are labeled with radioactive substances (probes). •X-ray film is exposed by the radioactivity of the labeled sequences. •The autoradiogram Evidence shows the pattern of a DNA profile. Match No match

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http://www.pbs.org/wgbh/nova/sheppard/labwave.html

Interphase $-G_1$, S, G_2



Unduplicated & Duplicated Chromosomes



- During interphase chromosomes go from being unduplicated to duplicated.
- Each chromosomes goes from possessing one DNA molecule to possessing two DNA molecule.
- Each chromosome goes from possessing one chromatid to possessing two chromatids.
- For animation of cell cycle visit: <u>http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter11</u>

Mitosis followed by Cytokinesis



Mitosis – P, M, A, T



Chromosomes become visible as the *chromatin* coils and forms rod-shaped strands. Each chromosome now consists of two identical strands called *sister chromatids* attached at the *centromere*.

The *nuclear membrane* breaks down and disappears. The *centrioles* move to opposite poles of the cell and the *mitotic spindle* forms.

Microtubules attach to the kinetochores (part of centromere)

Mitosis - prophase



Mitosis - metaphase





Chromosomes (*sister chromatids*) are moved to the equator (metaphase plate) of the spindle.

Mitosis - anaphase





Sister chromatids separate (now called chromosomes) and are moved towards opposite poles of the spindle by the spindle fibers (microtubules).

Mitosis - telophase





The chromosomes reach the poles. A nuclear membrane forms around the chromosomes, nucleoli reform, and the spindle disappears. Two identical daughter nuclei are formed.

Mitosis – telophase; Cytokinesis

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e)

Telophase and Cytokinesis Nuclear envelopes begin to reassemble around two daughter nuclei. Chromosomes decondense. Spindle disappears. Division of the cytoplasm into two cells.

Chromosomes Nuclear envelopes



Fertilization and the Fate of Cells



Cell Differentiation











Cancer: cell divison gone wrong



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- (a) Healthy, specialized cells In a healthy cell, oncogenes are not overexpressed, and tumor suppressor genes are expressed. As a result, cell division rate is under control. Cancer begins in a single cell when an oncogene is turned on or a tumor suppressor gene is turned off. This initial step may result from an inherited mutation, or from exposure to radiation, viruses, or chemicals that cause cancer in a somatic (nonsex) cell.
- (b) Other mutations

Malignancy often results from a series of mutations. An affected cell divides more often than the cell type it descends from and eventually loses its specialized characteristics.

(C) Invasion and metastasis

Cancers grow and spread by inducing formation of blood vessels to nourish them and then breaking away from their original location. The renegade cells often undergo further genetic change and surface characteristic alterations as they travel. This changeable nature is why many treatments eventually cease to work or a supposedly vanquished cancer shows up someplace in the body other than where it originated.



Cell Tissue Culture; Tissue/Organ Repair

IN THE NEWS



Implanted Tissue Repairs Damaged Bladders

National Public Radio - April 4, 2006 · Researchers announce they've grown bladder tissue in a laboratory and used it to successfully repair damaged bladders. The Wake Forest University researchers published their results in The Lancet. Link available at:

http://www.npr.org/templates/story/story.php?storyId=5321689

Doctors grow organs from patients' own cells

Wednesday, April 5, 2006

HADDAM NECK, Connecticut (CNN) -- Seven living with bladders from new process. Link available at: http://edition.cnn.com/2006/HEALTH/conditions/04/03/engineered.organs/index.html





Lab Grown Organs – Human Bladder



Scientists Rebuild Bladder in 7 Patients BOSTON, Apr. 3, 2006 See link at: http://www.cbsnews.c

om/stories/2006/04/03 /ap/health/mainD8GO Q9C83.shtml