The Cell Cycle

The life cycle of a cell consists of growth and division. There are several stages to the cell cycle:

**G1 phase**

* first gap is usually longest period of cell cycle
* however, in some embryonic cells that are rapidly dividing, G1 might only last a few minutes
* Some cells, like nerve cells never leave G1 and this is sometimes called a G0 state
* G1 prepares the cell to undergo the next stage of synthesis.

**S phase**

* all chromosomes are duplicated.
* DNA is replicated.
* new proteins synthesized to assemble with new DNA to form new chromosomes .
* replication begins at many sites along the length of a chromosome.
* time to complete S phase varies between different life stages and between species.

**G2 phase** -- cell prepares itself for mitosis by synthesizing needed components.

Some cells remain in interphase their whole lives because they do not divide. Two such examples are nerve cells and adult muscle cells. The long "G1" phase is sometimes called G0 phase.

**Control of the Cell Cycle**

* result of cell cycle is cell proliferation.
* critical in embryological development.
* critical in repairing tissue damage.
* critical in immune response.
* uncontrolled proliferation is called cancer - more later in course .

**Cell Nutrition**

Life is an energy intensive process. It takes energy to operate muscles, extract wastes, make new cells, heal wounds, even to think. It’s in an organism’s cells where all this energy is spent. In some cells, as much as half of a cell’s energy output is used to transfer molecules across the cell membrane, a process called ‘active transport.’

Cell movements require energy and thousands of energy-hungry chemical reactions go on in every living cell, every second, every day. The kind of energy cells use is chemical bond energy, the shared electrons that holds atoms together in molecules.

The Cell Development

Many eukaryotic organisms do not exist as one-celled bodies, and generally, the cells multiply and develop into a more complex organism. This development comes about by way of two processes -- growth and differentiation.

During the growth process, cells reproduce and grow more cells through mitosis. This process occurs daily, and even many times a day as cells continually need to be replenished as others die.

As cells form more complex organisms, they must produce different types of cells that result in a functioning integrated organism. A group of cells of the same type form a larger structure called a tissue (e.g. -- skin, muscle). Multiple tissues can form an organ (e.g. -- eye, kidney). This variation among cell groups is known as differentiation. Cells that are capable of differentiating into many different cell types are called totipotent.

The genetic information these cells contain is used sparingly and only at the key moments necessary during the developmental process. This "gene control" regulates the growth and development of the body. Genetic information that is not properly regulated causes vital problems in cell growth and can lead to diseases such as cancer.

When cells become a part of a tissue or organ, they lose their ability to work alone and cannot survive without the support of other cells. They become dependent on other cells to work as a group to govern the whole. In doing so, they are capable of astonishing things in the body. For example, our blood serves as a messenger for all types of nutrients throughout the body, carries oxygen to (and removes CO2 from) different parts of the body. It is through our blood and its immune system that we fight off diseases. Our muscles have the ability to contract, and our nerves can carry and receive electrical signals. Our digestive system can extract nutrients from the foods we eat. Our kidneys remove waste. The main organs of our senses provide us with sight, hearing, and the abilities to smell and taste. All of these abilities create the working body.

**The Cell Components**

Cells have large organic molecules and small molecules. The more complex molecules known as polymers are those such as carbohydrates, nucleic acids, and proteins. Carbohydrates are assembled by linking together sugars. Complex linking results in large molecules such as starch and cellulose. Carbohydrates can be attached to proteins and thereby alter the functioning of the protein. DNA and RNA are nucleic acids that are made by linking together nucleotides. DNA contains the genetic information, and RNA conveys that information to the rest of the cell and directs the synthesis of proteins.

Proteins are vital molecules that are long chains of amino acids held together through a unique bond known as the peptide bond. Because each protein has such a unique shape, this shape is easily recognized by other molecules enabling proteins to perform unique functions. Enzymes are catalytic proteins which carry out many vital processes to obtain energy from food, keep the flow of ions in and out of cells occurring, carry oxygen, and create new molecules such as DNA, RNA, lipids, carbohydrates, and other proteins. Proteins provide a structural backbone for the cell as well and provide a means of moving molecules within the cells.

Microtubules are rod-shaped fibers that exist in cells and serve as railroad tracks. Within the cell they move vesicles, mitochondria, and other materials and particles throughout the cell.

Actins fibers exist within a single cell and give the cell its shape through its constant interaction with myosin also present in cell.

**Cell-Cell Interactions**

Electrical interactions

* Nerve, muscle interaction
* Sensor cells (ex. perception of light in the retina)

**Chemical interactions**

* 1. Neurotransmitters (cause vesicles at end of neuron to fuse
* with membrane when the chemical gradient changes).
* 2. Hormones

Direct Interactions: cell-cell junctions that allow molecules to flow from one cell to another; ex. In muscle, the fusion of thousands of cells whose membranes dissolve to form synsytium.

Small molecules are also important to the cell, and these have different purposes. They include water, salts, sugars, lipids, amino acids, and nucleotides. The presence of salts allows for creating and maintaining the electrical balance within the cell -- inside and outside the membrane. Sugars serve as energy sources to the cell. Excess energy is stored as fat in the form of lipids. Some small amino acids can serve as neurotransmitters which move from cell to cell and transfer signals between nerves. Nucleotides are the building blocks of DNA and RNA.

Other Aspects of The Cells

It is important to understand how cells interact with one another. One such interaction is through electrical signals. Electrical signals transmitted between cells in the nervous system allow us to feel something. When we touch something, an electrical signal is sent through our nerve cells to our brain. Our brain processes the information and acknowledges the sensation of touch. Another type of cellular communication is through chemical transmitters. Chemical transmission is seen in the action of hormones -- chemicals that are released from one tissue in the body and act at other sites. For example, the hormone estrogen is released in the female from the ovaries and acts an many sites in the body during the menstrual cycle. Testosterone and estrogen are both involved in development.

The process of contact inhibition is another important concept. This is the process in which cells "realize" that it is time to stop multiplying. This is vital in tissue and organ growth, for malfunction of this process results in disease. This is the process that occurs when wounds heal -- growth stops when the cells meet and join together to heal the wound.

When contact inhibition does not occur, cells become "immortal" in a sense as they cannot recognize that they must stop growing. This is what occurs in cancer -- the cells continue to reproduce at a rapid rate and cannot be stopped unless they are all destroyed through removal of an organ or a process such as chemo-therapy.

Cell Mortality - normal cells are mortal and can continue to grow and divide from 50=100 times before dying.

* there is a natural limit to how many times cells can divide.
* biochemical errors accumulate during cell division and
* reproduction which eventually result in cell death.
* immortality of cancer cells shows there is a way to keep cells
* alive.
* cells can become immortal if transformed by infecting them
* with a virus .
* cell death is part of normal development (ex. In fetus, cells of
* webs between fingers and toes die before birth) .
* cell death important for regenerating tissues or bones after
* injury.