**Lec.3 Pathophysiology Dr.Baydaa Hameed**

**Apoptosis:**

 A form of cell death in which a programmed sequence of events leads to the elimination of cells without releasing harmful substances into the surrounding area.

 Apoptosis plays a crucial role in developing and maintaining the health of the body by eliminating old cells, unnecessary cells, and unhealthy cells.

The human body replaces perhaps one million cells per second. Too little or too much apoptosis can play a role in many diseases. When apoptosis does not work correctly, cells that should be eliminated may persist and become immortal.

For every cell, there is a time to live and a time to die.

There are two ways in which cells die:

* They are killed by injurious agents.
* They are induced to commit suicide.

Death by suicide

Cells that are induced to commit suicide:

* shrink;
* develop bubble-like blebs on their surface;
* have the [chromatin](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/Nucleus.html#Chromatin) (DNA and protein) in their nucleus degraded;
* have their mitochondria break down with the release of [cytochrome c](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/CellularRespiration.html%22%20%5Cl%20%22respiratory_chain);
* break into small, membrane-wrapped, fragments;
* release (at least in mammalian cells) [ATP](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/A/ATP.html) and [UTP](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/Nucleotides.html#nucleosides).
* These nucleotides bind to receptors on wandering [phagocytic](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/E/Endocytosis.html) cells like [macrophages](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/B/Blood.html#monocytes) and [dendritic cells](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/D/DCs.html) and attract them to the dying cells (a "find-me" signal").
* The [phospholipid](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Phospholipids.html) phosphatidylserine, which is normally hidden in the inner layer of the plasma membrane, is exposed on the surface.
* This "eat me" signal is bound by other receptors on the phagocytes which then engulf the cell fragments.
* The phagocytic cells secrete [cytokines](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/C.html#cytokine) that inhibit [inflammation](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/I/Inflammation.html) (e.g., [IL-10](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/T/Treg.html)and [TGF-β](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/CellSignaling.html#TGF-b))

The pattern of events in death by suicide is so orderly that the process is often called programmed cell death or PCD. The cellular machinery of programmed cell death turns out to be as intrinsic to the cell as, say, [mitosis](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/M/Mitosis.html).

Why should a cell commit suicide?

There are two different reasons.

1. Programmed cell death is as needed for proper development as mitosis is.

Examples:

* The formation of the fingers and toes of the fetus requires the removal, by apoptosis, of the tissue between them.
* The sloughing off of the inner lining of the uterus (the endometrium) at the start of [menstruation](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/S/SexHormones.html#menstrual) occurs by apoptosis.
* The formation of the proper connections ([synapses](http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/S/Synapses.html)) between neurons in the brain requires that surplus cells be eliminated by apoptosis.
* The elimination of T cells that might otherwise mount an autoimmune attack on the body occurs by apoptosis.

2. Programmed cell death is needed to destroy cells that represent a threat to the integrity of the organism.

Examples:

Cells infected with viruses

Cells of the immune system

Cells with DNA damage

Cancer cells

Radiation and chemicals used in cancer therapy induce apoptosis in some types of cancer cells.