- Juvenile and adolescent phase – biggest growth stages, hormones and growth factors stimulate and regulate growth.
- Cell division slows down at adult size so new cells replace dying cells. Salmon and lobster continue to grow at adult stage. Some can regenerate like salamander's eyes. After surgical removal of 70% of liver, liver grows back to its size rapidly.
- Aging – a progressive deterioration of physiological function, an intrinsic age related process of loss of viability and increase in vulnerability.
- Death – end of individual development, irreversible cessation of biological process.
- Clinical death – cessation of life support functions (breathing and circulation)
- Biological (brain) death – when electrical activity in brain ceases

- **Regeneration – definition, mechanism, medical significance.**
  - Regeneration is the process of renewal, restoration and growth that makes genomes, cells, organs, organisms that cause disturbances or damage.
  - Embryonics supports development of regenerative medicine, involving use of specially grown cells, tissues and organs as therapeutic agents to cure disease and repair injury and springs from development of mammalian cloning technology.
  - Use of transplanted tissue and organs in medicine is not classified as regenerative medicine because tissue and organs were not grown specifically for use as therapeutic agents.
  - Reprogramming adult stem cells or somatic cells removed from the patient so cells revert to the pluripotent, embryonic state. Synthetic stem cells then grown in culture and differentiated into appropriate cells indicated for treating the patient's disease or injury.
  - Human liver: one of the few glands in the body that has the ability to regenerate from as little as 25%of its tissue
  - Human kidney: if one of the kidneys is removed the other one will start to compensate the loss by growing bigger

- **Explantation – definition, condition, medical significance.**
  - To take cells from animal or plant for placement in a culture medium (in vitro - outside organism).
  - Start to grow and divide, different to cancer cells as they don't stop dividing
  - Cultivation of viruses help us to do vaccination
  - Help us to observe cell behavior – malignant or benign.
  - Lymphocyte cultures stops mitotic division
  - In transplantation immunology, observe reactions suitable to donator or not.

- **Arrabiosis, hypothermia and hibernation – nature and medical significance.**
  - The ability to return to life after apparent death – suspended animation.
  - Life processes are brought to minimum with no external symptoms of life, demonstrates a state opposite to life.
  - Adapting to harsh environmental condition lower organisms spend the unfavorable seasons through the year in a state of 'uta-minime' and then return back to normal
  - Hypothermia – reduction of core body temperature to 32 degrees or lower as that due to exposure to cold weather as a means of decreasing metabolism of tissues and the need of oxygen.
  - Hibernation – state of inactivity and metabolic depression in endotherms. Low body temperature, slow breathing and heart rate and low metabolic rate.
  - Artificial hibernation – state of reduced metabolism, muscle relaxation and a twilight sleep produced by controlled

transfer RNA carrying the amino acid methionine binds to the start codon of the mRNA sequence. The start codon in all mRNA sequence has the same sequence AUG and codes for methionine. The large ribosomal subunits binds to form the complete initiation complex.
    - During the elongation stage, the ribosome continues to translate each codon in turn. Each corresponding amino acid is added to the growing chain and linked via a bond called a peptide bond.
    - Elongation continues until all codons are read.
    - Termination occurs when the ribosome reaches a stop codon (UAA, UAG, UGA). Since there are no tRNA molecules that can recofnise these codons, the ribosome recognizes that translation is complete. The new protein is released and the translation complex comes apart.

- **Genetic code. Definition and characteristics**
    - is the way in which the nucleotide sequence in nucleic acids specifies the amino acids sequence in proteins.
    - It is a triplet code where the codons are adjacent and because many 64 codons specify the same amino acid, the genetic code is degenerate. 61 codons specify the 20 amino acids and 3 are stop codons.
    - Usually multiple codons differ only in the third codon position.
    - Grouping of synonymous codons means that the effects of mutations are minimized. Transitions in the third position have no effect.
    - The standard genetic code is universal, but some deviations exist in mitochondria and some unicellular organisms.
    - Open reading frame is the part of a reading frame that has the potential to code for a protein or peptide. It is a continuous stretch of codons that do not contain a stop codon.
    - Overlapping genes occur when the coding region of one gene partially or completely overlaps that of another. Thus a nucleotide sequence may make a contribution to the function of one or more gene products.

- **Gene and regulation of the gene activity operons and its functions.**
    - A gene is a unit of heredity composed of DNA occupying a fixed position on a chromosome. May determine a characteristic of an individual by specifying a polypeptide chain that focus a protein or part of a protein pr encode an RNA molecule or regulate the operation of other genes.
    - Genes are active only when cell requires their products. Binding of the repressor protein to the operator gene blocks the movement of the transcribing enzyme RNA polymerase thus prevents RNA transcription by the structural genes.
    - Histones and non histone chromosomal proteins (NHC proteins) regulate gene activity. Because histones are rich in lysine and arginine they have a net positive charge and are basic proteins. The positive charged groups interact with the negative charge of the phosphate backbone of DNA to reduce charge repulsion of the phosphate groups and would allow supercoiling of DNA. Histones thus prevent transcription by bringing about supercoiling of DNA.
    - Operon is a functioning unit of genomic DNA containing a cluster of genes under the control of a single regulatory signal or promoter.
    - The genes are transcribed together into an mRNA strand and so genes contained in the operon are expressed together or not at all.

aspects of the immune response cannot occur.

- H2 system of the mouse.
- HLA system is the major histocompatibility system of man and was found through a search for blood group-like determinants on white blood cells that would be effective in matching for transplantation.
- Class 1 MHC molecules are composed of two chains, a long alpha and a short beta chain called beta 2 microglobulin. The alpha chain has 4 regions:
  - A cytoplasmic region, containing sites for phosphorylation and binding to cytoskeletal elements.
  - A transmembrane region containing hydrophic amino acids by which the molecule is anchored in the cell membrane.
  - A highly conserved alpha 3 to which CD8 binds to.
  - A highly polymorphic peptide binding region formed from the alpha 1 and alpha 2 domains. The beta 2 microglobulin associates with the alpha chain and helps maintain the proper conformation of the molecule.
- Class 2 MHC Molecules composed of two polypeptide chains an alpha and a beta chain of equal length. Both chains have 4 regions:
  - A cytoplasmic region, containing sites for phosphorylation and binding to cytoskeletal elements.
  - A transmembrane region containing hydrophic amino acids by which the molecule is anchored in the cell membrane.
  - A highly conserved alpha 2 domain and Beta 2 domain to which CD4 binds to.
  - A highly polymorphic peptide binding region formed from the alpha 1 and beta 1 domains.
- Each MHC molecule has only one binding site, different peptides bind only one at a time. Because each MGC molecules can bind many different peptides, binding is termed degenerate.
- MHC molecules are membrane bound; recognition by T cells requires cell to cell contact. Alleles for MHC genes are co-dominant.
- A peptide must associate with a given MHC of that individual – first level of control. Secondary level of control – mature T cells must have a T cell receptor that recognizes the peptide associated with MHC.
- Cytokines especially interferon gamma, increase the level of expression of MHC.
- Peptides from the cytosol associate with MHC class I and peptides from within vesicles associate with MHC Class I and are recognized by Th cells.

Transplantation immunology. Relationship between donor and recipient. Host versus Graft (HvGR) and Graft versus Host Reaction (GvHR).

- Host reaction against the graft; Graft reaction against the host.
- Transplantation is called the act of engrafting of tissues or organs. Organ transplantation is the moving of an organ from one body to another or from a donor site to another location on the person's own body, to replace the recipient's damaged or absent organ. Organs and/or tissues that are transplanted within the same person's body are called autografts.
- HvGR performed as a cellular immune response and foreign MHC antigens initiate it. T lymphocytes of recipient activated. T helpers activate macrophages and T cytolytic lymphocytes. Local inflammatory reaction occurs, thrombi are formed which block the blood vessels and necrosis occurs, the graft is rejected,

cell, and therefore of an organism or individual, which determines a specific characteristic (phenotype) of that cell/organism/individual.
    - A dominant phenotype will be expressed when at least one allele of its associated type is present, whereas a recessive phenotype will only be expressed when both alleles are of its associated type.
    - The Hardy–Weinberg principle, also known as the Hardy–Weinberg equilibrium, model, theorem, or law, states that allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences.

- **Hardy Weinberg law. Factors affecting.**
    - States that allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences.
    - If an infinitely large, random mating population is free from outside evolutionary forces (ie mutation, migration and natural selection) then the gene frequency will not change over time and the frequencies in the next generation will be p^2 for the AA genotype, 2pq for the Aa genotype and q^2 for the aa genotype.
    - $p^2 + 2pq + q^2 = 1$
    - The sum of the allele frequencies for all the alleles at the locus must be 1, so $p + q = 1$
    - Infinitely large population – genetic drift is the change in the frequency of a gene variant (allele) in a population due to random sampling of organisms.
    - Random mating is a factor assumed in the Hardy-Weinberg principle and is distinct from lack of natural selection: in viability selection for instance, selection occurs before mating.
    - In population genetics, gene flow (gene migration) is the transfer of alleles or genes from one population to another. Migration into or out of a population may be responsible for a marked change in allele frequencies.
    - In population genetics studies, the Hardy-Weinberg equation can be used to measure whether the observed genotype frequencies in a population differ from the frequencies predicted by the equation.
    - Hardy-Weinberg Principle of Equilibrium. The Hardy-Weinberg principle states that a population's allele and genotype frequencies will remain constant in the absence of evolutionary mechanisms. Ultimately, the Hardy-Weinberg principle models a population without evolution under the following conditions: no mutations.
    - From the Hardy-Weinberg principle and the known allele frequencies, we can also infer the frequencies of the genotypes. Since each individual carries two alleles per gene (Y or y), we can predict the frequencies of these genotypes with a chi square.
    - Hardy-Weinberg law may fail to apply if there is mutation, gene flow, genetic drift, non random mating, natural selection.