

**MEDICAL UNIVERSITY – SOFIA**  
**FACULTY OF DENTAL MEDECINE**

**CURRICULUM**

**Subject: Biology and genetics for dental medical students**

For students of: **Dental Medicine**

Subject is taught in year: 1st

Subject is taught in semester: **1st and 2nd**

Examination after semester: **2nd**

The course length is: **105 academic hours**

DISTRIBUTION OF THE TEACHING HOURS

FORM OF TEACHING	HOURS		2 <sup>nd</sup> semester total per week	
	1 <sup>st</sup> semester total per week		week	
Lectures	30	2	15	1
Practicals	30	2	30	2
ALL :	60 acad. hours		45 acad. hours	

**PROGRAMME OF THE HUMAN BIOLOGY (MEDICAL  
BIOLOGY) COURSE**

**A. LECTURES**

<b><u>Unit 1. Basic principles in the organization of living systems</u></b>	<b>4 h</b>
1.1. Subject, place and significance of biology. Basic methods in biology.	
1 h	
1.2.	
1.3. Molecular organization of the living matter	1 h
Proteins - structure and function. Nucleic acids - types and functions. Self-assembly of the macromolecular subunits. Biological importance of macromolecules for the organism.	
1.4. Cellular basis of life.	1 h
Prokaryotic and eukaryotic cells - comparative structural and functional characterization. Origin and evolution of cells. The cell as an open biological system. Cell communications. Cell junctions. Cell receptors. Individual development of cells. Cell senescence	
1.5. Cell reproduction. Cell growth and division	1 h
Cell (mitotic) cycle - interphase, mitosis. Phases and mechanism of mitosis. MPF description. Control of cell division in multicellular organisms.	
<b><u>Unit 2. Molecular and cellular mechanisms of inheritance and variation</u></b>	<b>16 h</b>
2.1. Molecular mechanisms of the basic genetic processes	8 h
Replication of DNA (DNA biosynthesis). Basic modes of replication. Transcription. RNA processing. Genetic code. Translation. Protein sorting into cellular organelles. Posttranslational modification of proteins. Senescence and degradation of proteins. Mutagenic factors and the mechanism of their action. DNA repair. Genome organization in prokaryotic and eukaryotic cells. Regulation of gene expression. Sumbicroscopic structure of the chromosomes. Microscopic structure of the chromosomes. Karyotype.	
2.2. Laws of heredity	6 h
Heredity. Inheritance. Genotype and phenotype. Methods of genetic analysis - cytogenetic methods, molecular genetic methods. Allelic form of the genes. Interaction between genes. Basic types of inheritance. Inheritance of linked genes. Crossingover.	

Groups of linked genes in the human. Heredity and environment. Reaction norm. Phenocopies. Morphoses. Genocopies. Cytoplasmic heredity. Extrachromosomal heredity. Modificational and genetic variation. Hybrid and recombinational variation. Molecular mechanisms of crossingover. Mutational variation. Types of mutations. Gene mutations and disease. Chromosomal mutations. Genome mutations. Cytoplasmic mutations.

### 2.3. Genetic and gene engineerin 2 h

Genetic engineering at the level of population. Genetic engineering at the level of organism. Genetic engineering at cellular level. Genetic engineering at subcellular level. Recombinant DNA technologies and gene engineering. Specific DNA cleavage. Most important enzymes in recombinant DNA techniques. DNA sequencing. DNA libraries. Nucleic acid hybridization. DNA cloning. Polymerase chain reaction. Gene engineering and gene therapy.

<u>Unit 3. Immunobiology. The organism as a unified system. Immunological</u>	
<u>homeostasis</u>	11
h	
3.1. Immune system	1
h	
Central and peripheral organs of the immune system. Cells of the immune response. Complement system.	
3.2. Antigenes as inducers of the immune response	2
h	
Human alloantigens: ABO (H) system, Lewis system, biosynthesis of the A, B, H and Lewis antigens. Rhesus system. Origin and biological significance of the alloantigens.	
3.3. Antibodies.	2
h	
Immimoglobulins. Immunoglobulin classes. Genetic control of the antibody synthesis. Isotypic, allotypic and idiotypic determinants. V- and C-genes.	
3.4. Immune response	2 h
Cellular interactions during the immune response. Phases in differentiation of immunocompetent cells. Types of immune responses. Major histocompatibility complex. Genetic control of the immune response intensity.	
3.5 Immunobiological aspects of transplantation and anti-tumor immunity.	2 h
Immune tolerance.	
Laws for transplantation of tissues between inbred animal strains. Transplantation antigens in mouse and human. Host versus graft reaction. Immune tolerance. Graft versus host reaction. Anti-tumor immunity. Tumor antigens. Immune mechanisms directed against malignant tumors.	
3.6. Regulation and control of the immune processes. Immunity theories.	
Evolution of immunity	2 h

Unit 4. Reproduction and individual development 4 h

4.1. Reproductive biology 2 h

4.2.

Sex determination and differentiation. Reproduction of organisms. Sexual reproduction.

Haploid-diploid cycle. Benefits of sexual reproduction. Cytological basis of sexual reproduction. Meiosis. Origin of germ cells. Gametogenesis. Oogenesis. Molecular mechanisms of oocyte maturation. Characteristic features of mature ova. Spermatogenesis. Characteristic features of male gametes. Fertilization. Stages of external fertilization. Mechanisms for blocking polyspermy. Completion of fertilization. Internal fertilization in mammals. In vitro fertilization and other reproductive techniques. Atypical forms of reproduction.

4.3. Developmental biology (individual development) 2 h

Embryonic period. Cellular and molecular mechanisms of gastrulation. Embryonic development of mammals and human. Differentiation. Differences between cells and cell memory in development. Postembryonic period. Ageing and death.

Unit 5. Biological evolution 2 h

5.1. Population genetics and biology 2 h

Population. Phenotype, genotype and gene frequencies. Types of mating. Hardy-Weinberg law. Factors influencing gene frequencies. Mutations. Natural selection, balanced polymorphism, genetic homeostasis. Migration. Isolation. Quantitative traits. Molecular evolution.

Unit 6. Ecology and interactions between humans and environment 1 h

Populations, communities and ecosystems. Interactions between organisms in communities. Humans and the biosphere. Biology of behaviour.

Unit 7. Invertebrate evolution with elements of medical parasitology 3 h

Parasitism as a biological phenomenon. Parasites and hosts. Origin of parasitism. Parasite adaptation to the host. Host - parasite interactions. Ecology of parasitism.

Unit 8. Comparative anatomy and human evolution 4 h

Systematics of chordates. Origin of vertebrates. Origin and evolution of skull and digestive system.

## PRACTICAL COURSE

1. Techniques for light microscopy. Phylum Sarcomastigophora. Subphylum Mastigophora (Flagellata). *Trichomonas hominis*. *Trichomonas vaginalis*. *Lambliia intestinalis* (*Giardia lamblia*). 2 h
2. Phylum Sarcomastigophora. Subphylum Mastigophora (Flagellata). *Trypanosoma rhodesiense* and *Trypanosoma gambiense* (*Trypanosoma brucei*). *Trypanosoma equiperdum*. *Leishmania donovani*. *Leishmania tropica*. Subphylum Sarcodina. *Entamoeba histolytica*. *Entamoeba gingivalis* 2 h
3. Phylum Sporozoa (Apicomplexa). *Plasmodium vivax*. *Plasmodium malariae*. *Plasmodium falciparum*. 2 h
4. Phylum Sporozoa (Apicomplexa). *Toxoplasma gondii*. Phylum Ciliophora. Class Ciliata. *Balantidium coli*. *Paramecium caudatum*. Transition to Metazoa. Phylum Coelenterata. Genus *Hydra*. 2 h
5. Phylum Platyhelminthes (Plathelminthes). Class Trematoda. *Fasciola hepatica*. *Dicrocoelium lanceatum* (*Dicrocoelium dendriticum*). Genus *Schistosoma*. 2 h
6. Phylum Platyhelminthes. Class Cestoda. *Taenia solium*. *Taeniarhynchus saginatus* (*Taenia saginata*). *Diphyllobothrium latum*. *Echinococcus granulosus*. 2 h
7. Phylum Nematoda. *Ascaris lumbricoides*. *Enterobius vermicularis*. *Trichocephalus trichiurus*. *Trichinella spiralis*. 2 h
8. Phylum Arthropoda Class Arachnoidea (Arachnida, arachnids). Order Scorpiones (scorpions). Order Aranei (spiders). Order Acari (ticks and mites) - *Sarcoptes scabiei*, genus *Dermatophagoides*. Ticks - vectors of transmissive diseases: *Ixodes ricinus*, *Dermacentor marginatus*, *Hyalomma plumbeum*, *Rhipicephalus sanguineus*. 2 h
9. Phylum Arthropoda. Class Insecta. *Pediculus hominis*. *Phthirus pubis*. *Cimex lectularius*. *Pulex irritans*. The role of insects as vectors of transmissive diseases. 2 h
10. Phylum Arthropoda. Class Insecta. Genus *Culex* and genus *Anopheles*. *Phlebotomus papatasi*. The role of insects as mechanical carriers of pathogens and parasites. 2 h
11. Colloquium of parasitology 2 h
12. Comparative anatomy of skull (Neurocranium) 2 h
13. Comparative anatomy of skull (Cranium viscerale) 2 h
14. Comparative anatomy of the digestive system 2 h
15. Venomous animals and poisonous plants and fungi 2 h
16. Methods for protein purification: salting out and chromatographic separation according to the molecular mass. 2 h

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| 17. DNA and chromatin. Giant chromosomes in <i>Chironomus</i> larvae. Barr body in oral mucosa cells.  | 2 h |
| 18. Cell cycle and cell division. Mitosis, atypical forms of mitosis.  | 2 h |
| 19. Karyotype. Normal human and animal karyotype. Evolution of karyotype.  | 2 h |
| 20. Cellular basis of sexual processes. Meiosis. Gametogenesis.  | 2 h |
| 21. Fertilization in <u>mammals</u> . In vitro fertilization - a mouse model.  | 2 h |
| 22. Individual development. Embryonic period: cleavage, gastrulation, organogenesis. Slides of echinoderm, fish and frog. Postembryonic period: direct development, metamorphosis.                             | 2 h |
| 23. Central and peripheral organs of the immune system. Demonstration and removal of thymus, lymph nodes, spleen, bone marrow. Methods for preparation and evaluation of lymphocyte suspensions. Phagocytosis. | 2 h |
| 24. Immunogenetics. ABO (H) system. Blood group determination. Blood group inheritance.  | 2 h |
| 25. Immunological methods: agglutination - titration of serum; agglutination inhibition; Secretor's status   | 2 h |
| 26. Immunological methods: precipitation (ring test); Ouchterlony double gel immunodiffusion; ELISA, PCR, FISH   |     |
| 27. Colloquium of developmental biology and immunology.  | 2 h |
| 28. Methods in population genetics: qualitative traits. Hardy - Weinberg law.  | 2 h |
| 29. Methods in population genetics: quantitative traits.   | 2 h |
| 30. Mutation frequency. Natural selection. Migration. Isolation. Genetic drift. Kinship and inbreeding coefficients. Solving genetic problems.   | 2 h |

## **REQUIRED MINIMUM OF PRACTICAL SKILLS**

- 1 Microscopic observation.
- 2 Preparation of temporary microscope slides.
- 3 Knowledge of methods for statistical analysis of the population.
- 4 Blood group determination.
- 5 Dissection of vertebrates.
- 6 Preparation of cell suspensions and quantitative analysis of immunocompetent cells.
- 7 Knowledge of methods for detection of antigens and antibodies. Titration of immune serum
- 8 Observation and recognition of parasites.
- 9 Knowledge of a mammalian in vitro fertilization model.
10. Recognition of normal human karyotype.
11. Solving problems in medical genetics.

# LECTURES IN BIOLOGY AND GENETICS FOR ENGLISH SPEAKING DENTAL MEDICAL STUDENTS

## I SEMESTER

- 1. Levels of organization of living organisms - from Prokaryotes to Eukaryotes.**  
Parasitism as a biological phenomenon. Parasites and hosts. Origin of parasitism.  
Parasite adaptation to the host. Host - parasite interactions. Ecology of parasitism.
- 2. Protozoology.** Phylum Sarcomastigophora. Phylum Sporozoa (Apicomplexa)
- 3. Comparative anatomy.** Systematic of chordates. Origin of vertebrates. Origin and evolution of skull
- 4. Comparative anatomy.** Origin and evolution of digestive system.
- 5. Cellular basis of life.** Origin and evolution of cells. The cell as an open biological system. Cell communications. Cell receptors. Individual development of cells. Cell senescence. Cell (mitotic) cycle. Phases and mechanism of mitosis. MPF description. Control of cell division in multicellular organisms.
- 6. Basic trends in human genetics.** Regularities of heredity. Allelic form of the genes. Interaction between alleles. Interaction between non-allelic genes. Penetrance and expressivity. Autosomal and sex-linked inheritance. Inheritance of independently combining genes. Inheritance of linked genes. Crossing over.
- 7. Molecular bases of inheritance.** DNA replication in prokaryotes and eukaryotes  
Basic modes of replication. DNA repair.
- 8. Molecular bases of inheritance. Transcription. RNA processing.**
- 9. Modern concept of the gene.** Organization of the genome. Control of gene expression. Translation. Genetic code.
- 10. Biological evolution. Biology and genetic of populations.** Population. Phenotype, genotype and gene frequencies. The Hardy-Weinberg law. Application of the Hardy-Weinberg law
- 11. Biological evolution Biology and genetic of populations. Factors influencing gene frequencies.**
- 12. Biological evolution Biology and genetics of populations. Quantitative traits. Molecular evolution**
- 13. Organization of the genetic material in cells.** Chromosomal basis of inheritance.

Structure of the chromosomes. Human karyotype. Evolution of the karyotype

- 14. Reproductive biology.** Meiosis. Gametogenesis. Fertilization. External fertilization. Mechanisms for blocking polyspermy. Internal fertilization in mammals. Atypical forms of reproduction
- 15. Genetic and gene engineering.** Perspectives of the gene engineering (social and ethical aspects).
- 16. The concept for homeostasis.** Genetical homeostasis. Immunological homeostasis. Immune system. Immune response cells.
- 17. Inductors of the immune response.** Natural antigens. Human alloantigens. ABO (H) and Lewis systems. Rhesus system. System of the complement
- 18. Immune response.** Cellular interaction during the immune response. Phases in differentiation of immunocompetent cells. Types of immune responses. Major histocompatibility complex. Phases in the immune response.
- 19. Immune response.** Humoral immune response. Cellular immune response. Primary and secondary immune response.
- 20. Genetics of the immune response.** The generation of diversity of Immunoglobulin - and T cell- receptors
- 21. Regulation and control of the immune processes.** Cytokines. Immunity theories. Evolution of the immunity
- 22. Immunobiological aspects of transplantation and anti-tumor immunity.** Transplantation antigens. Host versus graft reaction. Immune tolerance. Graft versus host reaction. Anti-tumor immunity. Tumor antigens. Immune mechanisms directed against malignant tumors.
- 23. In vitro fertilization and new reproductive techniques.**



# Syllabus of Biology and Genetics for students of dental medicine

(1<sup>st</sup> year)

## A. HUMAN BIOLOGY

**1. Subject, place and significance of biology. Basic methods in biology.**

**2. Nucleic acids**

DNA - helix types and functions, RNA - types and functions

**3. Comparative structural and functional characterization of prokaryotic and eukaryotic cells**

Prokaryotic and eukaryotic cells. Origin and evolution of cell.

**4. The cell as an open biological system. Cell signaling. Cell junctions. Cell receptors.**

**5. Individual development of cells. Cell senescence. Apoptosis.**

**6. Cell reproduction**

Phases and mechanism of mitotic division. Mitosis

**7. Cell reproduction**

Consecutive events in mitosis (M-phase) and cytokinesis. Cell cycle control, MPF description.

**8. Molecular mechanisms of the basic genetic processes**

DNA replication. Basic modes of replication. DNA repair

**9. Molecular mechanisms of the basic genetic processes**

Transcription. RNA processing

**10. Molecular mechanisms of the basic genetic processes**

Genetic code. Translation.

**11. Molecular mechanisms of the basic genetic processes**

Protein sorting into cellular organelles. Posttranslational modification of proteins.

Senescence and degradation of proteins

**12. Organization of the prokaryotic genome. Regulation of gene expression in prokaryotic cells**

**13. Organization of the eukaryotic genome. Levels of regulation of gene expression in eukaryotic cells**

Molecular biology of the gene. Types of DNA sequences. DNA-binding proteins

**14. Submicroscopic structure of chromosomes. Cytoplasmic heredity**

**15. Microscopic structure of chromosomes. Karyotype. Evolution of karyotype.**

**16. Human karyotype. Methods of karyotyping and chromosomal analysis.**

**17. Laws of heredity**

Allelic form of the genes

**18. Laws of heredity**

Basic types of inheritance. Inheritance of independently combining genes

**19. Laws of heredity**

Inheritance of linked genes. Crossing over. Molecular mechanisms of crossing over.

Groups of linked genes in the human

**20. Heredity and environment. Reaction norm, Phenocopies and genocopies**

Genotype variation. Recombinational variation

**21. Mutational variation - gene, chromosomal and genome mutations**

Mutations and disease. Causes for mutations (mutagenic factors)

**22. Genetic engineering**

Genetic engineering at the level of population, organism and cell

**23. Genetic engineering**

Genetic engineering at subcellular level, cloning by transplantation of somatic cell nuclei into oocytes

**24. Recombinant DNA techniques and gene engineering**

Specific DNA cleavage, most important enzymes in recombinant DNA techniques.  
DNA sequencing

**25. Recombinant DNA techniques and gene engineering**

DNA cloning. Polymerase chain reaction. Gene engineering and gene therapy

**26. The organism as a unified system. Immunological homeostasis. Organs of the immune system**

**27. Antigens as inducers of the immune response. Haptens**

**28. Human alloantigens**

ABO(H) system. Lewis system. Biosynthesis of the A,B, H and Lewis antigens

**29. Human alloantigens**

Rhesus system. Immunological conflict between mother and fetus. Origin and biological importance of alloantigens.

**30. Cells involved in immune response**

T lymphocytes, B lymphocytes, phagocytic and antigen-presenting cells

**31. Antibodies. Complement system**

Structure and function of antibodies, antigenic determinants of antibodies. Antigen - antibody reaction

**32. Genetic control of the antibody synthesis**

**33. Cellular interactions during the immune response**

Activation of antigen-presenting cells. Activation of T lymphocytes. Cell-mediated immune response.

**34. Cellular interactions during the immune response**

Activation of B lymphocytes. Humoral immune response.

**35. Phases in differentiation of immunocompetent cells. Primary and secondary immune response.**

**36. Major histocompatibility complex (MHC). Transplantation immunity. Host versus graft reaction**

Types of transplantation. Primary and secondary rejection

**37. Graft versus host reaction. Anti-tumor immunity**

Runt disease, homologous wasting disease. Tumor antigens and anti-tumor defense

**38. Regulation and control of the immune processes. Immune tolerance**

**39. Immunity theories. Evolution of immunity**

**40. Reproductive biology**

Sex determination and differentiation

**41. Reproductive biology**

Haploid-diploid cycle. Cytological basis of sexual reproduction. Meiosis

**42. Reproductive biology**

Gametogenesis. Spermatogenesis. Characteristic features of male gametes. Origin of germ cells

**43. Reproductive biology**

Oogenesis. Molecular mechanisms of oocyte maturation. Characteristic features of mature ova

**44. Reproductive biology**

Fertilization. External fertilization and mechanisms for blocking polyspermy.

Completion of fertilization

**45. Reproductive biology**

Fertilization. Internal fertilization in mammals. Differences between external and internal fertilization

**46. Reproductive biology**

In vitro fertilization. ICSI method. Atypical forms of reproduction

**47. Developmental biology**

Embryonic period in vertebrates. Formation of the blastula.

**48. Developmental biology**

Embryonic period in vertebrates. Gastrulation. Cellular and molecular mechanisms of gastrulation

**49. Developmental biology**

Embryonic development of mammals and human. Differentiation, differences between cells, cell memory

**50. Developmental biology**

Postembryonic period. Life span, ageing and death

**51. Population genetics and biology**

Population. Qualitative traits - phenotype, genotype and gene frequencies. Types of mating.

**52. Population genetics and biology**

Hardy - Weinberg law and its application

**53. Population genetics and biology**

Factors influencing gene frequencies. Mutations. Migration

**54. Population genetics and biology**

Natural selection. Balanced polymorphism. Genetic homeostasis. Isolation

**55. Population genetics and biology**

**Quantitative traits**

**56. Theory of evolution**

Species. Speciation. Speciation mechanisms

**57. Theory of evolution**

Evolution of higher ranks (macroevolution). Origin of high-rank systematic groups. Direction of evolution

**58. Molecular evolution**

**59. Human evolution**

Anthropogenesis

**60. Human races.** Origin of the human races. Factors of racial diversification. Racism

**61. Ecology. Interaction between humans and environment**

Populations, communities, ecosystems. The overpopulation problem

**62. Behaviour - genetic basis and adaptive value**

Components of behaviour. Social organization and sociobiology. Strategy of natural selection

**63. Ecology of parasitism**

Parasitism as a biological phenomenon. Parasites and hosts

**64. Ecology of parasitism**

Origin of parasitism, parasite adaptation to the host. Host - parasite interactions

**B. PARASITOLOGY**

**65. Characteristics of Protozoa. Phylum Sarcomastigophora. Subphylum Mastigophora (Flagellata). *Leishmania donovani*. *Leishmania tropica*.**

**66. Phylum Sarcomastigophora.** *Lambliia intestinalis* (*Giardia lamblia*).

**67. Phylum Sarcomastigophora.** *Trichomonas tenax*. *Trichomonas vaginalis*.

**68. Phylum Sarcomastigophora.** *Trypanosoma rhodesiense* and *Trypanosoma gambiense* (*Trypanosoma brucei*). *Trypanosoma equiperdum*.

**69. Subphylum Sarcodina. *Entamoeba histolytica*.**

**70. Phylum Sporozoa (Apicomplexa).** *Plasmodium vivax*. *Plasmodium malariae*. *Plasmodium falciparum*.

**71. Phylum Sporozoa (Apicomplexa). *Toxoplasma gondii*. Phylum Ciliophora. Class Ciliata. *Balantidium coli*.**

**72. Transition to Metazoa. Phylum Coelenterata (Cnidaria). Genus *Hydra*.**

**73. Phylum Plathelminthes (Platyhelminthes). Class Trematoda. *Fasciola***

*hepatica.*

74. **Class Trematoda.** *Dicrocoelium lanceatum* (*Dicrocoelium dendriticum*).  
**Genus *Schistosoma*** and its species.
75. **Class Cestoda. *Taenia solium*.**
76. **Class Cestoda.** *Taeniarhynchus saginatus* (*Taenia saginata*). *Diphyllobothrium latum*.
77. **Class Cestoda.** *Echinococcus granulosus*.
78. **Phylum Nematoda.** *Ascaris lumbricoides*.
79. **Phylum Nematoda.** *Enterobius vermicularis*. *Trichocephalus trichiurus* (*Trichuris trichiura*).
80. **Phylum Nematoda.** *Trichinella spiralis*.
81. **Phylum Annelida.** *Lumbricus terrestris*. *Hirudo medicinalis*.
82. **Phylum Arthropoda** - general characterization. **Class *Arachnoidea* (*Arachnida*,** arachnids). **Order *Scorpiones*** (scorpions) and order ***Aranei*** (spiders).
83. **Order Acari (ticks and mites). The role of ticks as vectors of transmissible diseases**
84. **Class Insecta (insects). The role of insects as vectors of transmissible diseases**
85. **Class Insecta (insects).** *Pediculus hominis* (*Pediculus humanus*). *Phthirus pubis*.
86. **Class Insecta.** *Cimex lectularius*. *Pulex irritans*.
87. Genus ***Culex*** and genus ***Anopheles*** - morphological differences. *Phlebotomus papatasi*.

### C. COMPARATIVE ANATOMY OF VERTEBRATES

88. Origin and evolution of **skull** Cartilaginous cerebral skull. Bony cerebral skull
89. Origin and evolution of **skull** Cartilaginous visceral skull. Bony visceral skull
90. **Comparative anatomy of skull**
91. **Comparative anatomy of oral cavity, teeth, tongue and oral glands.**

### REFERENCES

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