The background features several 3D biological models. In the top left is a purple, oval-shaped cell with a central nucleus. In the center are two brown, X-shaped chromosomes. In the bottom right is a detailed DNA double helix with colorful base pairs. The overall background is a dark blue gradient with light rays.

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# **CYTOLOGY & GENETICS**

**UZHGOROD 2015**

**Ministry of Public Health Service of Ukraine  
Uzhgorod National University  
Faculty of Biology**

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Manual "Cytology&Genetics" involves consideration of subjects of theoretical and practical components for the module 1 and 2 of the course "Medical Biology". Structural material of the manual includes theoretical and practical questions for laboratory works, provided the specified program. The manual is designated for teaching of foreign students of medical specialties.

Reviewer: Prof., D.Sc. Nadiya Boyko

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## INTRODUCTION

Each species of living organism has a unique set of inherited characteristics that makes it different from other species. Species has its own developmental plan—often described as a sort of “blueprint” for building the organism— which is encoded in the DNA molecules present in its cells. This developmental plan determines the characteristics that are inherited. Because organisms in the same species share the same developmental plan, organisms that are members of the same species usually resemble one another, although some notable exceptions usually are differences between males and females.

The speciality of medical biology is concerned with the study of human biological variation and its relationship to health and disease. It encompasses mechanisms of inheritance, cytogenetics, molecular genetics and biochemical genetics as well as formal, statistical and population genetics. Clinical genetics is the branch of the specialty involved with the diagnosis and management of genetic disorders affecting individuals and their families

Course "Medical biology" provides students with a foundation for further assimilation of knowledge of relevant theoretical and clinical professional and practical subjects.

The content of the "Cytology and genetics" covers important aspects of human biology at the molecular, organismal, population and biosphere level of life.

This section covers the basics well cytology, the laws of heredity and variation, methods of studying human heredity and hereditary diseases, biology of individual development, ontogenesis and phylogenesis, human ecology. Textbook "Cytology and Genetics "presents all threads started the discipline.

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## MODULE 1. BIOLOGICAL FEATURES OF HUMAN VITAL ACTIVITY

### Content module 1. "Molecular-cellular level of life organization"

#### The themes of lectures

№	Topic	Hours
1.	Introduction in to the course of medical biology. Structural-functional organization of cell.	2
2.	Molecular bases of heredity. Realization of the inherited information	2
3.	Reproduction at the cellular level	2
	Total	6

#### The themes of practical classes

№	Topic	Hours
1	Levels of life organization. Optical systems in biological investigations.	2
2	Cell morphology. Structural components of cytoplasm and nucleus.	2
3	Plasma membrane. Transport across cell membrane.	2
4	Chromosomes morphology. Human karyotype.	2
5	Characteristic of nucleic acids. The organization of the information flow in cell.	2
6	Genes structure in pro- and eukaryotes. Structural and regulatory genes. Processes of genetic information realization.	2
7	Cell cycle. Mitosis.	2
8	Module control	2
	Total	16

#### The themes for independent work

№	Topic	Hours
1	Preparing for practical classes – theoretical preparing and practical experience.	2
2	Topics, which are not included to the plan of academic practical classes.	
2.1	The organization of the way of biological things and energy in cell.	1
2.2	Life of the cell outside the organism. Cell cloning.	1
3	Preparing of the control of the learning module 1	2
	Total	6

## MODULE 2. ORGANISM LEVEL OF ORGANIZATION OF THE LIFE. BASIS OF HUMAN GENETICS

### Content module 2. “Basic principles of heredity and variability”

#### The themes of lectures

№	Topic	Hours
4.	Organismic level of organization of genetic information. Gene interaction	2
5.	Chromosomal theory of heredity. Genetics of a sex	2
6.	Human variability as property of life and the genetic phenomenon	2
Total		6

#### The themes of practical classes

№	Topic	Hours
10	Human Genetics peculiarity. Heredity laws and traits expression in Human organism (monohybrid and polyhybrid inheritance).	2
11	Allelic and non-allelic gene’s interactions. Phenomena of pleiotropy.	2
12	Linkage inheritance. Sex genetics. Sex-linked inheritance.	2
13	Chromosomal theory of heredity. Linkage of gene’s. Crossing-over.	2
Total		8

#### The themes for independent work

№	Topic	Hours
1	Preparing for practical classes – theoretical preparing and practical experience.	2
2	Topics, which are not included to the plan of academic practical classes.	
2.1	Genetic maps. Methods of the human chromosomes mapping. Current state of human genome investigation.	1
2.2	Genetic dangerous of environment contamination. Conceptions about antimutagens and comutagens.	2
Total		5

### Content module 3. “Methods of the human inheritance investigation. Hereditary diseases”

#### The themes of lectures

№	Topic	Hours
7.	Bases of human genetic. Method of studying of human heredity	2
8.	Hereditary diseases	2
Total		4

#### The themes of practical classes

№	Topic	Hours
14	Variability of the organisms, its forms. Phenotypic and genotypic variation.	2
15	The basic principles of medical genetics. Gene’s and chromosomal diseases. Cytogenetics and biochemical analysis of the human being.	2
16	Study of twins. Genealogy of human as the method of human inheritance investigation.	2
17	Dermatoglyphics as the method of human inheritance investigation. Genetic characters of human populations (Hardy-Weinberg law).	2
18	Practical skills of content modules 2 and 3.	2
Total		10

### The themes for the independent work

№	Topic	Hours
1	Preparing for practical classes – theoretical preparing and practical experience.	3
2	Topics, which are not included to the plan of academic practical classes.	
2.1	Gene engineering. Biotechnology. Gene therapy.	1
2.2	Methods of human genetics: dermatoglyphics, immunologic, somatic cells hybridization.	1
3	Practical skills of content modules 2 and 3.	3
	Total	8

### Content module 4. “Biology of individual development”

#### The themes of lectures

№	Topic	Hours
9.	Molecular and genetic mechanisms of ontogenesis. Breaks of the ontogeny and their place in human pathology.	2
10.	Modern aspects of regeneration and transplantation. Biological mechanisms of homeostasis of the organism.	2
	Total	4

#### The themes of practical classes

№	Topic	Hours
19	Peculiarities of prenatal period of human development.	2
20	Postnatal period of human development	2
21	Aging as the finishing stage of human ontogeny. Theories of ageing.	2
22	<b>Control of the module 2</b>	2
	Total	8

### The themes for the independent work

№	Topic	Hours
1	Preparing for practical classes – theoretical preparing and practical experience.	2
2	Topics, which are not included to the plan of academic practical classes.	
2.1	The notion about aura, biological rhythms and their medical importance.	1
2.2	Regeneration and its types: physiological and reparative. Levels and ways of regeneration.	2
3	Preparing of the control of the learning module 2	2
	Total	7



## MULTIPLE QUESTIONS ON CYTOLOGY

**1. Which organelle is considered the powerhouse of the cell?**

- a. Rough endoplasmic reticulum
- b. Smooth endoplasmic reticulum
- c. Lysosome
- d. Golgi apparatus
- e. Mitochondria

**2. Which organelle sorts and packages proteins within a cell?**

- a. Rough endoplasmic reticulum
- b. Smooth endoplasmic reticulum
- c. Lysosome
- d. Golgi apparatus
- e. Mitochondria

**3. Which of the following is not a membranous organelle?**

- a. Lysosomes
- b. Filaments
- c. Peroxisomes
- d. Mitochondria
- e. Endoplasmic reticulum

**4. What is the term for the process used by cells for the transport in of particulate matter?**

- a. Endocytosis
- b. Exocytosis
- c. Pinocytosis
- d. Phagocytosis
- e. Active transport

**5. Which organelle is studded with ribosomes?**

- a. Rough endoplasmic reticulum
- b. Smooth endoplasmic reticulum
- c. Lysosome
- d. Golgi apparatus
- e. Mitochondria

**6. Where is the site of protein synthesis?**

- a. Ribosomes
- b. Peroxisome
- c. Microfilaments
- d. Centrioles
- e. Nucleoli

**7. One of the functions of DNA is to:**

- a. secrete vacuoles
- b. make copies of itself
- c. join amino acids to each other
- d. carry genetic information out of the nucleus
- e. join nucleotides to each other

**8. The number of adenine bases in a DNA molecule equals the number of thymine bases because:**

- a. DNA contains equal numbers of all four bases

- b. thymine always follows adenine on each DNA strand
- c. DNA is made of alternating adenine and thymine bases
- d. adenine on one strand bonds to thymine on the other strand
- e. DNA contains different numbers of all four bases

**9. Which of the following describes a DNA molecule?**

- a. double helix of glucose sugars and phosphates
- b. ladder-like structure composed of fats and sugars
- c. double chain of nucleotides joined by hydrogen bonds
- d. a chain of alternating phosphates and nitrogenous bases
- e. double helix of glucose sugars

**10. Which of the following is the correct matching of base pairs in DNA?**

- a. Adenine–Guanine and Thymine–Uracil
- b. Guanine–Cytosine and Adenine–Uracil
- c. Adenine–Thymine and Guanine–Cytosine.
- d. Guanine–Thymine and Adenine–Cytosine
- e. Adenine–Guanine and Thymine–Cytosine

**11. Which of the following statements best describes DNA replication?**

- a. tRNA, by complementary base pairing with mRNA, produces proteins
- b. RNA nucleotides, by complementary base pairing with DNA, produce DNA
- c. DNA nucleotides, by complementary base pairing with DNA, produce DNA
- d. RNA nucleotides, by complementary base pairing with DNA, produce tRNA
- e. RNA nucleotides, by complementary base pairing with DNA, produce RNA

**12. The product of transcription is:**

- a. DNA
- b. protein
- c. mRNA
- d. a ribosome
- e. tRNA

**13. Which of the following best describes the function of mRNA?**

- a. it stays in the nucleus and is copied by DNA
- b. it carries amino acids to the growing polypeptide chain
- c. it makes up the ribosomes and provides the site for protein synthesis
- d. it is transcribed from the DNA and carries the information to the ribosome
- e. it is transcribed from the DNA and carries the information to the mitochondria

**14. If the code for an amino acid is AGC on the DNA molecule, the anticodon on the tRNA would be:**

- a. AGC
- b. TGC
- c. UCG
- d. UGC
- e. UGG

**15. How many chromosomes does the cell have during the anaphase?**

- a. 96
- b. 92
- c. 46
- d. 48
- e. 64

**16. The main function of centrosome is:**

- a. osmoregulation
- b. formation of spindle fibre
- c. secretion
- d. regulation
- e. join nucleotides to each other

**17. Which of the following structures is found in eukaryotic but not prokaryotic cells?**

- a. Mitochondria
- b. Ribosomes
- c. DNA
- d. Cytosol
- e. Plasma membrane

**18. During the cell cycle regular changes in quantity of genetic material happen. What is the period, when the replication of DNA happens, called?**

- a. Prophase
- b. Telophase
- c. Interphase
- d. Prometaphase
- e. Metaphase

**19. Which of the following structure is found in animal cells but not plant cells?**

- a. Plasma membrane
- b. Golgi apparatus
- c. Mitochondria
- d. Centrioles
- e. Rough endoplasmic reticulum

**20. Use the following events to answer the question. 1. mRNA is formed. 2. DNA segment opens (unzips). 3. mRNA attaches to ribosomes. 4. amino acids form peptide bonds. 5. tRNA carries amino acids to mRNA. 6. The correct order of events required for protein synthesis is:**

- a. 1, 2, 3, 4, 5
- b. 2, 1, 3, 4, 5
- c. 2,1, 3, 5, 4
- d. 2, 1, 4, 5, 3
- e. 2, 3, 5, 4, 1

**21. Which of the following is not a membranous organelle?**

- a. lysosomes
- b. peroxisomes
- c. mitochondria
- d. ribosomes
- e. Endoplasmic reticulum

**22. Collectively, what is the cytoplasm and nucleus called?**

- a. plasmalemma
- b. glycocalyx
- c. protoplasm
- d. cristae
- e. ground substance

**23. What is the term for the general process that cells use to expunge material from the cell?**

- a. endocytosis
- b. exocytosis
- c. pinocytosis
- d. phagocytosis
- e. active transport

**24. mRNA is produced in the process called:**

- a. respiration
- b. translation
- c. replication
- d. transcription
- e. transportation

**25. Two sugars found in nucleic acids are:**

- a. sucrose and ribose
- b. glucose and fructose
- c. deoxyribose and ribose
- d. deoxyribose and glucose
- e. glucose and pentose

**26. Which of the following would not occur during complementary base pairing?**

- a. A-T
- b. U-G
- c. C-G
- d. A-U
- e. T-A

**27. DNA replication involves the breaking of bonds between:**

- a. bases
- b. sugars and bases
- c. phosphates and bases
- d. sugars and phosphates
- e. sugars and sugars

**28. A section of DNA has the following sequence of nitrogenous bases: CGATTACAG Which of the following sequences would be produced as a result of transcription?**

- a. CGTUUTCTG
- b. GCTAATGTC
- c. CGAUUACAG
- d. GCUAAUGUC
- e. GGTAATGTC

**29. A function of transfer RNA (tRNA) is to:**

- a. stay in the nucleus and be copied by DNA
- b. carry amino acids to the growing polypeptide chain
- c. copy DNA and carry the information to the ribosome
- d. read the codons and provide the site for protein synthesis
- e. read the anticodons

**30. A polypeptide found in the cytoplasm of a cell contains 12 amino acids. How many nucleotides would be required in the mRNA for this polypeptide to be translated?**

- a. 4
- b. 12

- c. 24
- d. 36
- e. 34

**31. If the nucleotide sequence of an anticodon was AUC, then the DNA triplet would be:**

- a. ATC
- b. TAG
- c. AUC
- d. UAG
- e. AUU

**32. A role of mRNA in protein synthesis is to:**

- a. form ribosomes
- b. form the protein's tertiary structure
- c. carry appropriate amino acids into place.
- d. carry genetic information out of the nucleus
- e. form the protein's secondary structure

**33. How many DNA molecules does any human somatic cell in the presynthesis period G<sub>1</sub> have?**

- a. 23
- b. 92
- c. 46
- d. 48
- e. 64

**34. A nucleotide is made up of which of the following chemical components?**

- a. a nitrogenous base, a fatty acid, and an amino acid
- b. a nitrogenous base, an amino acid, and a phosphate group
- c. a series of nitrogenous bases, a nucleic acid backbone, and a hexose sugar
- d. a nitrogenous base, an amino acid, and a pentose sugar
- e. a nitrogenous base, a phosphate group, and a pentose sugar

**35. Bacterial cells are prokaryotic. Unlike a typical eukaryotic cell they:**

- a. Have no membrane-bounded organelles in their cytoplasm
- b. Lack a plasma membrane
- c. Have a smaller nucleus
- d. Have no ribosomes
- e. Lack chromosomes

**36. Detoxification is a characteristic function of what type of organelle?**

- a. Mitochondria
- b. Golgi apparatus
- c. Nucleus
- d. Peroxisome
- e. Rough endoplasmic reticulum

**37. Which of the following statements about diffusion is true?**

- a. It is a passive process
- b. It occurs when molecules move from a region of lower concentration to a region of higher concentration
- c. It always requires integral proteins of the cell membrane
- d. It is very rapid over long distances
- e. It requires expenditure of energy by the cell

**38. Which of the following categories best describes the function of the rough endoplasmic reticulum?**

- a. Manufacturing
- b. Energy processing
- c. Structural support of cells
- d. Information storage
- e. Breakdown of complex foods

**39. In the cell the chromosomes are in the condition of maximum spiralization and are placed along the equatorial zone. What period of mitosis is described?**

- a. Prophase
- b. Telophase
- c. Anaphase
- d. Prometaphase
- e. Metaphase

**40. Use the following information to answer the question: 1. Uracil bonds with adenine. 2. Complementary bonding between codon and anticodon. 3. DNA unzips. 4. mRNA joins with ribosome. The correct order of the above during protein synthesis is:**

- a. 1, 2, 4, 3
- b. 1, 3, 2, 4
- c. 3, 1, 4, 2
- d. 3, 2, 1, 4
- e. 1, 4, 2, 3

**41. If you are provided with root-tips of onion in your class and are asked to count the chromosomes which of the following stages can you most conveniently look into:**

- a. Prophase
- b. Telophase
- c. Anaphase
- d. Prometaphase
- e. Metaphase

**42. The major event that occurs during the anaphase of mitosis, which brings about the equal distribution of chromosomes, is:**

- a. condensation of the chromatin
- b. replication of the centromeres
- c. replication of the genetic material
- d. splitting of the chromatids
- e. splitting of the centromeres

**43. Which of the following is unique to mitosis and not a part of meiosis?**

- a. Homologous chromosomes pair and form bivalents
- b. Homologous chromosomes behave independently
- c. Homologous chromosomes crossover
- d. Chromatids are separated during anaphase
- e. Chromatids are separated during metaphase

**44. DNA replication takes place during**

- a. S - phase
- b. G<sub>2</sub> - phase
- c. Anaphase
- d. Prometaphase

e. G<sub>1</sub> – phase

**45. During mitosis ER and nucleolus begin to disappear at:**

- a. Early prophase
- b. Late prophase
- c. Anaphase
- d. Prometaphase
- e. Late metaphase

**46. During which stage the chromosomes first become visible?**

- a. Prophase
- b. Telophase
- c. Anaphase
- d. Prometaphase
- e. Metaphase

**47. The stage in which daughter chromosomes move toward the poles of the spindle is:**

- a. Prophase
- b. Telophase
- c. Anaphase
- d. Prometaphase
- e. Metaphase

**48. Which of the following cellular structures always disappears during mitosis?**

- a. Plasma membrane
- b. Nucleolus and nuclear envelope
- c. None of these
- d. Centrioles
- e. Plastids

**49. Cytoplasmic division of a cell is called**

- a. Cell plate formation
- b. Cytokinesis
- c. Synapsis
- d. Disynapsis
- e. Mitosis

**50. Plasma membrane is made up of**

- a. Protein, lipid, carbohydrate
- b. Protein
- c. Lipid, carbohydrate
- d. Lipid
- e. Protein, lipid

## MULTIPLE QUESTIONS ON GENETICS

**51. Single base mutations:**

- a. may have no effect on an organisms
- b. may have a small effect on an organism
- c. may have a large effect on an organism
- d. all of the above
- e. all answers are correct

**52. If traits X, Y, and Z are consistently inherited together, which of the following best explains why this is the case?**

- a. These 3 traits are all dominant.
- b. The parents both carry the dominant form of each trait.
- c. These 3 traits are located on different chromosomes
- d. These 3 traits are located close to each other on the same chromosome.
- e. These 3 traits are located far from each other on the same chromosome.

**53. Hemophilia is a sex-linked recessive trait. A male hemophiliac and phenotypically normal female have a girl that is a hemophiliac. All of the following statements are correct EXCEPT:**

- a. The daughter inherited a recessive gene from each parent.
- b. The daughter inherited a dominant allele from her mother.
- c. The mother is a carrier of hemophilia
- d. The genotype of the mother is XH Xh
- e. The genotype of the father is XhY

**54. A male and female have 3 offspring all of which are female. The couple is now pregnant again. What is the likelihood that the next child will be a female?**

- a. 1/16
- b.  $\frac{1}{4}$
- c. 1/3
- d.  $\frac{1}{2}$
- e.  $\frac{3}{4}$

**55. If one parent has type A blood and the other parent has type B blood, what blood type will the offspring denoted by the white square and circle have?**

- a. Type A.
- b. Type B.
- c. Type AB.
- d. Type O.
- e. Type AO

**56. In the F1 generation of a monohybrid cross, the phenotypic ratio would be:**

- a. 3:1
- b. 1:2:1
- c. 2:1:1
- d. 1:1:2
- e. 1:1:1:1

**57. An example of alleles is:**

- a. AB and Tt.
- b. TT and Tt.
- c. T and t.
- d. X and Y.
- e. BB



**58. Which blood type would not be possible for children of a type AB mother and a type A father?**

- a. O.
- b. A.
- c. B.
- d. AB.
- e. AA

**59. Long radishes crossed with round radishes result in all oval radishes. This type of inheritance is:**

- a. Multiple alleles.
- b. Complete dominance.
- c. Co-dominance.
- d. Incomplete dominance
- e. Epistasis

**60. An extra finger in humans is rare but is due to a dominant gene. When one parent is normal and the other parent has an extra finger but is heterozygous for the trait, what is the probability that the first child will be normal?**

- a. 0%.
- b. 25%.
- c. 50%.
- d. 75%.
- e. 100%

**61. Offspring inherit from parents**

- a. Gametes, that then fuse to form the new individual
- b. Body tissues, these then provide the template for the new offspring's tissues
- c. Pure information provided in a sequence of codons that replicate the parents' genome
- d. Genes, a set of coded information that guides the orderly sequence of development along with the environment
- e. The phenotype, since only this is expressed in the new organism

**62. In tobacco, if the diploid number of chromosomes is 48, how many chromosomes will be found in a pollen grain?**

- a. 96.
- b. 48.
- c. 24.
- d. 12
- e. 6

**63. An allele is:**

- a. one of the bases in DNA
- b. an alternate form of a gene
- c. another term for epistasis
- d. present only in males and is responsible for sex determination
- e. found in mitochondria but not in nuclei

**64. In dihybrid crosses, the ratio 9:3:3:1 indicates**

- a. Codominance
- b. Independent assortment
- c. Intermediate dominance
- d. Three alleles for each trait
- e. Epistasis

**65. The fundamental Mendelian process which involves the separation of contrasting genetic elements at the same locus would be called:**

- a. segregation
- b. independent assortment
- c. continuous variation
- d. discontinuous variation
- e. dominance or recessiveness

**66. What ratios typically result from crosses dealing with a single genetic locus?**

- a. 9:3:3:1, 1:2:1
- b. 1:1:1:1, 1:4:6:4:1
- c. 3:1, 1:1, 1:2:1
- d. 9:7, 12:3:1
- e. 15:1, 1:2

**67. There are three different genotypes resulting from a monohybrid cross. How many different genotypes would there be resulting from a dihybrid cross?**

- a. 2
- b. 4
- c. 8
- d. 9
- e. 16

**68. Starting with a P generation with the following genotypes (AABB x aabb). Based on classical Mendelian inheritance, what is the expected phenotypic ratio observed among the F2 progeny?**

- a. 9:3:3:1
- b. 1:2:1
- c. 3:1
- d. 1:1
- e. 1:1:1:1

**69. Usually, an egg cell from a human female contains**

- a. one X chromosome and one Y chromosome.
- b. one X chromosome.
- c. one Y chromosome.
- d. two X chromosomes.
- e. two Y chromosomes.

**70. What is epistasis?**

- a. A phenotype is inherited only from the mother.
- b. A gene is expressed in only one sex.
- c. One trait is affected by several genes.
- d. One gene affects the way others are expressed.
- e. One gene influences several phenotypes

**71. Pedigrees are:**

- a. used by geneticists to determine the sequence of an individual's genes.
- b. histories of families with regard to particular genetic traits.
- c. used only for dogs, cats, and horses.
- d. mutated alleles capable of causing genetic disorders.
- e. characteristics that are apparent in an individual.

**72. With respect to genetic traits, what is the opposite of recessive?**

- a. regressive
- b. progressive
- c. dominant
- d. subordinant
- e. hybrid

**73. Different forms of a gene are known as:**

- a. alleles.
- b. hybrids.
- c. recessives
- d. Genotypes
- e. phenotypes.

**74. A gene on the X chromosome is said to be:**

- a. heterozygous.
- b. sex limited.
- c. x-linked
- d. bipolar.
- e. a mutation

**75. Mendel observed that dominant traits:**

- a. are only expressed in hybrids.
- b. were absent in the F1 generation of pea plants that he used in his experiments.
- c. were the only trait seen in the F2 generation of pea plants in his experiments.
- d. are expressed in all plants.
- e. are seen in all the F1 hybrid pea plants in his experiments.

**76. The physical characteristics of an organism resulting from its genes are known as the organism's:**

- a. alleles.
- b. hybrids
- c. recessive characteristics.
- d. genotype.
- e. phenotype.

**77. Mutations which occur in body cells which do not go on to form gametes can be classified as:**

- a. auxotrophic mutations
- b. somatic mutations
- c. morphological mutations
- d. oncogenes
- e. temperature sensitive mutations

**78. A gene showing codominance**

- a. has both alleles independently expressed in the heterozygote
- b. has one allele dominant to the other
- c. has alleles tightly linked on the same chromosome
- d. has alleles expressed at the same time in development
- e. has alleles that are recessive to each other

**79. The phenomenon of “independent assortment” refers to:**

- a. expression at the same stage of development

- b. unlinked transmission of genes in crosses resulting from being located on different chromosomes, or far apart on the same chromosome.
- c. association of an RNA and a protein implying related function
- d. independent location of genes from each other in an interphase cell
- e. association of a protein and a DNA sequence implying related function

**80. X-chromosome inactivation:**

- a. normally takes place in males but not females
- b. is the cause of the Y chromosome being genetically inactive
- c. takes place in humans so that the same X chromosome is inactive in all of the cells of a female
- d. occurs in fruit flies but not in mammals
- e. results in genetically turning off one of the two X chromosomes in female mammal

**81. The Cystic Fibrosis gene affects several different phenotypes including reproductive ducts, salivary ducts, and lachrymal ducts (tears). What term do we use to describe a gene that affects multiple phenotypes?**

- a. Autosome
- b. Pleiotropy
- c. Co-dominance
- d. Incomplete dominance
- e. Epistasis

**82. Which term describes the genetic condition of inheriting an XXY genotype?**

- a. Turner's syndrome
- b. Klinefelter's syndrome
- c. Familial aneuploidy
- d. Trisomy X
- e. Down syndrome

**83. Which of the following results in the production of offspring from unfertilized eggs?**

- a. Budding
- b. Fragmentation
- c. Mitosis
- d. Parthenogenesis
- e. Binary Fission

**84. What do we call the situation where different cells in the body express different genotypes and all the cells are derived from the same fertilized egg?**

- a. Chimera
- b. Gynandromorph
- c. Mosaic
- d. Diandry
- e. Protandry

**85. What term do we use when chromosomes do not segregate equally?**

- a. Aneuploidy
- b. Non-disjunction
- c. Mosaicism
- d. Trisomy
- e. Crossing over

**86. Klinefelter Syndrome is:**

- a. The cause is a mutation affecting the long arm of X chromosome
- b. It is commonly associated with congenital heart disease
- c. The cause is mtDNA damage
- d. Sexually underdeveloped
- e. Is a fatal disease

**87. Which one is not the environmental cause for birth defect:**

- a. Virus
- b. Alcohol use in pregnancy
- c. Folic acid
- d. Toxoplasma
- e. Radiation

**88. Characteristics of mitochondrial diseases:**

- a. Threshold effect
- b. X-linked
- c. Inherited from the father
- d. Only female can be affected
- e. Affected bone and teeth

**89. Color-blindness is a recessive trait that is carried on the X chromosome. Suppose a colorblind woman marries a man who is not color blind. What is the % chance that their daughter will be colorblind (% chance of possible genotypes for daughters only, not all children)?**

- a. 0%
- b. 25%
- c. 50%
- d. 75%
- e. 100%

**90. The ABO blood group has three alleles (*A*, *B*, *O*). If a woman with genotype *AO* mates with a man with genotype *BB*, the expected proportion of *heterozygotes* among their offspring is:**

- a. 0%
- b. 25%
- c. 50%
- d. 75%
- e. 100%

**91. Which of the following is the most likely explanation for a high rate of crossing-over between two genes?**

- a. The two genes are far apart on the same chromosome.
- b. The two genes are both located near the centromere.
- c. The two genes are sex-linked.
- d. The two genes code for the same protein.
- e. The two genes are on different chromosomes.

**92. Genes S and T are not linked. If there is a 50% probability that allele S is in a gamete and there is a 50% probability that allele T is in a gamete, what is the probability that both are in the same gamete?**

- a. 5%
- b. 25%
- c. 50%
- d. 75%
- e. 100%

**93. In Huntington's disease, CAG repeats occur more frequently than in people without the disease. The results in many more additional amino acids of the same type added in the polypeptide. The addition of these CAG repeats (due to mutation over time) would be best described as:**

- a. Base-pair substitutions
- b. Deletions
- c. Insertions
- d. Silent mutations
- e. Frameshift mutations

**94. In drosophila (fruit flies), eye colour is sex-linked and red eye colour is dominant to white eye colour. Which of the following are not possible in a cross between a red-eyed male and a heterozygous female?**

- a. Red-eyed male.
- b. White-eyed male.
- c. Carrier female.
- d. Homozygous white-eyed female.
- e. Heterozygous red-eyed female

**95. Normal human eggs have:**

- a. 22 autosomes and an X chromosome.
- b. 22 autosomes and a Y chromosome.
- c. 23 autosomes.
- d. 46 chromosomes.
- e. 44 chromosomes

**96. There are three different genotypes resulting from a monohybrid cross. How many different genotypes would there be resulting from a dihybrid cross?**

- a. 4
- b. 8
- c. 9
- d. 16
- e. 24

**97. If a single locus controls wing shape, then the alleles for this gene act as:**

- a. dominant-recessive alleles
- b. incomplete-dominance alleles
- c. codominant alleles
- d. multiple alleles
- e. variable alleles

**98. Which of the following is the most likely explanation for a high rate of crossing-over between two genes?**

- a. The two genes are far apart on the same chromosome.
- b. The two genes are both located near the centromere.
- c. The two genes are sex-linked.
- d. The two genes code for the same protein.
- e. The two genes are on different chromosomes

**99. Which is X-linked recessive inheritance?**

- a. Down syndrome is an example
- b. Retinoblastoma is an example
- c. Show female to male transmission

- d. Are determined by both environmental and genetic factors
- e. The cause is a mutation affecting the long arm of X chromosome

**100. Although schizophrenia runs in families, the particular subtype (catatonic, paranoid, disorganized) does not. This means that:**

- a. if you have the genes, you will be schizophrenic
- b. if you have the genes, you will be schizophrenic, but environmental factors will determine your subtype of schizophrenia
- c. schizophrenia is not actually a single disorder
- d. as a quantitative disorder, milder forms of schizophrenia will be more heritable because the abnormal is normal
- e. all answers are correct

## TASKS FOR SOLVING OF CYTOLOGY

1. 4000 cytosolic nucleotides in DNA molecule are 24% from the general amount of nucleotides. To define how many adenyllic, guanylic and thymidylic nucleotides are in this DNA fragment?
2. A fragment of DNA coding chain has next nucleotide CAA-GAC-GCT-TTA-TTA-GGG-CCC. Write down the fragment of polypeptide molecule, which encode by DNA. What amino acids it contains?
3. mRNA was synthesized on the one strand of DNA. The A amount is 24%, G – 10%, U – 42%, C – 24%. What are the percent amounts of the nucleotides the DNA molecule?
4. A fragment of DNA coding chain has next nucleotide sequences GTC-GGC-GTG-TGG-TAC-CCC-GCG-ACC. Write down the fragment of polypeptide molecule, which encode by DNA. What amino acids it contains?
5. The DNA chain consists of 2000 nucleotides. Introns (noncoding inserts) are composed of 100 nucleotides. Determine number of amino acids that are coded by DNA chain.
6. To determine the molecular weight of the gene that controls the synthesis of a protein that consists of 420 amino acids. It is known that the average molecular weight of one nucleotide is 345 a.m.u.
7. A protein consists from 800 amino acids. What length is the gene that controls it one?
8. 16000 guanylic nucleotides in DNA molecule are 44% from the general amount of nucleotides. To define how many adenyllic, cytosolic and thymidylic nucleotides are there in this DNA fragment? What is the length of this fragment in DNA molecule?
9. 2400 thymidylic nucleotides in DNA molecule are 22% from the general amount of nucleotides. To define how many adenyllic, cytosolic and guanylic nucleotides are there in this DNA fragment? What is the mass of corresponding fragment in mRNA molecule?
10. 2800 cytosolic nucleotides in DNA molecule are 16% from the general amount of nucleotides. To define what is the length and mass of this fragment in DNA molecule? What is the mass of corresponding fragment in mRNA molecule?
11. Write the complementary of a daughter strand of DNA replicated from the following parental base sequences:  
ACA – TTC – TCG – ATT – AGA – ATC – TCG – ATT
12. mRNA was synthesized on the one strand of DNA. The A amount is 12%, G – 28%, U – 40%, C – 20%. What are the percent amounts of the nucleotides the DNA molecule?
13. 1600 guanylic nucleotides in DNA molecule are 42% from the general amount of nucleotides. To define:How many adenyllic, cytosolic and thymidylic nucleotides are there in this DNA fragment? What is the length of this fragment in DNA molecule? What is the mass of this fragment in DNA molecule?
14. A fragment of DNA coding chain has next nucleotide sequences: ACC-GAT-CAC-ATA-TTC-AAA. Write down the fragment of polypeptide molecule, which encode by DNA.
15. Insulin fragment consists of 7 amino acids: valine – tyrosine – glutamine - glycine – isoleucine - serine - proline. What is the structure of corresponding DNA fragment?



16. A fragment of DNA coding chain has next nucleotide CAA-GAA-GTT-TTA-ATA-GAG-CCC. Write down the fragment of RNA. What amino acids it contains?
17. The DNA chain consists of 2800 nucleotides. Introns (noncoding inserts) are composed of 200 nucleotides. Determine number of amino acids that are coded by DNA chain.
18. mRNA was synthesized on the one strand of DNA. The A amount is 14%, G – 20%, U – 38%, C – 28%. What are the percent amounts of the nucleotides the DNA molecule?
19. To determine the molecular weight of the gene that controls the synthesis of a protein that consists of 840 amino acids. It is known that the average molecular weight of one nucleotide is 345 a.m.u.
20. A protein consists from 640 amino acids. What length is the gene that controls it one?

## TASKS FOR SOLVING OF GENETICS

1. A woman with Type O blood has a child with the same blood type. Can the child's father have Type AB blood? Why or why not?
2. Given what you know about human A-B-O blood types, what parental cross would yield an F1 consisting of 50% type A, 25% type AB, and 25% type B?
3. As a genetic advisor to a hospital you are confronted with the following problem: two women had babies in the hospital at about the same time on the same day. Mrs. Cartman took home a boy (Eric), and Mrs. Simpson took home a girl (Lisa). However, in her postpartum daze, Mrs. Simpson thought she recalled the delivery room nurses commenting on her child as being a boy. The blood types of all concerned parents were determined as follows: Mr. Cartman = B; Mrs. Cartman = AB; Eric = A; Mr. Simpson = B; Mrs. Simpson = O; Lisa = O. Has there been an interchange of babies? Support your conclusion or be fired.
4. Skin color in humans is determined by a polygenic inheritance system, possibly involving involving as many as 9 genes. For simplicity let's consider the influence of 3 genes: A, B, and C, where the dominant allele darkens skin color. Suppose a woman who is AABbCc mates with a man who is AaBbcc. List all of the possible genotypes of the gametes that could be produced by each the parents?
5. If a female carrier of Fragile X syndrome has children with a normal male, what are the chances that a boy will be born with Fragile X syndrome?
6. Cross a female carrier of Duchenne's muscular dystrophy with a healthy male. What are the chances they will have a girl with Duchenne?
7. Mrs. Eryth is carrier of the sex-linked hemophilia allele, and Mr. Eryth is normal (as far as blood chemistry goes). Draw a Punnett square that shows the theoretical genotypes and phenotypes among their children.
8. Mr. A and Mrs. A has a new born baby with albinism, Mr. A said the baby is not his child, because he is healthy. The couple fight everyday, please help them.
9. Cross a male with Huntington's disease with a normal female. What are the chances a child will have Huntington's?
10. Mrs. B (29-years-old) was pregnant, and the doctor suspected that Mrs. B got gestational diabetes. Since Mrs. B's mother, her brother and her grandmother had diabetes. Her mother has to use insulin every day. Meantime, her grandfather has hypertension. Now she wants to know her risk of diabetes and hypertension in the future, Please consult for her.
11. Mrs C (41-year-old) was pregnant with her third child, she is healthy, and her husband (42-year-old) is a patient of LHON. But their two children are all the patients of Down syndrome. They plan to have a baby again. Now they need your help, please consult for them.
12. Miss D has family history with hemophilia disease (XR), her grandfather and 2 uncles are suffered from the disease. Miss D want to know if her offspring will get the disease.
13. In humans brown eyes are dominant over blue eyes. What type of offspring would you expect if you crossed a heterozygous brown eyed person to a heterozygous brown eyed person?

14. In humans tongue rolling is dominant to non-tongue rolling. What would be the expected type of offspring if a homozygous tongue roller was crossed to a heterozygous tongue roller?
15. A man and his wife are both heterozygous for brown eyes. They have six children all of whom have blue eyes. A) How is this explained? B) What are the chances that their next child will have brown eyes? C) What are the chances that their next child will have blue eyes?
16. Red eyes (R) in fruit flies are dominant over white eyes (r). Using Punnett squares, find the possible eye colors of the F1 generation for each of the following crosses. A) Rr x rr, B) rr x RR, C) Rr x Rr.
17. If a man with blood type A, one of whose parents had blood type O, marries a woman with blood type O, what percentage of their offspring would have blood type OO?
18. In humans, polydactylism (having an extra finger on each hand) is dominant to the typical 5-finger arrangement. Tongue rolling is dominant to not being able to roll one's tongue. A man who is homozygous for 5-fingers and who cannot roll their tongue has children with a woman who is heterozygous for polydactylism and tongue rolling. Draw a Punnett square that represents the cross. What is the probability the couple will produce a polydactyl baby who cannot roll their tongue?
19. In humans, dark hair (D) is dominant over blonde hair (d) and curly hair (H) is dominant over straight hair (h). A woman with curly, blonde hair marries a man with curly, dark hair. What is the probability that they will have a child with straight, blonde hair?
20. Suppose that black hair (B) is dominant over blonde hair (b) and brown eyes (E) are dominant over blue eyes (e). The father has black hair (heterozygous) and brown eyes (heterozygous) and the mother has blonde hair and blue eyes. 1. What percent of the offspring will be totally heterozygous? 1. What is the phenotype ratio? 3. What percent of the offspring will have blonde hair and blue eyes?
21. In human the dominant gene determines a migraine. a) A healthy woman has married the man, heterozygous on migraine. What probability of a child with migraine birth in them? b) A healthy woman has married the man, homozygous on migraine. What probability of a child with migraine birth in them?
22. Albinism is inherited as a recessive trait. If two normally pigmented parents produce an albino offspring, what ratio of albino to normal would be expected among subsequent offspring?
23. Polydactyly and myopia are dominant and autosomal traits. What probability of birth children without anomalies in family, where parents sick in two illnesses and are heterozygous in both traits.
24. Astigmatism and day-blindness – autosomal-dominant traits. Father has an astigmatism, mother has a day-blindness. What genotypes must be in parents that children will born healthy?
25. Polydactyly (extra fingers and toes) is dominant trait in humans. A heterozygous woman has polydactyly and brown eyes. The man has 5 fingers and blue eyes. The genes for these traits assort independently. The dominance relationships of the alleles are as follows: A – polydactyly; a – normal; B – brown eyes; b – blue eyes. What is the probability that their child will have the same genotype as mother? Father?
26. Rhesus-negative man with the 1<sup>st</sup> group of blood married with rhesus-positive woman with the 4<sup>th</sup> group of blood. What blood will their children have?

27. The parents are brown-eyed, rhesus-positive, with II group of blood. They are heterozygous by all three traits. How many and what types of gametes form of this parents? Brown eyes are autosomal sign.
28. One of the forms of cystinuria (metabolism disorder) is inherited as an autosomal recessive sign. Though it is noticed that heterozygotes have only the increased content of cystine in the urine and homozygotes get cystine stones in their kidneys. Determine the possible forms of cystinuria that can get children in a family where one of the parents fell ill with kidney stones and the other is normal according analyzed trait.
29. Formation in a human's cells of an interferon is connected with complementary interaction of two dominant non-allelic genes (A and B). a) In one of parents there is no ability to form an interferon in consequence of absent in him a gene "A", another is healthy and all his relatives are healthy too. What probability of a healthy children birth? b) Parents are healthy, but are double heterozygous in genes A and B. Determine probability of a healthy children birth.
30. In human, diseases, for example a gastritis, for which there is typically polygenic inheritance, are known. What probability of birth children with inheritable predisposition to the gastritis, if both parents sick in gastritis and are heterozygotes in two pairs of polymeric genes.
31. In a human the locus of an Rh factor bonded to the locus that determines the form of erythrocytes and locates from it on distance 3 Morganides (3% of crossing-over frequency). Rhesus-positive and elliptocytosis (erythrocytes have form similar to ellipse) are determined by dominant autosomal genes. One among the family is heterozygous in both attributes. Positive Rh factor he has inherited from one of parents, elliptocytosis – from another. Other among the family is rhesus-negative and has normal erythrocytes' form. Determine the percentage ratios of probable genotypes and phenotypes in this family.
32. In human the gene determining a set of symptoms of defect of nails and a patella and the gene determining a blood group on AB0 system are in one chromosome on distance 10 Morganides. In the father II (A) blood group and he has a set of symptoms (he has inherited this attribute from mother with I (0) a blood group), and mother without a set of symptoms with III (B) blood group, the healthy boy with I (0) blood group was born. What probability of birth ill child with I (0) blood group in this family?
33. The daughter of the man with colour blindness marries the son of the man with colour blindness (in the groom and brides vision is a normal). What vision is possible in their children?
34. The recessive gene of the absent of the sweat glands (a) located in X-chromosome in human. Healthy man marries a heterozygous woman. Is it possible to reveal this trait in their offspring?
35. In human colour-blindness is a sex-linked recessive disorder. A normal-sighted woman with O-blood type marries a colour-blinded man with A-blood type. What are the parent's genotypes? What is the probability that their child will be colour-blinded with O-blood type?
36. Hemophilia in human is a sex-linked recessive disorder (h – allele of the hemophilia, H – allele of the normal blood clotting).
- Which types of gametes does normal heterozygous woman produce?
  - Which types of gametes does normal homozygous woman produce?
  - Which types of gametes could produces a man with normal blood clotting?
  - Which types of gametes could produces a man with hemophilia?
37. Proband is the boy with freckles. His brother has no a freckles. Proband's mother and father have freckles. Father was married twice. His other wife and their children (one daughter and two sons)

are without freckles. Make a genealogical tree; determine a mode of inheritance this attribute and genotypes of all people specified in the task.

38. Proband (boy) is right hander. His brothers and sisters are left-handers. Proband's father is right-hander and mother is left-hander. Proband's mother has two brothers: one of them is left-hander and another is right-hander. Proband's grandmother in the mother's line – right-hander, the grandfather - left-hander. Brother of proband's mother (the proband's uncle) is right-hander and he has married the right-hander woman, but their two daughters are left-handers. Compose genealogical tree, determine inheritance type and family members' genotypes.

39. Members of one family are deaf-mutes (they don't hear and speak). Proband is a girl with deaf-mutism. Her brother, mother and father are healthy. From the fathers side aunt and grandfather are healthy and grandmother is sick. Proband's mother has deaf-mute brother and healthy brother and healthy sister. Compose the pedigree. Determine inheritance type and family member's genotypes.

40. A curly haired person and a straight haired person mate and all their offspring have wavy hair (note that wavy hair is a phenotype *in between* that of the curly and straight haired individuals). What would be the result of a cross between two wavy haired individuals? (give phenotype %'s)

41. A man and a woman of normal vision have one son and one daughter. Son is colour blind and his son is with normal vision. Daughter is with normal vision but one of her sons is colour blind and other is normal. What are the genotypes of father, mother, son, daughter?

42. A man's maternal grand mother had normal vision, his maternal grandfather was colour blind. His mother is colour blind and father is with normal vision. What are the genotypes of parents, grand parents? What type of vision he has? What type of vision his sisters have? If he marries a woman genotypically like one of his sisters what type of progeny is expected?

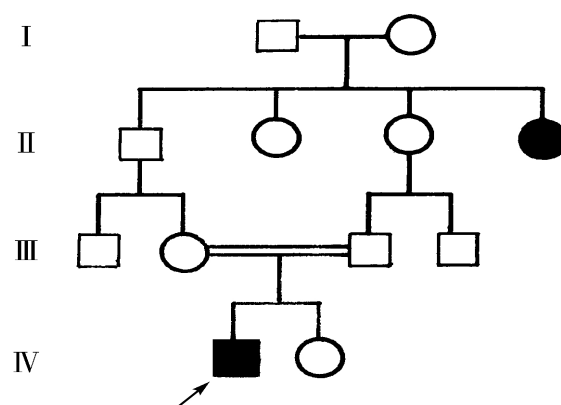
43. A colour-blind man married a woman who is the daughter of a clourblind father and homozygous mother with normal vision. What is the probability of their daughter being colorblind?

44. What is the ratio between colour-blind and normal vision sons, and color-blind and normal vision daughters in a marriage between color-blind female and a normal vision male?

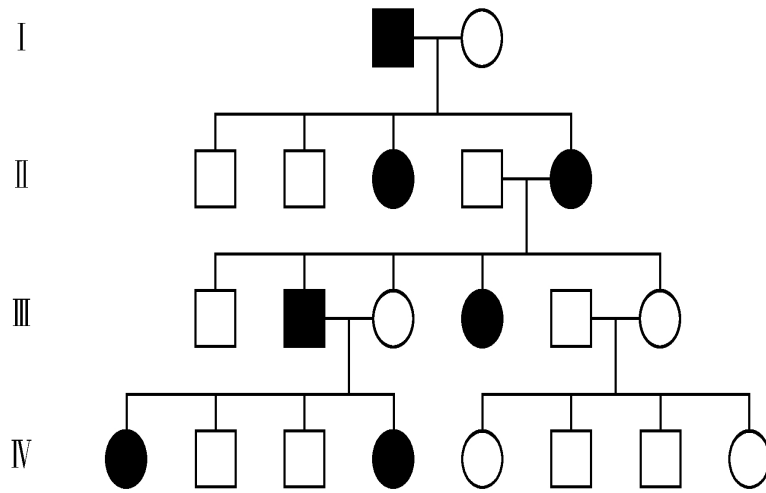
45. A man with type AB blood marries a woman with type A blood. The woman's genotype is not known in that it can be either homozygous or heterozygous. If one particular genotype were to show up in their children, it would tell us the precise genotype of the mother. What is this blood type for the offspring that would allow us to determine the mother's genotype? Explain.

46. Analyze the pedigree, what inheritance model do you think? Why?

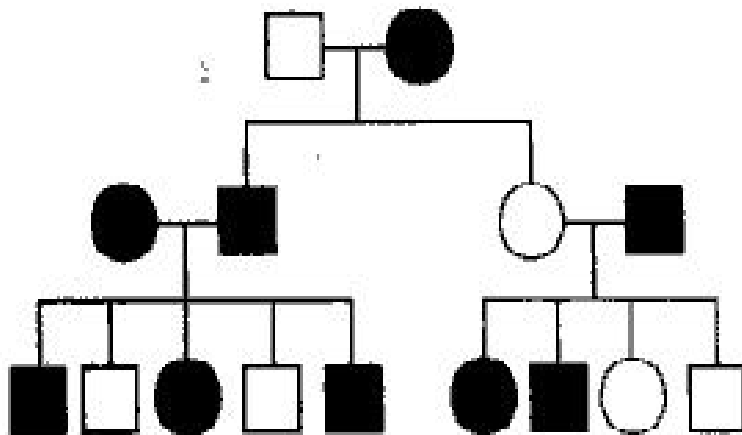
a



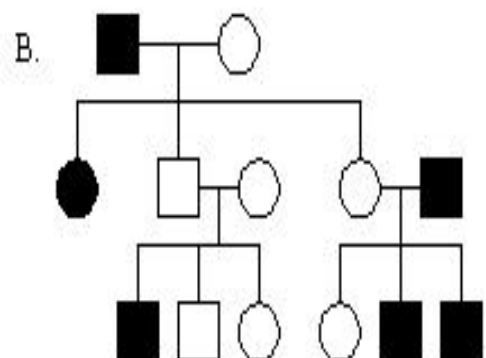
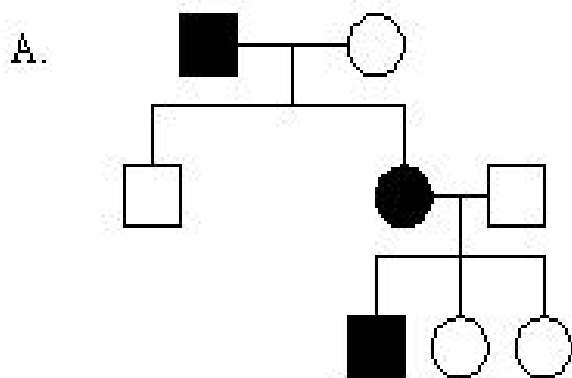
b



47. In the pedigree, squares represent males and circles represent females. Individuals who express a particular trait are represented by shaded figures. Which of the following patterns of inheritance best explains the transmission of the trait?

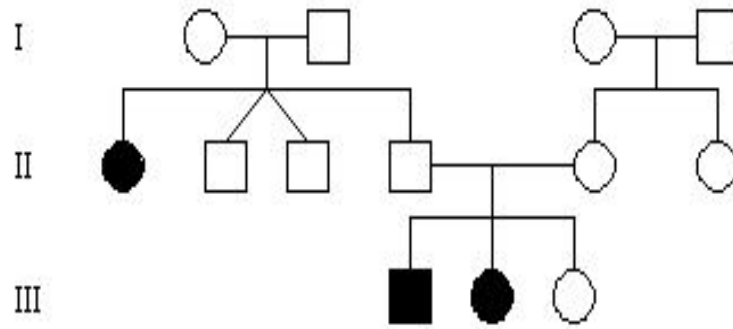


48. Study the pedigrees of family A and family B in the figure below.



- a. Which family pedigree shows an autosomal dominant mode of inheritance? Give reasons for your choice.
- b. What type of inheritance is demonstrated by the other family? Why did you decide on that type of inheritance?

49. Cystic fibrosis is inherited as an autosomal recessive trait, as shown in the pedigree below. How many genotypes are possible for individual III-3? What are they? Is individual II-4 homozygous or heterozygous for this trait? Explain.



## CONTROL QUESTIONS ON CYTOLOGY

1. Medical Biology as a science: definition, subject, tasks, importance to medicine.
2. Levels of biological organization: molecular, cellular, tissular, organismic, levels of population and species, biocenotical, ecosystems, biospheric.
3. Importance of levels of biological organization for medicine.
4. Light microscope structure: mechanical, optical, illuminative parts.
5. The main principles of working with light microscope.
6. The principles of provisional specimen preparation.
7. The Cell Theory in its modern form. Importance for medicine.
8. Cellular level of life organization: prokaryotic cell.
9. Cellular level of life organization: eukaryotic cell.
10. The common functions and structures of cells: cytoplasm, nucleus and cell membrane.
11. Structural compounds of cytoplasm: cytoskeleton, organelles and inclusions.
12. Nucleus: nucleus envelope, nucleoplasm, nucleolus and chromatin.
13. Organelles for general and for special prescription, their structure and functions.
14. Inclusions: trophic, secretory and special.
15. Structure and property of cell membrane.
16. Chemical composition of cell membrane.
17. Function of cellular membrane. Compartmentency.
18. General characteristic of transport across cell membrane.
19. Intercellular contacts.
20. Structural states of the chromosomes.
21. Functional states of the chromosomes.
22. Euchromatin and heterochromatin.
23. The levels of organization of eukariotic chromosomes.
24. Chromosomes types: metacentric, submetacentric, acrocentric, telocentric chromosomes.
25. Normal human karyotype characteristics.
26. Human chromosomes ideogram.
27. Conceptions about genome and chromosome mutations.
28. A history of development of the doctrine about material bases of a heredity.
29. Proofs of a genetical role of the DNA on an example of transformation and transduction.
30. The characteristic of chemical constitution of the DNA.
31. Chargaff's rules.



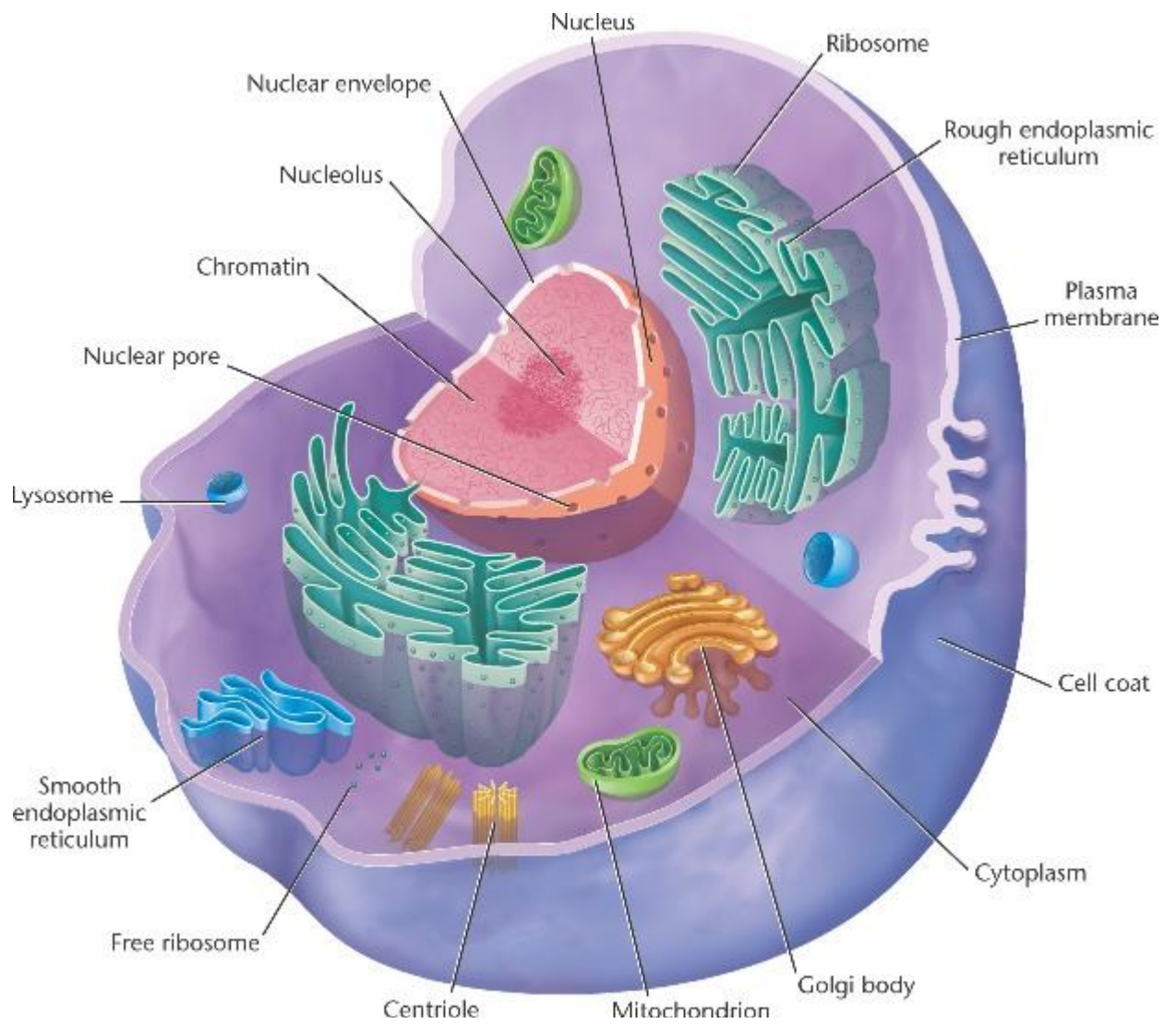
32. A spatial constitution of the DNA molecule (model of Watson and Crick), kinds of the DNA.
33. The function characteristic of parts of a molecule of DNA with different frequency of repetition of nucleotides.
34. The structurally functional characteristic of a molecule of RNA.
35. Kinds of the RNA.
36. Autosynthetic function of the DNA molecule.
37. A genetic code and its properties.
38. A gene as a functional unit of heredity, classification of genes.
39. A constitution of prokaryotes and eukaryotes genes.
40. Stages of realization of the inheritable information: transcription, processing, and translation.
41. The operon model.
42. Gene regulation in prokaryotes.
43. Gene regulation in eukaryotes.
44. DNA's reparation.
45. Cell (mitotic) cycle, its stages: G<sub>1</sub>-, S-, G<sub>2</sub>- phases, mitosis.
46. Mitosis, its stages.
47. Biological significance of mitosis.
48. Cytological and cytogenetical characteristics of meiosis, mechanisms of the gametes genetic diversity formation.
49. Cytogenetical characteristics of meiosis.
50. Biological significance of meiosis.

## CONTROL QUESTIONS ON GENETICS

1. The object and purpose of human genetics and medical genetics.
2. Genotype, phenotype.
3. Patterns of inheritance in monohybrid cross. The first and second laws of Mendel.  
Monogenic diseases.
4. Patterns of inheritance in di- and polihybridnomu crossing. The third law of Mendel.
5. Multiple alleles. Inheritance blood group antigen system for ABO and Rh factor. Value for medicine.
6. The interaction of allelic genes: complete dominance, incomplete dominance, overdominance.
7. Genotype –environment interaction
8. Interaction nonallelic genes.
9. Polymeric inheritance of traits in humans. Pleiotropy.
10. Linked inheritance of genes. Crossing over.
11. The chromosome theory of heredity.
12. The current state of research of the human genome. Genetic engineering. The genetic map of human chromosomes.
13. Genetics of sex. Chromosomal diseases that are caused by changes in the number of sex chromosomes.
14. Inheritance of traits linked to sex.
15. Discovery of Crossing-Over and Recombination
16. Sex-Linkage and Sex-determining Chromosomes
17. Variability, its form, meaning in ontogeny and evolution.
18. Phenotypic variability and its characteristics. The norme of reaction. Phenocopy.
19. Penetrance and expressivity of genes.
20. Genotypic variability, its shape.
21. Classification of mutations genome. Spontaneous and induced mutations.
22. Phenotypic (nonhereditary) variability
23. Genotypic (hereditary) variability
24. Gene mutation mechanisms . The concept of monogenic diseases.
25. Chromosomal aberrations. The mechanisms of the disease and examples that are of consequence.
26. Mechanisms of genomic mutations
27. Hereditary diseases that are the outcome of the number of autosomes and sex chromosomes.
28. Mutagenic factors, their types. Mutagenesis. Genetic monitoring.

29. Methods of studying human heredity.
30. Genealogical and twins methods of studying human heredity.
31. Biochemical method for studying genetic diseases. The screening program.
32. Cytogenetic method study of human heredity.
33. Prenatal diagnosis of hereditary diseases.
34. Population and statistical method for studying human heredity.
35. Reproduction - universal property of living. Forms reproduction. The possibility of cloning organisms.
36. Asexual and sexual reproductions in unicellular and multicellular organisms
37. Gametogenesis: spermatogenesis and oogenesis
38. Morphogenetic specialization of sex cells: a sperm and an ovum
39. Fertilization.
40. The periods of ontogenesis
41. Molecular and cellular mechanisms of differentiation.
42. Differentiation of germ layers and tissues. Embryonic induction. Cloning of organisms and tissues.
43. The critical periods of fetal development. Teratogenic environmental factors.
44. The post-embryonic development of man and his periodization. Neurohormonal regulation of growth and development.
45. Aging as a stage of ontogeny. Theories of aging. The concept of gerontology and geriatrics.
46. Clinical and biological death.
47. The regeneration of organs and tissues.
48. Types of regeneration. Value regeneration problems in biology and medicine.
49. The problem of transplantation of organs and tissues. Types of transplants.
50. The concept of homeostasis. Mechanisms of regulation of homeostasis at different levels of life.

## APPENDIX



**Figure 1**







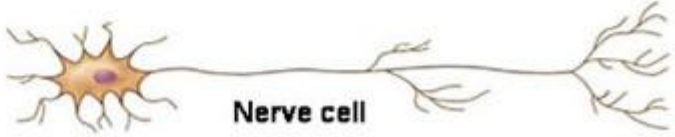

<b>Biosphere</b>	The part of Earth that contains all ecosystems	 <b>Biosphere</b>
<b>Ecosystem</b>	Community and its nonliving surroundings	 <b>Hawk, snake, bison, prairie dog, grass, stream, rocks, air</b>
<b>Community</b>	Populations that live together in a defined area	 <b>Hawk, snake, bison, prairie dog, grass</b>
<b>Population</b>	Group of organisms of one type that live in the same area	 <b>Bison herd</b>
<b>Organism</b>	Individual living thing	 <b>Bison</b>
<b>Groups of Cells</b>	Tissues, organs, and organ systems	 <b>Nervous tissue      Brain      Nervous system</b>
<b>Cells</b>	Smallest functional unit of life	 <b>Nerve cell</b>
<b>Molecules</b>	Groups of atoms; smallest unit of most chemical compounds	 <b>Water      DNA</b>

Figure 2



## Components of Nucleic Acids

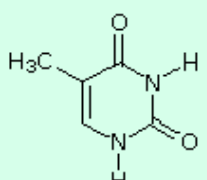
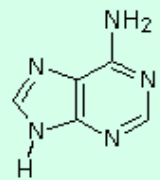
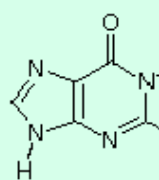
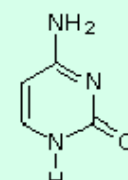
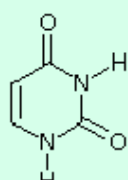
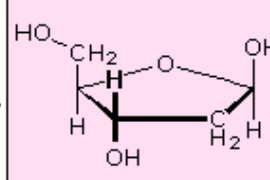
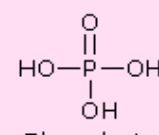
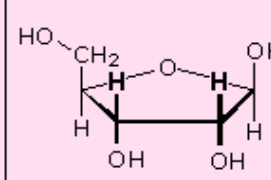
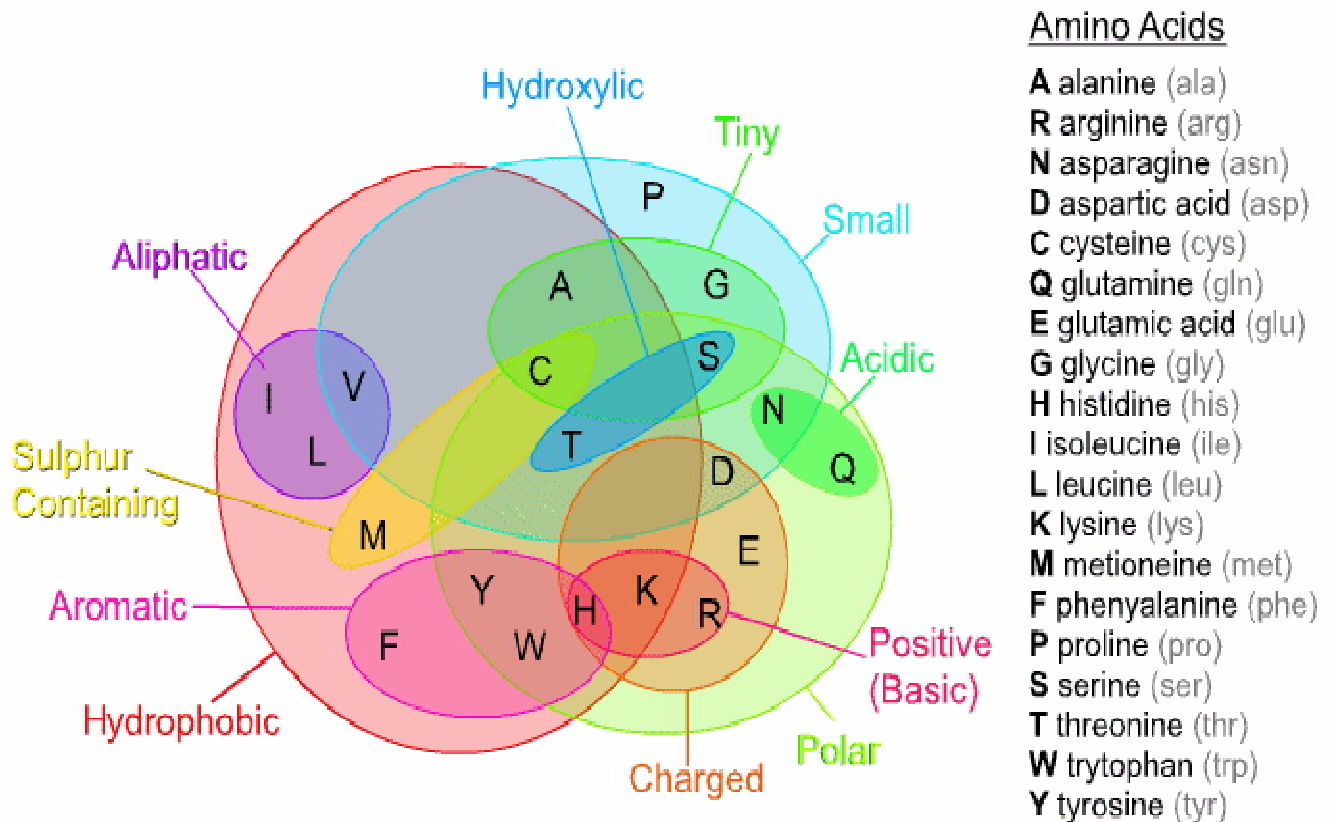
	DNA only	DNA & RNA			RNA only
Nitrogen Bases	 Thymine	 Adenine	 Guanine	 Cytosine	 Uracil
Sugars & Phosphate	 2-Deoxyribose	 Phosphate			 Ribose

Figure 3

		Second base					
		U	C	A	G		
First base	U	UUU } Phenylalanine <b>F</b>	UCU } Serine <b>S</b>	UAU } Tyrosine <b>Y</b>	UGU } Cysteine <b>C</b>	U C A G	Third base
		UUC } Phenylalanine <b>F</b>	UCC } Serine <b>S</b>	UAC } Tyrosine <b>Y</b>	UGC } Cysteine <b>C</b>		
		UUA } Leucine <b>L</b>	UCA } Serine <b>S</b>	UAA } Stop codon	UGA } Stop codon		
		UUG } Leucine <b>L</b>	UCG } Serine <b>S</b>	UAG } Stop codon	UGG } Tryptophan <b>W</b>		
C	CUU } Leucine <b>L</b>	CCU } Proline <b>P</b>	CAU } Histidine <b>H</b>	CGU } Arginine <b>R</b>	U C A G	Third base	
	CUC } Leucine <b>L</b>	CCC } Proline <b>P</b>	CAC } Histidine <b>H</b>	CGC } Arginine <b>R</b>			
	CUA } Leucine <b>L</b>	CCA } Proline <b>P</b>	CAA } Glutamine <b>Q</b>	CGA } Arginine <b>R</b>			
	CUG } Leucine <b>L</b>	CCG } Proline <b>P</b>	CAG } Glutamine <b>Q</b>	CGG } Arginine <b>R</b>			
A	AUU } Isoleucine <b>I</b>	ACU } Threonine <b>T</b>	AAU } Asparagine <b>N</b>	AGU } Serine <b>S</b>	U C A G	Third base	
	AUC } Isoleucine <b>I</b>	ACC } Threonine <b>T</b>	AAC } Asparagine <b>N</b>	AGC } Serine <b>S</b>			
	AUA } Isoleucine <b>I</b>	ACA } Threonine <b>T</b>	AAA } Lysine <b>K</b>	AGA } Arginine <b>R</b>			
	AUG } Methionine start codon <b>M</b>	ACG } Threonine <b>T</b>	AAG } Lysine <b>K</b>	AGG } Arginine <b>R</b>			
G	GUU } Valine <b>V</b>	GCU } Alanine <b>A</b>	GAU } Aspartic acid <b>D</b>	GGU } Glycine <b>G</b>	U C A G	Third base	
	GUC } Valine <b>V</b>	GCC } Alanine <b>A</b>	GAC } Aspartic acid <b>D</b>	GGC } Glycine <b>G</b>			
	GUA } Valine <b>V</b>	GCA } Alanine <b>A</b>	GAA } Glutamic acid <b>E</b>	GGA } Glycine <b>G</b>			
	GUG } Valine <b>V</b>	GCG } Alanine <b>A</b>	GAG } Glutamic acid <b>E</b>	GGG } Glycine <b>G</b>			

Figure 4



**Figure 5**

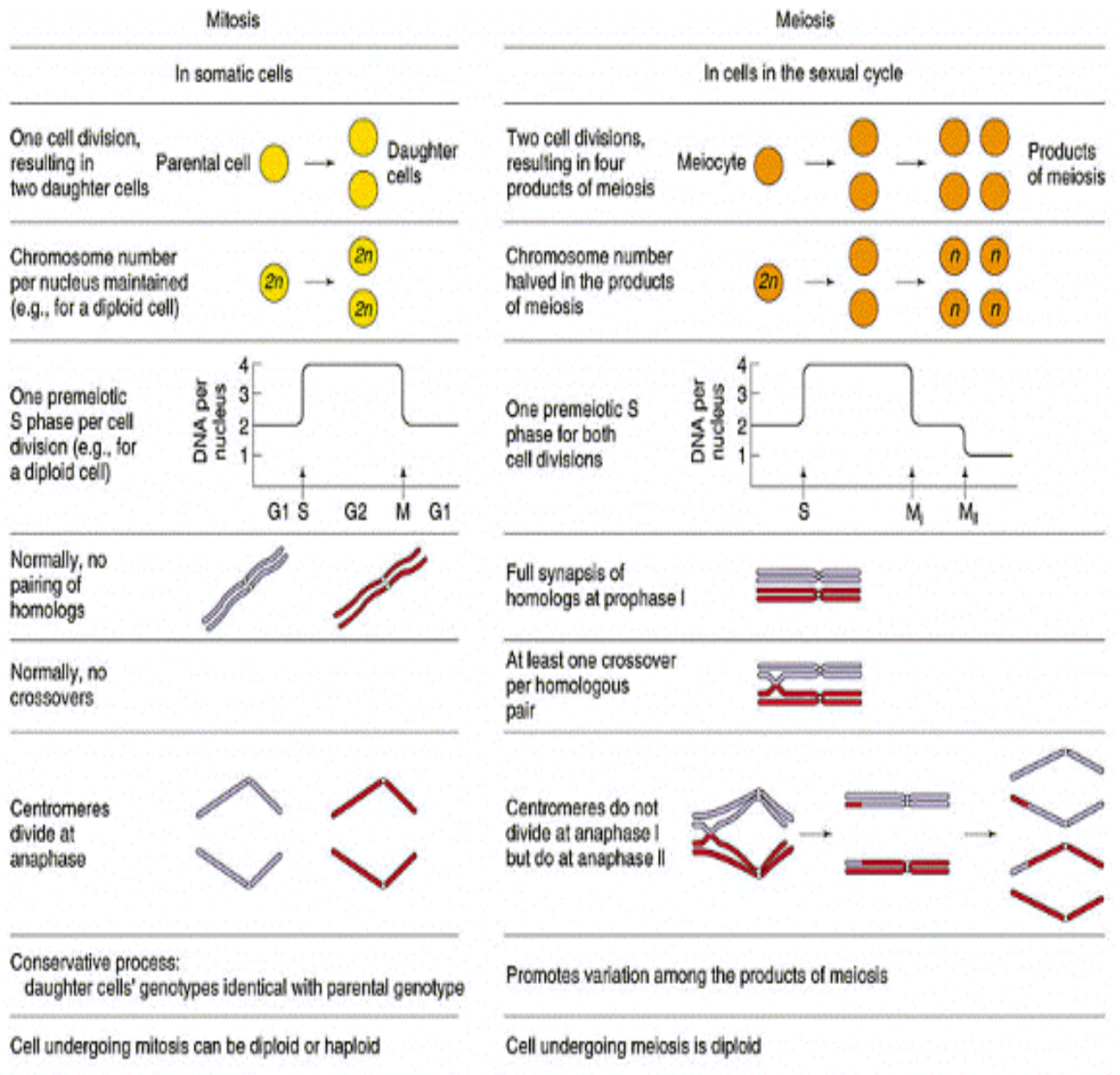


Figure 6



# Cell Cycle – 4 Phases

## $G_1$ (& $G_0$ ) – S – $G_2$ - M

- $G_1$  (Gap 1) phase
  - characterized by resumption of bio-synthesis
  - growth and production of proteins for DNA synthesis
  - duration is highly variable
- S phase
  - Amount of DNA effectively doubled  $\rightarrow$  cell replicates its DNA
  - Each chromosome replicated  $\rightarrow$  sister chromatids

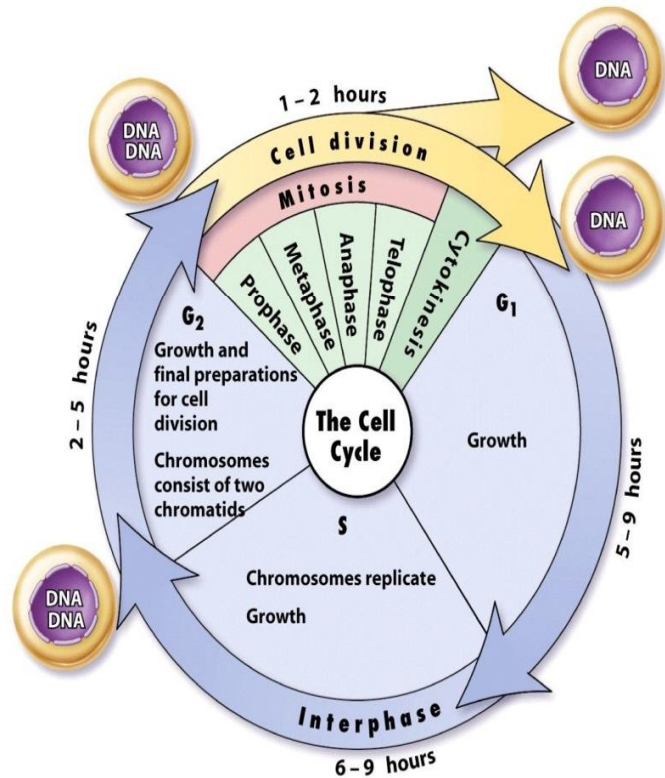


Figure 19-2 Biology of Humans, 2/e  
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Figure 7

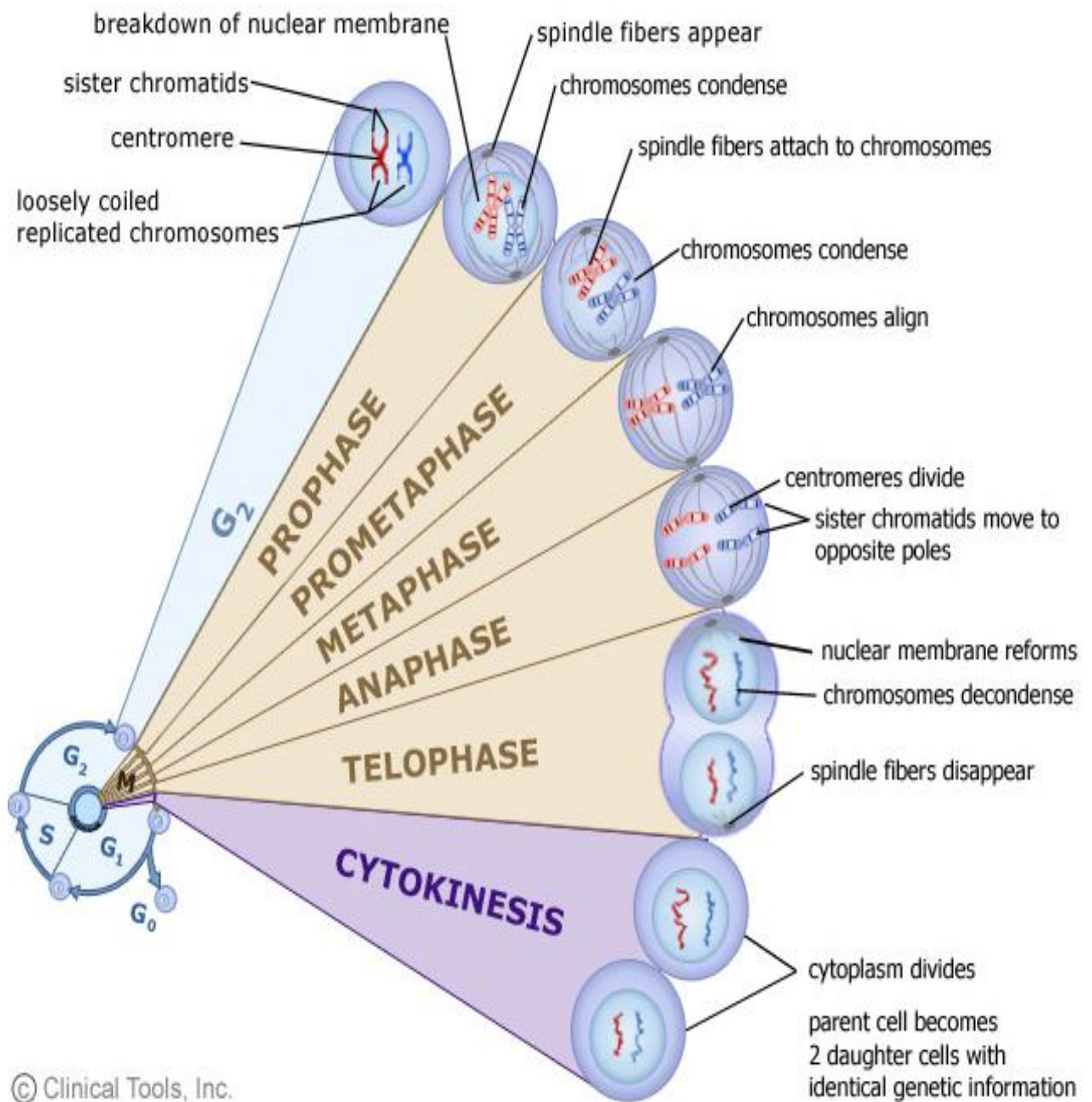


Figure 8

# The ABO Blood System


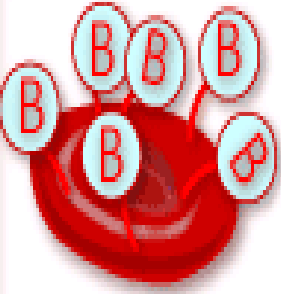

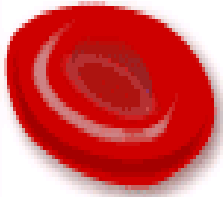
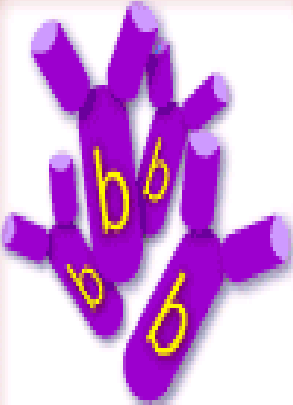
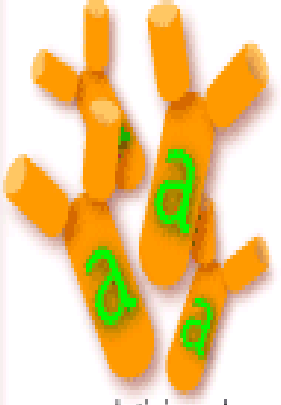
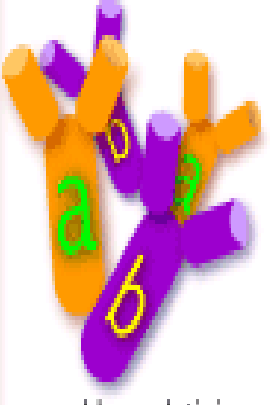
Blood Type (genotype)	Type A (AA, AO)	Type B (BB, BO)	Type AB (AB)	Type O (OO)
Red Blood Cell Surface Proteins (phenotype)	 <p>A agglutinogens only</p>	 <p>B agglutinogens only</p>	 <p>A and B agglutinogens</p>	 <p>No agglutinogens</p>
Plasma Antibodies (phenotype)	 <p>b agglutinin only</p>	 <p>a agglutinin only</p>	<p>NONE.</p> <p>No agglutinin</p>	 <p>a and b agglutinin</p>

Figure 9

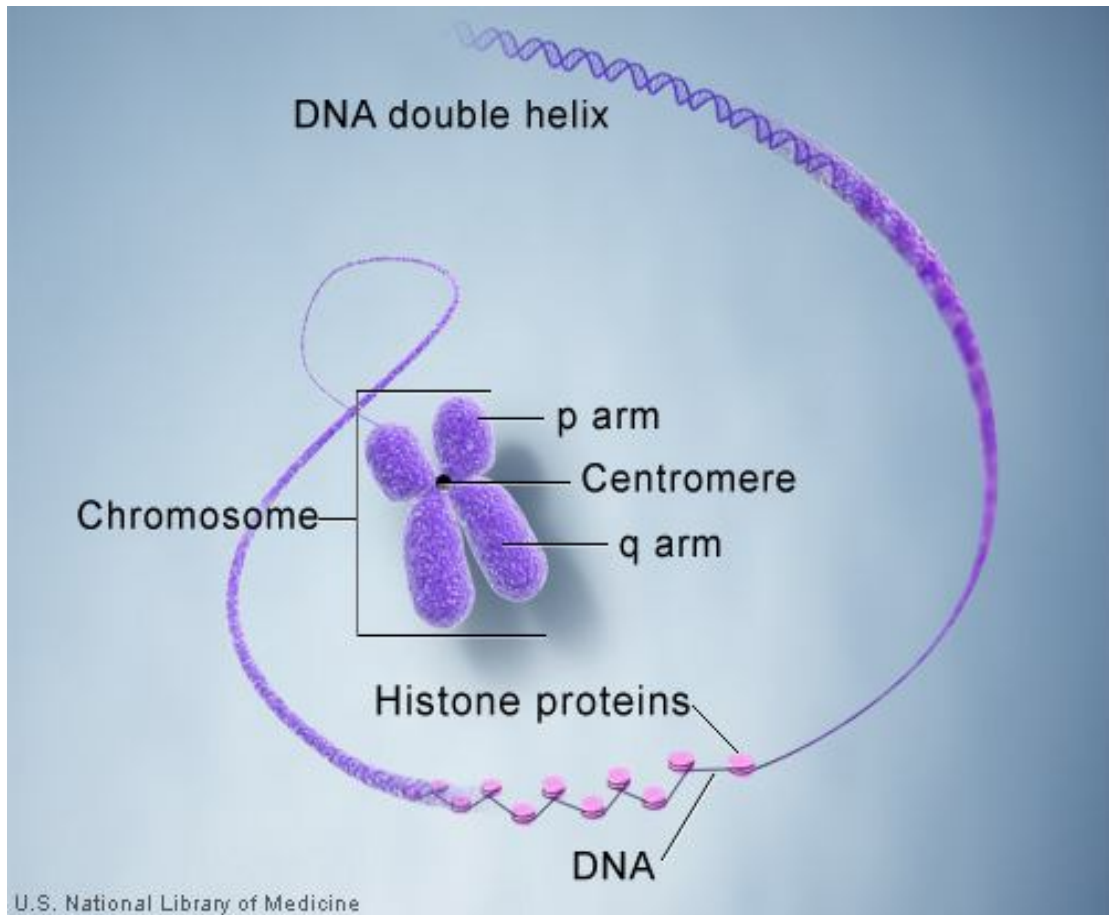


Figure 10

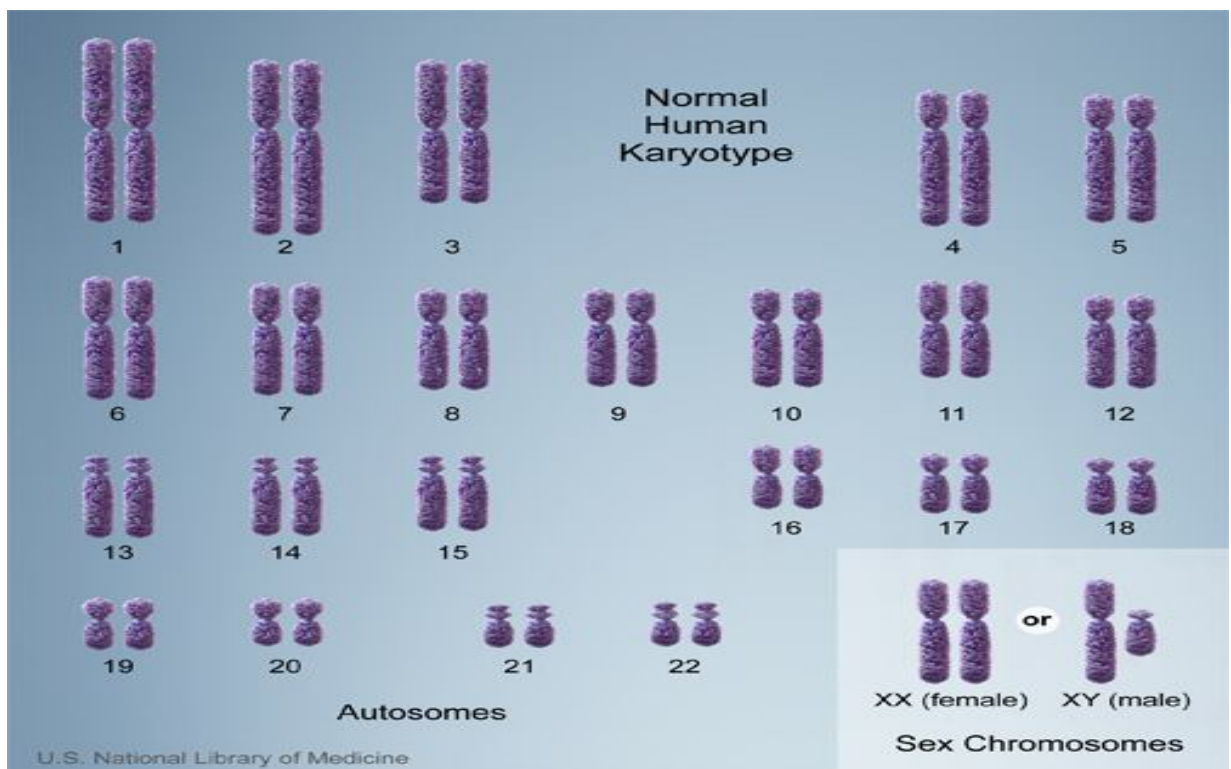


Figure 11

# Gametogenesis

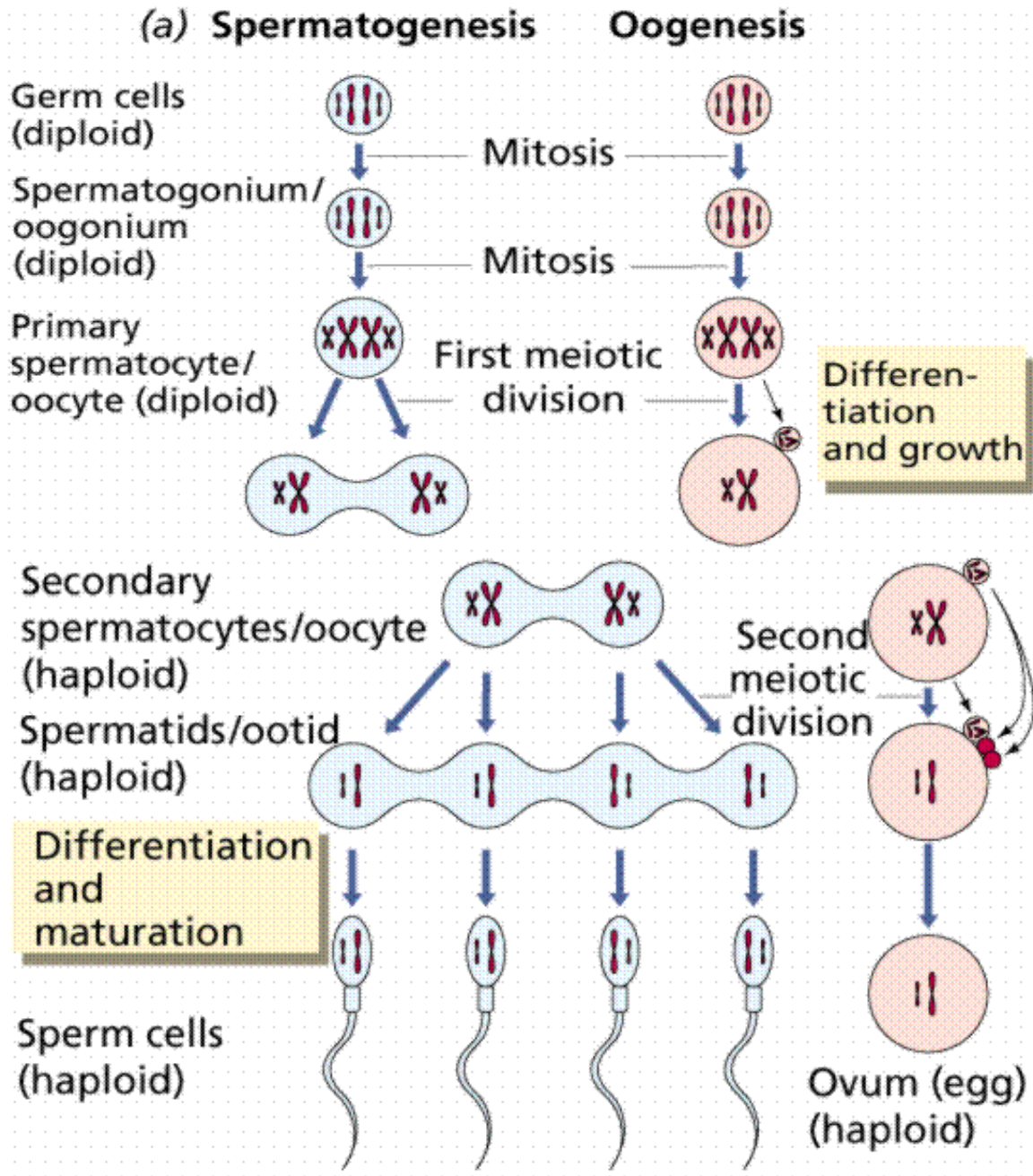
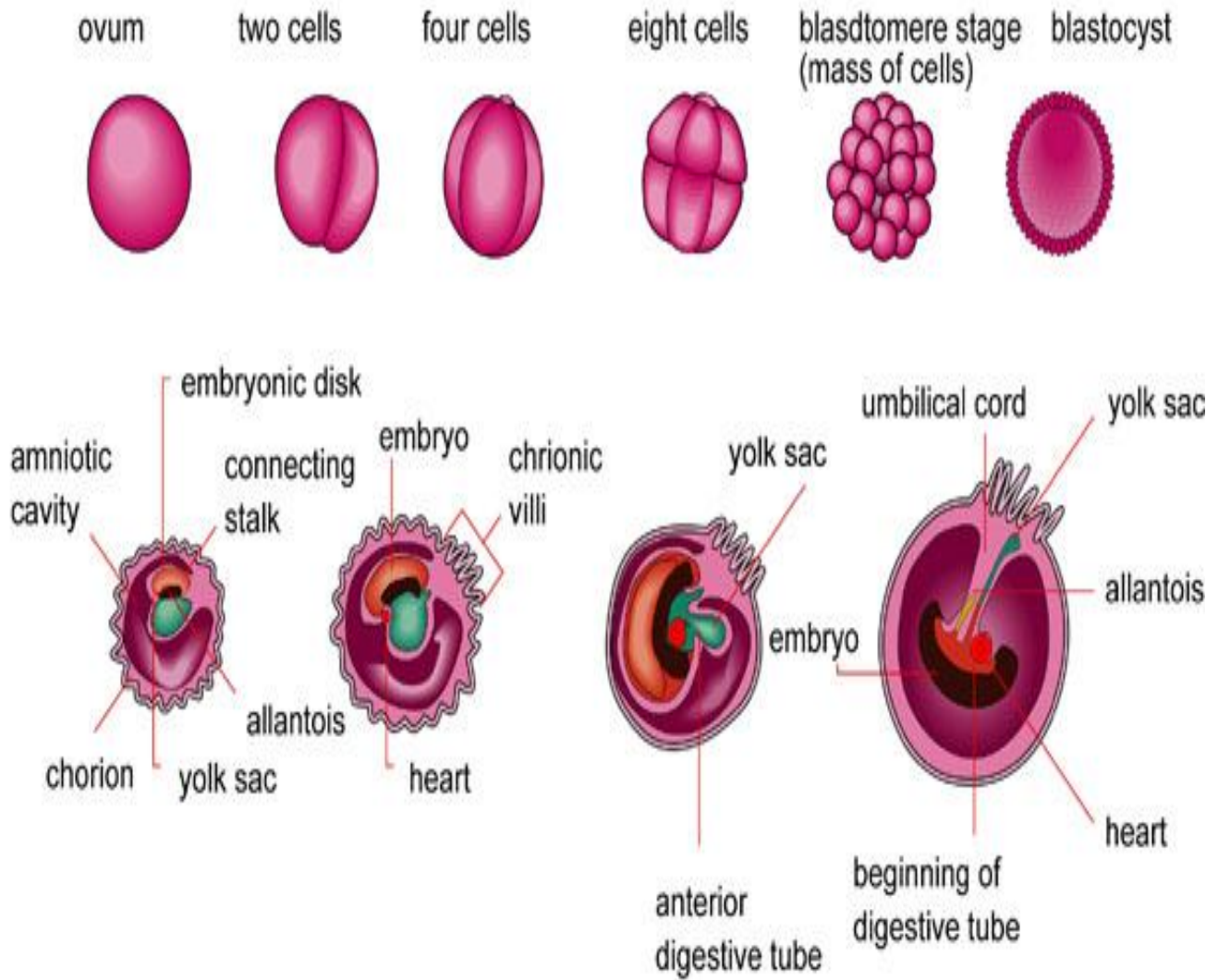
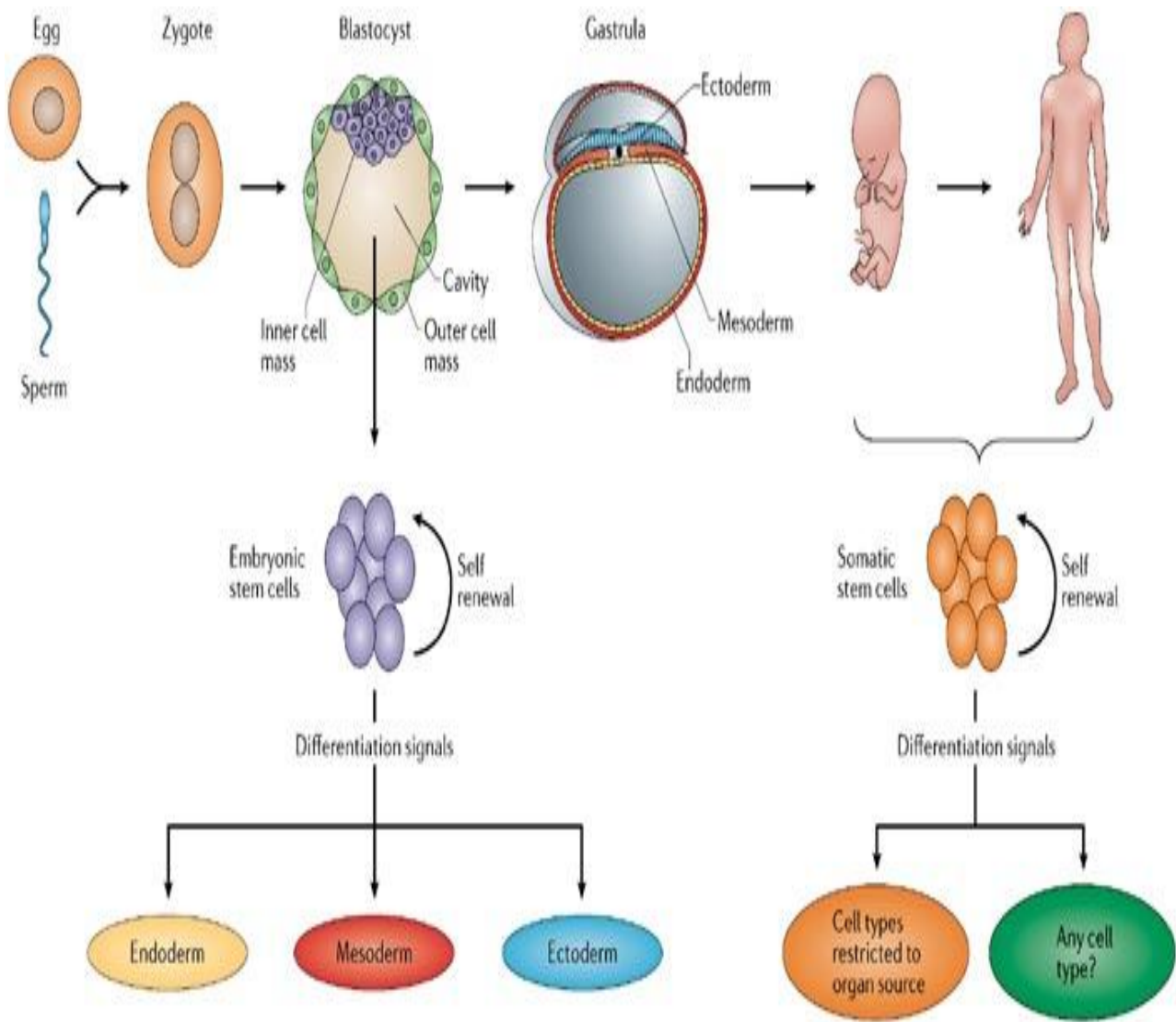


Figure 12





**Figure 13**



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**Figure 14**

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