



GOA UNIVERSITY  
Taleigao Plateau

**SYLLABUS FOR GOA UNIVERSITY ADMISSIONS RANKING TEST (GU-ART) IN BIOTECHNOLOGY**

**BIOCHEMISTRY AND METABOLISM**

**Amino acids & Proteins:** Structure & Function. Types of proteins and their classification, Forces stabilizing protein structure and shape.

Protein Purification; Denaturation and renaturation of proteins. Fibrous and globular proteins. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions.

Lipids: Structure and functions - Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA. Cot curve

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Michaelis-Menten equation. Factors affecting enzyme activity, Role of: NAD<sup>+</sup>, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, Vitamin B12, Tetrahydrofolate. Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation.  $\beta$ -oxidation of fatty acids.

**CHEMISTRY I FOR BIOTECHNOLOGY**

***Inorganic Chemistry-1***

**Atomic Structure:** Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. What is Quantum mechanics . Time independent Schrodinger equation and meaning of various terms in it. Significance of  $\psi$  and  $\psi^2$ . Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions Significance of quantum numbers, orbital angular momentum and quantum numbers  $ml$  and  $ms$ . Shapes of  $s$ ,  $p$  and  $d$  atomic orbitals, nodal planes. Discovery of spin, spin quantum number ( $s$ ) and magnetic spin quantum number ( $ms$ ). Rules for filling electrons in various orbitals, Electronic configurations

of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

**Chemical Bonding and Molecular Structure:** *Ionic Bonding:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

*Covalent bonding:* VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals,

### **Organic Chemistry-I**

**Fundamentals of Organic Chemistry:** Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

**Stereochemistry:** Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

**Aliphatic Hydrocarbons:** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Alkanes:** (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

**Alkenes:** (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* *cis*-addition (alk. KMnO<sub>4</sub>) and *trans*-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

**Alkynes:** (Upto 5 Carbons) *Preparation:* Acetylene from CaC<sub>2</sub> and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline KMnO<sub>4</sub>, ozonolysis and oxidation with hot alk. KMnO<sub>4</sub>.

## ANIMAL DIVERSITY I

- a) Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata
- b) Protozoa: Locomotion, Reproduction, General features of *Paramoecium* and *Plasmodium*. Pathogenic protozoans
- c) Porifera: General characters, outline of Classification; skeleton, Canal System
- d) Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.
- e) Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.
- f) Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.
- g) Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.
- h) Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.
- i) Mollusca : General features, Outline of classification, Shell Diversity; Torsion in gastropoda,
- j) Echinodermata: General features, Outline of Classification Larval forms
- k) Hemichordata: Phylogeny: Affinities of *Balanoglossus*

## PLANT DIVERSITY I

**Algae:** General character, classification and economic importance. Life histories of algae belonging to

various classes: Chlorophyceae – *Volvox*, *Oedogonium*, Xanthophyceae – *Vaucheria*, Phaeophyceae – *Ectocarpus*, Rhodophyceae – *Polysiphonia*

**Fungi:** General characters, classification & economic importance. Life histories of Fungi: Mastigomycotina – *Phytophthora*, Zygomycotina – *Mucor*, Ascomycotina – *Saccharomyces*, Basidiomycotina – *Agaricus*, Deutromycotina – *Colletotrichum*

**Lichens:** Classification, general structure, reproduction and economic importance. Plant diseases:

4 of 36 Casual organism, symptoms and control of following plant diseases. Rust & Smut of Wheat.

White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

**Bryophytes:** General characters, classification & economic importance. Life histories of following:

*Marchantia*. *Funaria*.

## GENERAL MICROBIOLOGY

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses. Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. Control of Microorganisms: By physical, chemical and chemotherapeutic agents. Water Microbiology: Bacterial pollutants of water, coliforms and non-coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.

Major food born infections and intoxications,

## CHEMISTRY II FOR BIOTECHNOLOGY

### *Physical Chemistry-1*

**Chemical Energetics:** Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermo chemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

**Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

**Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

**Organic Chemistry-2:** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Aromatic hydrocarbons:** *Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzenesulphonic acid.

**Alkyl and Aryl Halides:** Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution ( $S_N1$ ,  $S_N2$  and  $S_Ni$ ) reactions. *Preparation:* from alkenes and alcohols.

Aromatic nucleophilic substitution (replacement by  $-OH$  group) and effect of nitro substituent. and Relative

**Alcohols, Phenols and Ethers:** Alcohols: *Preparation:* Preparation of 1<sup>o</sup>, 2<sup>o</sup> and 3<sup>o</sup> alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

## **ANIMAL DIVERSITY II**

**Proto-chordates, Pisces and Amphibia** Proto-chordates: Outline of classification, General features and important characters of Herdmania, Branchiostoma, Origin of Chordates Cyclostomata- General features, Classification, Pisces: General features, Migration in Pisces, Outline of classification, Amphibia: General features, Classification, Origin, Parental care, Neoteny and Paedogenesis, Reptilia: General features, Classification, Origin, Aves: General features, Classification, Origin, flight- adaptations, migration, Flightless birds or ratitae, Beak and feet in birds. Mammalia: General features, Classification, Origin, dentition, Aquatic and flying mammals

## **PLANT DIVERSITY II**

**Pteridophytes:** General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Psilotum, Selaginella, Equisetum and Pteris. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

**Gymnosperms:** General characteristics, Classification (Coulter & Chamberlain), morphology, anatomy and reproduction of Cycas, Pinus and Gnetum. (Developmental details not to be included). Ecological and economical importance.

**Introduction to plant taxonomy:** Identification, Classification, Nomenclature.

**Identification:** Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access.

Taxonomic evidences from palynology, cytology, photochemistry and molecular data.

### **Taxonomic hierarchy**

Ranks, categories and taxonomic groups.

**Botanical nomenclature:** Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

**Biometrics, numerical taxonomy and cladistics:** Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

## **CELL BIOLOGY**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport, Cell wall Ultrastructure & Function. Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion. Lysosomes: Vacuoles and micro

bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure. Cell cycle: Mitosis & Meiosis, Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

## **CHEMISTRY III FOR BIOTECHNOLOGY**

### ***Physical Chemistry-2***

**Solutions:** Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. .

**Phase Equilibrium:** Phases, components and degrees of freedom of a system, criteria of phase equilibrium. **Conductance:** Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.

**Electrochemistry:** Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode.

### ***Organic Chemistry-3***

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Carboxylic acids and their derivatives:** Carboxylic acids (aliphatic and aromatic), Preparation: Acidic and Alkaline hydrolysis of esters,

**Amines and Diazonium Salts:** Amines (Aliphatic and Aromatic): (Upto 5 carbons), Preparation: from alkyl halides, Hofmann Bromamide reaction. Reactions. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.

**Amino Acids, Peptides and Proteins:** Preparation of Amino Acids Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of –NH<sub>2</sub> group, complexation with Cu<sup>2+</sup> ions, ninhydrin test.

Determination of Primary structure of Peptides by degradation Edmann degradation (Nterminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & Activating groups and Merrifield solid-phase synthesis.

**Alkaloids:** Natural occurrence, General structural features, Isolation and their physiological action.

**Terpenes:** Occurrence, classification, isoprene rule;

## MAMMALIAN PHYSIOLOGY

**Digestion and Respiration** Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O<sub>2</sub> and CO<sub>2</sub>, Oxygen dissociation curve, Chloride shift.

**Circulation:** Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

**Muscle physiology and osmoregulation:** Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

**Nervous and endocrine coordination** **Reproduction:** Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, salutatory conduction, Neurotransmitters, Mechanism of action of hormones (insulin and steroids), Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

## PLANT PHYSIOLOGY AND METABOLISM

**Plant-water relations:** Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

**Mineral nutrition:** Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

**Nutrient Uptake:** Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

**Translocation in the phloem:** Experimental evidence in support of phloem as the site of sugar translocation.

**Plant growth regulators:** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

**Physiology of flowering:** Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

**Phytochrome, cryptochromes and phototropins:** Discovery, chemical nature, role in photo-morphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

**Photosynthesis:** Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, Electron transport and mechanism of ATP synthesis; C<sub>3</sub>, C<sub>4</sub> and CAM pathways of carbon fixation; Photorespiration.

**Nitrogen metabolism:** Biological nitrogen fixation; Nitrate and ammonia assimilation.

## **CBC104 - CHEMISTRY IV FOR BIOTECHNOLOGY**

### **Inorganic Chemistry 2**

**Acids and Bases:** Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases.

**Bio-Inorganic Chemistry:** A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na<sup>+</sup>, K<sup>+</sup> and Mg<sup>2+</sup> ions: Na/K pump; Role of Mg<sup>2+</sup> ions in energy production and chlorophyll. Role of Ca<sup>2+</sup> in blood clotting, stabilization of protein structures and structural role (bones).

### **Physical Chemistry-3**

**Kinetic Theory of Gases:** Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Vander Waals equation of state for real gases. Boyle temperature . Critical phenomena, critical constants and their calculation from van der Waals equation. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

**Liquids:** Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

**Solids:** Forms of solids.Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices.X-Ray diffraction by crystals, Bragg's law.Structures of NaCl, KCl and CsCl (qualitative treatment only).

**Chemical Kinetics:** The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Half-life of a reaction.General methods for determination of order of a reaction.Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

## **GENETICS**

**Overview of Mendelian genetics, its modifications, Sex determination and linkage**Introduction: Historical developments in the field of genetics. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. Epistasis and Hypostasis- Multiple alleles with example, Multiple genes with example Sex determination and sex linkage - Sex determination in Drosophila, Insects, Honeybee, Bonelia, Turtle, Birds and Man. Barr bodies, dosage compensation, genetic balance theory, sex influenced dominance, sex limited gene expression, sex linked inheritance.

**Chromosomal structure, Linkage and crossing over:** Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.Chromosome and genomic organization: Eukaryotic nuclear



genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, repetitive transposed sequences, repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

**Gene mutations:** Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), spontaneous mutation and induced mutation, Types of mutagens- physical, Chemical and Biological. Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, Chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy, Chromosome and gene mutations: Definition and types of mutations, causes of mutations, s, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression,

**Human genetics:** Eugenics, Pedigree construction and analysis (Inheritance pattern of sex linked, autosomal dominant and recessive traits), Inheritance of human traits- Brown eyes, polydactyl, Diabetes insipidus, sickle cell anaemia. Study of Human chromosomal disorders: Down's syndrome, Klinefelter's syndrome, Turner's syndrome, Philadelphia syndrome. In breeding and out breeding, applications and evolutionary significance. Evolution and population genetics: Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.