1920-09-LUG

Medical Sciences Divisional Board

Approved by Ros Whiteley on 25.08.20

Title of Programme/ Name of Regulation

Preliminary Examination in Molecular and Cellular Biochemistry

Brief note about nature of change: Changes following major course revision.

Location of change

In *Examination Regulations 2019*
https://examregs.admin.ox.ac.uk/Regulation?code=peimandcellbioc&srchYear=2019&Term=1

Effective date

For students starting from MT 2020

And

For first examination from 2020-21

Detail of change

A

[1.1]1. The ~~subjects of the~~ Preliminary Examination in Molecular and Cellular Biochemistry shall ~~be~~ consist of five written papers:

- [1.2](1) ~~Molecular Cell Biology~~ Cellular Biochemistry
- [1.3](2) ~~Biological Chemistry~~ Mechanistic Biochemistry
- [1.4](3) ~~Biophysical Chemistry~~ Molecular Biochemistry
- [1.5](4) ~~Organic Chemistry~~ Physical Biochemistry
- [1.6](5) ~~Mathematics and Statistics for Biochemists~~ Quantitative Biochemistry

[1.7]2. Candidates shall be deemed to have passed the examination if they satisfy the Moderators in all five ~~subjects~~ papers.

[1.8]3. Candidates must offer all five ~~subjects~~ papers at their first examination attempt.

[1.9]4. A candidate who fails one or two ~~subjects~~ papers will be permitted one further attempt at the failed ~~subject/s~~ paper or papers, at the first available opportunity.

[1.10]5. A candidate who fails three or more ~~subjects~~ papers shall be deemed to have failed the examination. ~~He or she~~ The candidate will be permitted one further attempt at the whole examination, at the first available opportunity.

[1.11]6. The Moderators may award a Distinction to candidates of special merit who satisfy them in all five ~~subjects~~ papers at their first examination attempt.

B

[1.12]~~One written paper will be set in each subject. The duration of the written papers will be three hours for subjects 1, 2, and 3, and two and a half hours for subjects 4 and 5. The syllabus for each subject will be that set out in the schedule below~~.

Papers 1 and 3 will be of three hours duration and shall be a computer-based assessment. Papers 2 and 4 will be of three hours duration and shall be a hand-written assessment. Paper 5 will be of two hours and thirty minutes duration and shall be a hand-written assessment.

[1.13]The Moderators will permit the use of hand-held pocket calculators subject to the conditions set out under the heading 'Use of Calculators in examinations' in the *Regulations for the Conduct of University Examinations*. A list of recommended calculators will be provided by the Chair of the Moderators not later than the Wednesday of the fourth week of the Michaelmas Full Term preceding the examination. The use of calculators may not be permitted in certain papers.

[1.14]All candidates shall be assessed as to their practical ability in coursework under the following provisions:

[1.15](*a*) The Chair of the Teaching Committee, or a deputy, shall make available to the Moderators, at the end of the fifth week of the term in which the examinations are first held, evidence showing the extent to which each candidate has completed the prescribed coursework.

[1.16](*b*) The Moderators may request coursework from any candidate. Such candidates will be named in a list posted by the day of the first ~~written~~ paper.

[1.17](*c*) Coursework cannot normally be retaken. Failure to complete the coursework to the satisfaction of the Moderators, in the absence of appropriate

documentary evidence (e.g. a signed medical certificate), will normally constitute failure of the examination.

Schedule

(1) ~~*Molecular Cell Biology*~~ *Cellular Biochemistry*

1.18~~Classification, evolution and structure of bacterial, archeal, and eukaryotic cells; structure of subcellular organelles and the cytoskeleton of eukaryotes. Multicellularity and cell specialization. Differences between plant and animal cells. Nuclear and cell division in plants, animals, and bacteria. Intra- and intercellular signalling.~~ Cells as the basic unit of life; multicellularity; cell signalling; cell metabolism.

1.19~~Chromosomes and genes. Transmission of information between generations. Mitosis and meiosis. Evidence for DNA as the genetic material. The nature of the gene. Organisation and expression of genetic information: mechanism of DNA replication; mechanism and control of transcription; mechanisms and structures involved in protein synthesis; the genetic code; phages, plasmids, and hosts. Gene cloning and mapping techniques.~~

1.20~~Major metabolic pathways - chemical and thermodynamic principles. ATP. Oxidation of fuels: glycogen, sugars, amino acids, fats. The TCA cycle. Synthesis of carbohydrates and fats. The glyoxylate cycle. Photosynthesis. Urea cycle.~~

1.21~~Structure and properties of biological membranes. Membrane potentials and ion channels. Membrane transport; biological pumps. Bioenergetics; electron transfer, oxidative and photophosphorylation.~~

(2) ~~*Biological Chemistry*~~ *Mechanistic Biochemistry*

1.22~~Chemical constraints on biology. Energy transformations. Biological polymers. Polysaccharides: amylose and cellulose. Membranes. Lipid and protein components of membranes.~~ Basic organic chemistry; chemistry of enzymatic reactions; biological chemistry of the elements.

1.23~~Structure and properties of proteins: amino acids, peptide bonds, conformational preferences, *α*-helices, *β*-sheets, stabilisation by non-covalent interactions; protein sequences and amino acid modification; glycoproteins.~~

1.24~~Tertiary structure and protein folding. Structural proteins. Myoglobin and haemoglobin.~~

1.25~~Principles of enzyme catalysis - acid-base and nucleophilic catalysis. Proteases and other enzymes.~~

1.26~~Organic chemistry of enzyme reactions, particularly those in glycolysis.~~

1.27~~Biological aspects of sulphur, iron, and phosphorus chemistry.~~

1.28~~Organic chemistry of sugars and other heterocyclic compounds.~~

~~1.29Structure and properties of nucleic acids; ribose and deoxyribose, keto-enol tautomerism and H-bonding in purines and pyrimidines, phosphate as linking group; nucleotides; polymeric chains of nucleotides; differences in stability between RNA and DNA; the double helix; DNA damage and mutation.~~

~~1.30Techniques in molecular biology: purification of DNA and proteins. Electrophoresis. DNA sequencing, cloning, blotting.~~

(3) ~~*Biophysical Chemistry*~~ *Molecular Biochemistry*

1.31~~Principles of Newtonian mechanics and electrostatics. Quantum theory: concepts of quantum mechanics in terms of energy levels. Boltzmann distribution. Atomic and molecular structure, atomic orbitals: crystal field theory; LCAO approach to molecular orbitals.~~ DNA and RNA; genotype and phenotype; proteins; membrane structure and function.

~~1.32Electromagnetic radiation and its interaction with matter. Light absorption. Spectroscopy, Beer's Law. Diffraction; Bragg's Law. X-ray diffraction by crystals. Modern optical microscopy. Electron microscopy.~~

~~1.33Thermodynamics of solutions: introduction to First and Second Laws. Gibbs function, chemical potential and electrochemical potential. Osmotic equilibria; chemical equilibria; redox equilibria. Buffer solutions and pH. Non-ideal solutions: activity co-efficients. Debye-Huckel theory. Solubility of proteins and other compounds.~~

~~1.34Kinetics: order and molecularity; first, second, and pseudo-first order kinetics, steady state. Half lives. Theories of reaction rates; collision theory, transition state theory. Activation energy and the Arrhenius equation. Isotope effects, acid-base catalysis. Radioactive decay as a first order process. Biological effects of radiation. Enzyme kinetics, Michaelis-Menten equation and the steady state derivation. Irreversible and reversible inhibitors of enzymes. Classification of reversible inhibitors. Allostery.~~

~~1.35Non-covalent interactions. Electrostatic forces and dipoles. Electronegativity. Lennard-Jones potential and van der Waal's radii. Hydrogen bonding in proteins, DNA and oligosaccharides. The hydrophobic effect; role of entropy. Accessible surface area and solubility. Protein folding – thermodynamic and kinetic aspects. Co-operativity of folding. Protein denaturation and misfolding.~~

(4) ~~*Organic Chemistry*~~ *Physical Biochemistry*

1.36~~Structure: Elementary atomic and molecular orbital theory. Bonding and molecular geometry. Methods for structure determination (e.g. spectroscopy, mass spectrometry, nmr). Stereochemistry: Absolute configuration. Cis-trans and other isomerisations.~~ Thermodynamics; chemical and enzyme kinetics; atomic, molecular and macromolecular structure and bonding; electromagnetic radiation and its interaction with matter.

[1.37]~~Reactivity: Electronegativity; inductive, mesomeric and stereoelectronic effects. Lowry-Bronsted acidity and basicity of organic compounds. Nucleophilicity and electrophilicity. Simple molecular orbital theory as unifying concept.~~

[1.38]~~Mechanism: Classification of reactions proceeding via intermediates and transition states. Substitution, elimination and addition processes. Rate determining steps; kinetic and thermodynamic control. Carbocation, carbanion, carbene and radical intermediates.~~

[1.39]~~Functional group chemistry: Characteristic chemistry of carbonyl groups. Structure, properties and reactions of carbonyls~~.

(5) ~~*Mathematics and Statistics for Biochemists*~~ *Quantitative Biochemistry*

[1.40]An elementary treatment of the following topics will be expected:

[1.41]*Mathematics*

[1.42]~~Indices, logarithms, and exponential functions. Graphs and graphical representation of simple equations, slopes, inflexion points. Partial fractions. Basic trigonometric functions: sine and cosine functions, representation of waves. Differentiation: maxima and minima; rates of progress, use of Product and Chain rules. Partial differentiation. Integration: of powers of x including x^{-1}; by substitution, by parts and using partial fractions. Introduction to Complex numbers. Simple separable differential equations and their solution. Zeroth, first and second order processes. Permutations and combinations. Factorials and the Binomial Theorem. Binomial and Poisson distributions.~~ Graphs; logarithms; basic trigonometry; integration and differentiation; differential equations; vectors.

[1.43]*Statistics*

[1.44]~~Mean, median, and mode – measures of central tendency. Normal, unimodal, and bimodal distributions. Standard deviation, standard error, and coefficient of variance. Confidence limits. Experimental errors and biological variation. Relationships between variables – line fitting. Accuracy and precision. Experimental design. Significance testing; t-tests and non-parametric tests. Conditional probabilities and expectation.~~ Probabilities and distributions; simple parametric and non-parametric tests of statistical significance; linear regression analysis.

Explanatory Notes