**UNIVERSITY OF MUMBAI**
No. UG/ 103 of 2017-18

**CIRCULAR:-**

A reference is invited to the syllabi relating to the Bachelor of Science (B.Sc) Degree Course **vide** this office Circular No.UG/367 of 2011, dated 25th October, 2011 and the Principals of the affiliated Colleges in Science, are hereby informed that the recommendation made by Board of Studies in Biochemistry at its meeting held on 3rd December, 2016 has been accepted by the Academic Council at its meeting held on 11th May, 2017 **vide** item 4.186 and that in accordance therewith, the revised syllabus as per the (CBCS) for the F.Y.B.Sc. (Biochemistry) Part- I (Sem-I & II) which is available on the University's website (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2017-18.

MUMBAI– 400032
27th July, 2017
To

REGISTRAR

The Principals of the affiliated Colleges in Science.

**A.C/4.186/11/05/2017**

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No. UG/ 103 -A of 2017 MUMBAI-400 032 27th July, 2017

Copy forwarded with Compliments for information to:-
1)The Co-ordinator, Faculty of Science,
2) The Offg. Director, Board of Examinations and Evaluation.
3) The Director, Board of Student Development.
4) The Chairperson, Ad-hoc Board of Studies in Life Science.
5) The Professor-cum-Director, Institute of Distance and Open Learning (IDOL).
6) The Co-Ordinator, University Computerization Centre.

REGISTRAR

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# UNIVERSITY OF MUMBAI

**Syllabus for the F.Y.B.Sc.**
**Program: B.Sc.**
**Course: Biochemistry**

(Credit Based Semester and Grading System
with
effect from the academic year 2017 – 2018)

## Preamble

Biochemistry is central to all areas of the “biological” and “life” science. It aims to provide an understanding of every aspect of the structure and function of living things at cellular level. Being an interdisciplinary subject it is spanning a wide range of areas from microbiology to plant and animal sciences to pathology of diseases and nutrition.

The impact of studies in biochemistry on modern life is enormous. Therefore, the syllabus is structured to touch upon broad base at the beginning. Unique physical and chemical characteristics of water enable it to function in ways essential to human and other life processes due to its structure and composition. Life on Earth began more than 3 billion years ago, evolving from the most basic of microbes into a dazzling array of complexity over time, which makes it necessary to study the origin of life and evolution of a modern species over span of years. After an in-depth understanding of how the first cells originated, students are introduced to detailed structural organization of basic unit of a living system “The Cell”. Biomolecules are the basic and important constituents of a living system. Hence, it is mandatory to study structure, occurrence and functions of large biomolecules like carbohydrates, lipids and proteins along with nucleic acids. In order to prepare the students for detailed course in Applied Nutrition in the higher education, the syllabus is made to understand human nutrition and its significance. In order to understand the biological processes occurring in the living body, processes as digestion, absorption, respiration and excretion are necessary to be studied. As stated earlier, life evolved from a small microbe, it is our aim to study living microscopic size organisms which includebacteria, fungi, protozoa and special type of microorganisms called extremophiles

## Objectives of the first year of the course

- Develop an adequate background to enable the first year students to study more advanced biochemistry topics.
- Acquaint the learners with the unique properties of the universal solvent - water, essential for life processes.
- Understand the life constituting bio molecules: proteins, carbohydrates, lipids, nucleic acids.
- Familiarize the learners about the origin of life and take them through the process of evolution.
- Focus on Cell as the basic unit of life which is the center for all biochemical processes.
- Familiarize the learners to the world of microorganisms which exist as independent cellular units.
- Develop an interest in the learner in nutrition for sustaining life, and physiology and functioning of life systems.
- Appreciate the importance of the broad spectrum of biochemistry.
- Provide familiarity with basic biochemistry laboratory techniques.
- Develop the practical skills of students to enhance their observational skills and to use these skills for problem solving.

**F. Y. B. Sc. Biochemistry Syllabus**

**Credit Based Semester and Grading System**

**To be implemented from the academic year 2017 - 2018**

**Semester I**

| Course Code | Unit | Topics | Credits | Lectures |
|---|---|---|---|---|
| **Biomolecules and Nutrition** | | | | |
| **USBCH101** | **I** | Water | **2** | 15 |
| | **II** | Amino acids and proteins | | 15 |
| | **III** | Carbohydrates | | 15 |
| **Introduction cell biology, Physiology and Microbiology** | | | | |
| **USBCH102** | **I** | Origin of life and formation of cells | **2** | 15 |
| | **II** | The cell wall, cell membrane, cell organelles and cell division | | 15 |
| | **III** | Microbiology I | | 15 |
| **USBCHP01** | | Practicals based on both courses in theory - USBCH101 and USBCH102 | **2** | 2 |

**Semester II**

| Course Code | Unit | Topics | Credits | Lectures |
|---|---|---|---|---|
| **Biomolecules and Nutrition** | | | | |
| **USBCH201** | **I** | Lipids | **2** | 15 |
| | **II** | Nucleic acids | | 15 |
| | **III** | Nutrition | | 15 |
| **Introduction cell biology, Physiology and Microbiology** | | | | |
| **USBCH202** | **I** | Physiology of digestion and absorption | **2** | 15 |
| | **II** | Physiology of respiration and excretion | | 15 |
| | **III** | Microbiology II | | 15 |
| **USBCHP02** | | Practicals based on both courses in theory - USBCH201 and USBCH202 | **2** | 2 |

# F.Y.B.Sc. Biochemistry Syllabus
## Restructured for Credit Based and Grading System
## to be implemented from the Academic year 2017 - 2018
## Semester I
## USBCH101 - Bio molecules and Nutrition

| Course Code | Title | Credits |
|---|---|---|
| **USBCH101** | **Biomolecules and Nutrition** | **2 Credits (45 lectures)** |

**Unit I: Water** — **15 Lectures**

**1.1** ***Water*****:** Its effect on Biomolecules, hydrogen bonding and structure, properties (surface tension, latent heat, specific heat, viscosity, dilectric constant, colligative properties) of water and their biological significance, water as a universal solvent.

1.1.1 Entropy and dissolution of solute
1.1.2 Effect of non polar compounds on the structure of water
1.1.3 Weak interactions of biomolecules in aqueous solutions

**1.2** ***Solutions***

1.2.1 Concepts of mole, molar, molar equivalent and normal, Dalton

**1.3** ***Ionization of water, weak acids and weak bases***

1.3.1 pH: pH scale, $H^+$ and $OH^-$ concentrations
1.3.2 Weak acids and bases and their dissociation constants Ka & Kb
1.3.3 Buffers - definition, action, physiological buffers - phosphate and carbonate (No derivations. Only simple problems on solutions)

**Unit II: Amino acids and proteins** — **15 Lectures**

**2.1** ***Amino acids***

2.1.1 Amino acid structure - D & L forms of all 20 amino acids
2.1.2 Detailed classification based on polarity, essential and non essential amino acid
2.1.3 Physical properties: zwitter ions, pI of amino acids amino acids as ampholytes, melting point, optical rotation, UV absorption and chemical properties: Chemical reactions of amino acids with Ninhydrin, Sanger's reagent, Edman's reagent and Dansyl chloride

**2.2** ***Peptides and Proteins***

2.2.1. ASBC - APS classification on the basis of shape and function
2.2.2 Primary structure - Formation and characterization of the peptide bond
2.2.3 Secondary structure - Alpha helix and beta sheet
2.2.4 Tertiary( myoglobin) and Quaternary( hemoglobin)structures - an introduction
2.2.5 Protein denaturation

**Unit III: Carbohydrates.** — **15 Lectures**

**3.1** Definition, Classification, and functions of carbohydrates (mono, oligo polysaccharides)

**3.2** ***Monosaccharides***

3.2.1 Classification in terms of aldoses and ketoses
3.2.2 Occurrence,structures and significance of glucose, fructose, galactose, mannose, and ribose
3.2.3 Properties:
- a) Physical - isomerism D & L, optical; epimers : anomers
- b) Chemical reactions -
  - i) oxidation to produce aldonic. aldaric and uronic acids (with respect to glucose);
  - ii) reducing action in boiling alkali, enediol formation (with respect to glucose and fructose)
  - iii) Osazone formation (with respect to glucose and fructose).
  - iv) Orcinol (with respect to ribose)

| | |
|---|---|
| **3.3 *Disaccharides***<br>3.3.1 Occurrence and structure of maltose , lactose and sucrose<br>3.3.2 Formation of glycosidic bonds<br><br>**3.4 *Polysaccharides***<br>3.4.1 Classification based on function. storage and structure<br>a) Composition: homo & hetero. with examples<br>b) Storage : starch and glycogen - action of amylase on starch<br>c) Structural: cellulose, chitin | |

## USBCH102 - Introduction to Cell biology, Physiology and Microbiology

| Course Code | Title | Credits |
|---|---|---|
| **USBCH102** | **Introduction to Cell biology, Physiology and Microbiology** | **2 Credits (45 lectures)** |
| **Unit I: Origin of Life & Formation of cells**<br><br>**1.1** Big bang theory, Theories on the origin of life: Abiogenesis, Heterotroph hypothesis, RNA world, protein world, Miller's experiment, Formation of the first cell, endosymbiont theory<br><br>**1.2** Evolution - Darwinian theory, Modern synthetic theory of evolution and its factors: Gene mutations( recombination), heredity, natural selection and isolation Biological evidences: Fossil record,chemical and anatomicalsimilarities of related life forms, geographic distribution of related species, genetic changes in living organisms over generations and Mechanism of evolution, Gene flow and genetic drift, Hardy-Weinberg principle | | **15 Lectures** |
| **Unit II: The cell- cell wall, cell membrane, cell organelles and cell division**<br><br>**2.1 *Structural organization of cells***<br>2.1.1 Prokaryotic, Eukaryotic (plant & animal) and yeast cells - a comparative overview<br><br>**2.2** Cell wall structure (plant), cell membrane (fluid mosaic model) Cytoskeleton: microtubules & microfilaments<br><br>**2.3 *Cell organelles*:**<br>2.3.1 Mitochondrion*:* Organization & function of the mitochondria, mitochondrial genome<br>2.3.2 Chloroplast: Structure and function of the chloroplast. the chloroplast genome, other plastids<br>2.3.3 Ribosome*: ER*: *Golgi* Structure & Function of Ribosome, ER, Golgi apparatus<br>*2.3.4* Peroxisome & Lysosome: Peroxisome function & assembly (in brief) and Lysosome structure and function<br>2.3.5 Nucleus: Structure & function of the nucleus, nuclear envelope, nuclear pores, nuclearmatrix and Nucleolus<br><br>**2.4 Mitosis and Meiosis** | | **15 Lectures** |

| | |
|---|---|
| **Unit III: Microbiology I**<br><br>**3.1** Historical background (contributions of Leeuwenhoek. Pasteur ,etc) and general characteristics (size, shape and structure) of Bacteria<br><br>**3.2** ***Microbial Taxonomy*****:** Microbial species and strains. classification of bacteria based on morphology (shape and flagella), staining reaction. nutrition and extreme environment<br><br>**3.3** ***Bacterial cell wall:*** Structure and function, components of peptidoglycan frame work (structures of NAG and NAMA not necessary)<br><br>**3.4** ***An introduction to extremophiles*****:** thermophiles, psychrophiles, halophiles, magnetotactic, radiation resistant - examples with their application<br><br>**3.5** Staining methods ( principles of staining & types or stains ) and microscopic identification of bacteria | **15 Lectures** |

# SEMESTER I - USBCHP01

**PRACTICAL – I** **45 Lectures hours**

1. Preparation & Standardisation of laboratory reagents
   Primary standards - 0.1N oxalic acid
   Secondary standards - 0.1N NaOH, 0.1N HCl

2. Preparation of buffers - acetate and phosphate

3. Determination of pKa of acetic acid

4. Qualitative tests for Carbohydrates –
   - Monosaccharides (glucose and fructose),
   - Disaccharides (lactose ,maltose and sucrose)
   - Polysaccharides (starch and dextrin)
   - unknown

5. Qualitative test for amino acids

6. Effect of heat, organic solvents and ammonium sulphate on proteins

DEMONSTRATION EXPERIMENT

pH meter – working of a pH meter

**PRACTICAL – II** **45 Lectures hours**

1. Effect of isotonic, hypertonic and hypotonic solutions on cells – onion peel
2. Staining of bacterial yeast cells (negative staining)
3. Staining techniques-
   - gram staining,
   - endospore,
   - capsule and
   - lipids
4. Permanent slides/ diagrams or electron micrograph of organelles-nucleus, mitochondria and chloroplast
5. Study of stages of mitosis using onion root tips

6. Permanent slides of mitosis and meiosis

DEMONSTRATION EXPERIMENT

1. Microscopy – study of a compound microscope

## Semester II
## USBCH201- Bio molecules and Nutrition

| Course Code | Title | Credits |
|---|---|---|
| **USBCH201** | **Biomolecules and Nutrition** | **2 Credits (45 lectures )** |

**Unit I : Lipids** — **15 Lectures**

**1.1** Definition, classification (Bloor's) and functions of Lipids

**1.2** Fatty' acids and Triacylglvcerol

1.2.1 Classification &Chemistry,
Saturated fatty acids - classification of C2 to C20: even carbon: Common and IUPAC names. Unsaturated fatty acids MUFA, PUFA (2.3.4 double bonds) Omega - 3.6.9 fatty acids. Triacyl glycerol - simple and mixed - names and structure

1.2.2 Chemical Reactions of fats
Saponification, Iodination, Ozonolysis, Auto-oxidation,
Action of heat on glycerol and choline,
Rancidity Definition & significance - Acid number, Saponification number, Iodine number, Reichert - Meissel number

**1.3** Compound Lipids
Functions of glycerophospholipids (PE.PC.PL)
Phosphosphingolipids (ceramide, sphingomyelin), Glycolipids /Cerebrosides (gluco & galactocerebrosides )

**1.4** Steroids Cholesterol structure and biochemical significance.

**Unit II : Nucleic Acids** — **15 Lectures**

**2.1** Structure - Purine & Pyrimidine bases, ribose, deoxyribose, nucleosides and nucleotides (ATP, CTP, GTP, TTP, UTP) Formation of polynucleotide strand with its shorthand Representation

**2.2** RNAs (various types in prokaryotes and eukaryotes) mRNA & rRNA - general account, tRNA - clover leaf model, Ribozymes

**2.3 DNA**

2.3.1 Physical evidence of DNA helical structure. Chargaff's rules (chemical evidence), Watson-Crick model of DNA & its features

2.3.2 Physical properties of DNA - Effect of heat on physical properties of DNA (Viscosity, buoyant density, UV absorption), Hypochromism, hyperchromism, denaturation of DNA.

2.3.3 Reactions of nucleic acids (with DPA and Orcinol)

**Unit III: Nutrition** — **15 Lectures**

**3.1** Definition: Calorie, Joule, Food calorimetry - calorific value determination by 130mb calorimeter, calorific values of proximate principles, concept of BMI, BV and PER

**3.2** BMR – definition, factors affecting BMR, Significance of BMR in clinical diagnosis

**3.3** SDA/DIT -General concept and significance, energy requirement of individuals for various activities- sedentary, moderate and heavy

**3.4** Nutritional significance of carbohydrates, Protein, lipids, vitamins, minerals and water

**3.5** Formulation of balanced diet

**3.6** Numerical problems based on above concepts

## USBCH202 - Introduction to Cell biology, Physiology and Microbiology

| Course Code | Title | Credits |
|---|---|---|
| **USBCH202** | **Introduction to Cell biology, Physiology and Microbiology** | **2 Credits (45 lectures )** |
| **Unit I: Physiology of digestion and absorption**<br><br>**1.1** Parts and Functions of gastro intestinal tract (GIT)<br><br>**1.2** Organs and Glands associated with GIT<br>Secretions and Juices of GIT (Saliva, Gastric juice, Intestinal juice, pancreatic and Bile juice)<br><br>**1.3** Digestion and Absorption of carbohydrates<br><br>**1.4** Digestion and Absorption of Lipids<br><br>**1.5** Digestion and Absorption of Proteins<br><br>**1.6** Disorders - Peptic ulcer, Lactose Intolerance | | **15 Lectures** |
| **Unit II : Physiology of respiration and excretion**<br><br>**2.1** Respiratory system,<br><br>**2.2** Breathing - inspiration and expiration,<br><br>**2.3** Composition of air and partial pressure of gases<br><br>**2.4** Physical exchange of gases<br>2.4.1 Transport of oxygen<br>2.4.2 Transport of carbon dioxide<br>Respiratory disorders – cyanosis, respiratory acidosis and alkalosis<br><br>**2.5** ***Excretion***<br>2.5.1 Structure of the nephron: Bowman's capsule & glomerulus - Structure & function, ( ultrafiltration, pressures involved, GFR, regulation of GFR); Renal tubule - structure & function (proximal and distal convoluted tubules and Henle's loop)<br>2.5.2 Urine formation: Reabsorption / Secretion of glucose, Na+, K+. HCO3 $Cl^-$ and $H^+$ : renal threshold, Excretory disorder: Nephritis | | **15 Lectures** |
| **Unit III: Microbiology II**<br><br>**3.1** Microbial Growth - Growth Curve, Mathematical expression, Synchronous growth, Generation time<br><br>**3.2** Culture media (N, C, Special requirements), Natural and Synthetic media<br><br>**3.3** Sterilization and Disinfection techniques<br><br>**3.4** Physical Agent of sterilization - Temperature- Pressure (Hot Air Oven, Autoclave), Radiations (UV, Gamma) (examples with mechanism)<br>Chemical agents of sterilization - Alcohol, Halogens, Formaldehyde | | **15 Lectures** |

## SEMESTER II – USBCHP02

**PRACTICAL - I** **45 Lecture hours**

1. Qualitative tests for lipids
   a) Miscibility test
   b) Saponification test
   c) Unsaturation test
   d) Sudan black dye test
   e) Salkowski test for cholesterol
2. Determination of SAP value of given oil sample
3. Determination of Acid value of give oil sample
4. Staining of DNA and RNA (methyl green: pyronine) using onion peel
5. Qualitative tests for DNA (DPA) & RNA (Orcinol) (Neumann's test for presence of phosphorus) -
6. Estimation of Calcium by oxalate method
7. Qualitative analysis for Proteins (albumin, peptone , gelatine and casein - any four proteins)

## SEMESTER II

**PRACTICAL – II** **45 Lecture hours**

1. Identification of organs / parts of digestive system
2. Identification of organs / parts of respiratory system
3. Identification of organs / parts of excretory system
4. Analysis of the action of salivary α - amylase action on starch
5. Concept of Dialysis: Ammonium sulphate precipitation → Dialysis (Test with $BaCl_2$ for presence of sulphate in the buffer or water outside)
6. Estimation of total acidity of gastric juice
7. Urine analysis:
   - Inorganic constituents: $SO_4^{-2}$ ($BaCl_2$), $Cl^-$ ($AgNO_3$), $Na^+$, $K^+$ (Flame test)
   - Organic constituents: Urea, Uric acid, Creatinine
   - Abnormal constituents – glucose by Benedicts method, proteins by Hellers ring test

## Scheme of Examination:

**Semester end assessment**: It is defined as the assessment of the learners on thebasis of performance in the semester end theory/ written/ practical examination.

**a) Theory** **100 marks**

Question Paper Pattern for Semesters I & II (100 marks) 3hrs

Q1) Objective questions based on all units with no internal options: 20 marks

a) Define the following (10 marks) : (Provide 5 terms to be defined, each definition will carry 2 marks)
b) True or False with reasons (10 marks): (Provide 5 statements, for each the student has to state whether it is true or false and provide reasons.)

Q2) Questions based on Unit I 20 marks

(either answer any 4 out of 8 sub-questions OR any 2 out of 4 )

Q 3) Questions based on Unit II 20 marks

(either answer any 4 out of 8 sub-questions OR any 2 out of 4 )

Q4) Questions based on Unit III 20 marks

(either answer any 4 out of 8 sub-questions OR any 2 out of 4 )

Q 5) Questions based on Units I,II,III 20 marks
(Answer 4 out of 6 sub-questions)

**b) Practicals 50 marks**

The Course having Practical training will have Practical Examination **20 marks**
for 50 marks at theend of Semester, out of which 30 marks for the Practical task assigned at the time of examination.
The 20 marks are allotted as Internal Assessment.

| Sr. No | Evaluation type | Marks |
|---|---|---|
| 1 | Two best practicals | 10 |
| 2 | Journal | 05 |
| 3 | Viva | 05 |

**Practical External Assessment** **30 marks**

## Suggested Reading


1. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

2. Becker W. M. Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland,Washington, D.C.; Sinauer Associates, MA.

4. Lehninger, Albert L, Biochemistry, Kalyani Publishers

5. Nelson, D. L. and Cox, M.M, (2008). Lehninger, Principles of Biochemistry 5th Edition, W. H. Freeman and Company, NY., USA.

6. Voet, D. and Voet, J.G. (2004) Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA.Biochemistry by Zubay, Geoffrey L.; Wm. C. Brown publishers

7. Zubay, Geoffrey L., Biochemistry; Wm.C.Brown publishers

8. Stryer, Lubert; W.H.; Biochemistry; Freeman publishers.

9. Harpers illustrated biochemistry by Murray, Robert K. etal.; Mc Graw Hill

10. Freifelder, D. (1982) Physical Biochemistry 2nd edition, W.H. Freeman and Co.NY. USA.

11. Cooper, T.G. (1977) TheTools of Biochemistry John Wiley and Sons, N.Y. USA.

12. Pattabhi. V. and Gautham N. (2002) Biophysics. Narosa Publishing House, India.

13. Roy, R.N. (2005) A Textbook of Biophysics. New Central Book Agency(P) Ltd., Calcutta, India

14. Guyton, Arthur C. and Hall, John E.;Text book of Medical physiology ; Harcourt Brace & Company Asia Pvt. Ltd.

15. Orten, J.M. and Neuhaus, O.W.; Human biochemistry; Mosby publishers.

16. Davidson, S. etal; Human nutrition and dietetics; Churchill Livingstone Publishers.

17. Joshi, Shubhangini A.; Nutrition and dietetics; Tata Mc Graw and Hill publishers.

18. Srilakshmi, B.; Nutrition Science; New Age International publishers.

19. Plummer, David T.; Introduction to practical biochemistry; Tata Mc. Graw and Hill publishers.

20. Boyer, Rodney F.Modern experimental biochemistry

21. Sawhney, S.K. and Singh, Randhir;Introductory practical biochemistry ;Narosa Publishing House.

22. Verma, P.S. and Agarwal V.K.; Cell Biology, Genetics, Molecular biology, Evolution and Ecology ; Publishers : S. Chand and Co.Ltd., (2009)

23. Essential Cell Biology Ed: Bruce Alberts, Dennis Bray, Karen Hopkin and Alexander Johnson (2009) 3rd Edition Pub: Garland Science

24. B. Hall and B. HallgrimssonStrickberger's Evolution ; 4th Edition (2008) Jones and Bartlett Publishers

25. Sean B. Carrol, Remarkable Creatures: Epic Adventures in Search of the Origin of Species (2009). Mariner Books

26. Stanier,Ingraham et al ,General Microbiology 4th & 5th Ed. 1987, Macmillan Education Ltd 6.

27. Pelczar Michael J.; Chan Jr., E.C.S. , Krieg ,Noel R.; Microbiology TMH 5th Edition .

28. Ananthanarayanan and Panniker,Textbook of Microbiology 5th Edition (1996). Orient Longman