ANNAMALAI UNIVERSITY

ANNAMALAINAGAR - 608002
(A State University Accredited with 'A' Grade by NAAC)

MYAS-AU DEPARTMENT OF SPORTS SCIENCES

DIVISION
of
EXERCISE PHYSIOLOGY AND SPORTS BIOCHEMISTRY

MASTER OF SCIENCE
IN
SPORTS BIOCHEMISTRY

REGULATIONS AND SYLLABUS

(For students to be admitted from academic year 2019-20 onwards)

UNDER CHOICE BASED CREDIT SYSTEM

M.Sc. SPORTS BIOCHEMISTRY

REGULATIONS AND SYLLABUS

(For students admitted from academic year 2019-20 onwards)

1. Objectives:

The M.Sc. Sports Biochemistry program is designed to provide an opportunity to students to apply theory to practice, which creates a highly valuable learning experience with clear vocational and professional significance. The content on M.Sc. Sports Biochemistry has been carefully designed to provide quality assured professional training to meet the needs of the athletes/sportsmen/researcher/scientist and to foster life-long learning in participants.

This programme is designed to:

- Develop knowledge and understanding of the principles and applications of biochemistry and their application to vocational/professional practice.
- Provide an opportunity to critically assess a broad range of theories, methodologies and research findings in biochemistry.
- Develop a critical understanding of how to apply theories, strategies and methodologies in appropriate ways.
- Enable the student to develop empirical rigour in identifying solutions to complex problems.
- Develop the appreciation of inter-related scientific concepts that promote understanding of problems and issues in the study of biochemistry.
- Provide a forum for the development of research skills and professional competencies in the field of sports biochemistry.

2. Definition of key words:

- **Program:** An educational program leading to the award of a Degree, diploma or certificate.
- **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
- **Semester:** Each semester consists of 15-18 weeks of academic work equivalent to 90 days of actual teaching days. The odd semester may be scheduled from July to December and even Semester from January to June.
- **CBCS (Choice Based Credit System):** It provides choice for students to select from the prescribed courses.

- **Course:** It is usually referred to as "Papers". All courses need not carry the same weight. A course may comprise lectures/tutorials/laboratory, work/field, work/outreach activities/project work/vocational training/viva/seminars etc or a combination of some of these.

- **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching or two hours of practical work.

- **Core course:** Are course that are basic to the subject of the degree. This is a course which is to be compulsorily studied by a student as a core requirement to the completion of the program.

- **Elective Courses:** This is a course that is supportive to the discipline of study, provides an expanded scope, enables exposure to some other domains or nurtures proficiency/skills. Elective papers can be of two types: Discipline Specific Elective (DSE) and Generic Elective (GE). Core / DS Electives will not be offered as Generic Electives. Elective papers can be taken from MOOC courses and credit transfer should be allowed.

- Each of the Core courses and Discipline Specific Elective (DSE) shall be of 4 credits. Credits under DSE may vary (16/12/8) depending upon the number of DSE courses offered across the semesters.

- **Discipline Specific Elective (DSE):** These courses are inter disciplinary in nature and considered similar to core course. And, the students have to choose one course from the option provided for them.

- **Generic Elective (GE):** These courses add generic proficiency to the students. Students have to choose generic elective courses in consultation with the head of the department from the Generic Elective courses offered by other Division of study in Sports Science or from other Departments in university.

3. Course Structure:

This M.Sc. Sports Biochemistry is a programme consists of core courses, soft core courses, practical courses, internship and project work. The entire programme carries credit system. The number and distribution of credits for the programme will be decided by the respective faculties. A programme is divided into two Semesters, Odd Semester and Even Semester. The normal Semester periods are:

Odd Semester: July to November (90 Working days)

Even Semester: December to April (90 Working days)

4. Credits:

The term credit is used to describe the quantum of syllabus for various courses in terms and hours of study. It indicates differential weight age given according to the contents and

duration of the courses in the curriculum design. The minimum credit requirement for a two years Master's Programme shall be 90.

One credit of theory equals one lecture hour and
One credit of practical equals two laboratory hours.

5. Courses:

Each Programme may consist of Lectures / Tutorials / Laboratory Work / Seminar / Project Work / Practical Training Report / Viva-Voce etc. Normally, in each of the programmes, credits will be assigned on the basis of the Lectures/Tutorials/Laboratory Work and other form of learning in a 18 week schedule.

6. Eligibility for Admission:

Bachelor's Degree in Sports Science / Physical Education and Sports / Biology / Biochemistry/Life science/Chemistry/Botony/Zoology or equivalent thereto in 10+2+3 or 10+2+4 pattern from a recognized university with a minimum of 50% marks in aggregate.

7. Grading System:

The term grading system indicates a 10 point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

8. Duration:

The duration for completion of two Years Master's programme in any subject is four Semesters, but in any case not more than five years from the year of admission.

9. Attendance:

Every teaching faculty handling a course shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course.

The teacher of the course must intimate the Head of the Department at least Seven Calendar Days before the last instruction day in the semester about the particulars of all students who have secured an attendance of less than 75%.

A candidate who has attendance less than 75% shall not be permitted to sit for the end–semester examination in the course in which the shortage exists.

However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons on payment of a condonation fee and such exemptions should not under any circumstances be granted for attendance below 65%.

10. Examination:

There will be two sessional assessment tests and one End–Semester examination during each semester.

Sessional Test–I will be conducted after 35 working days and Sessional Test–II will be conducted after 70 working days.

Sessional Test–I will be a combination of a variety of tools such as class test, assignment and paper presentation that would be suitable to the course. This requires an element of openness. The students are to be informed in advance about the nature of assessment and the procedures. However, the tests are compulsory. Test–I may be for one hour duration. The pattern of question paper will be decided to the respective faculty. Sessional Test–I will carry 12.5% of marks of the entire course.

Sessional Test–II will be held after 70 working days for the syllabi covered between Seventh and Eleventh weeks.

Sessional Test–II will be conducted with a variety of assessment tools. It will also have an element of openness. The students are to be informed in advance about the nature of assessment and the procedures. However, the tests are compulsory. Test–II may be for two hours duration. The pattern of question paper will be decided by the respective Faculty. Sessional Test–II carries 12.5% of marks of the entire course.

There will be one End–Semester Examination of 3 Hours' duration in each course. The end semester examination will cover all the syllabus of the course for 75% of marks.

Each course shall carry a maximum of 100 marks for the purpose of grading. The distribution of marks shall be as follows.

Theory Marks			**Practical Marks**		
Internal	**External**	**Maximum**	**Internal**	**External**	**Maximum**
25	75	100	40	60	100

11. Non-Credit Course

For the Non-Credit Courses offered in a Semester, a 'Satisfactory Participation Certificate' shall be issued to the Student from the concerned authorities, only after securing ≥ 65% attendance in such a Course. No credits, marks or Letter Grade shall be allotted for the non-credit course.

12. Internship and Field visit:

The Internship / Practical Training shall carry 100 marks and shall be evaluated through internal assessment only. At the end of Internship / Practical training / Summer Project, the candidate shall submit a certificate from the organization where he /she has undergone training and a brief report. The evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a three member Departmental Committee constituted by the Head of the Department. Certificates (issued by the training centre or Organization) submitted by the candidate shall be attached to the mark list sent by the Head of the Department.

Field visit carry 100 marks and shall be evaluated through internal assessment only. At the end of field visit students has to submit the field visit report. Similarly, like internship evaluation will be made based on this report and a Viva-Voce Examination, conducted internally

by a three member Departmental Committee constituted by the Head of the Department. Certificates (issued by the training centre or Organization) submitted by the candidate shall be attached to the mark list sent by the Head of the Department.

13. Evaluation:

Evaluation will be done on a continuous basis. Evaluation may be by Objective Type Questions, Quiz, Short Answers, Essays or a combination of these, but at the end semester it has to be a written examination.

The performance of students in each course is evaluated in terms of percentage of marks (PM) with a provision for conversion to Grade Point (GP). The sum total performance in each semester will be rated by GPA while the continuous performance from the IInd Semester onwards will be marked by (OGPA).

14. Marks and Grading:

A student cannot repeat the Sessional Assessment Test–I and Sessional Test– II. However, if for any compulsive reason the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

A minimum of 50% marks in each course is prescribed for a pass. A student has to secure 50% minimum in the End Semester Examination.

If a candidate who has not secured a minimum of 50% of marks in a course shall be deemed to have failed in that course.

The student can repeat the End Semester Examination when it is offered next in the subsequent Odd/ Even semesters till the regulations are in force. However, a candidate cannot move to the next semester if he/she has more than six papers as arrears at any point of time.

A candidate who has secured a minimum of 50 marks in all courses prescribed in the programme and earned a minimum of the credits will be considered to have passed the Master's Degree Programme.

15. Grading:

A ten point rating is used for the evaluation of the performance of the student to provide a letter grade for each course and overall grade for the Master's Programme. The letter grade assigned is given below:

Marks	Grade Point	Letter Grade	Class
90+	10	S	Exemplary
85-89	9.0	D	Distinction
80-85	8.5	D	Distinction
75-79	8.0	D	Distinction
72-74	7.5	A	First class

65-69	7.0	A	First class
60-64	6.5	A	First class
55-59	6.0	B	Second class
50-54	5.5	C	Second class
49 or less	-	F	Fail

The successful candidates are classified as follows:

I – Class 60% marks and above in over all percentage of marks (OPM).

II – Class 50–59% marks in over all percentage of marks.

Candidates who obtain 75% and above but below 91% of marks (OPM) shall be deemed to have passed the examination in First Class (Distinction) provided he/she passes all the course prescribed for the programme at the first appearance.

Candidates who obtain 90% and above (OPM) shall be deemed to have passed the examination in First Class (Exemplary) provided he/she passes the entire course prescribed for the programme at the first appearance.

For the Internal Assessment Evaluation the break up marks shall be as follows.

Test	10 marks
Assignment	05 marks
Case Study / Seminar / Short Answers etc.	05 marks
Attendance	05 marks
Total	25 Marks

Marks for Attendance Percentage

90% and above	5 Marks
80 – 89%	4 Marks
70 – 79%	3 Marks

16. Course–Wise Letter Grade:

The percentage of marks obtained by a candidate in a course will be indicated in a letter grade. A student is considered to have completed a course successfully and earned the credits if he/she secures over all grades other than F. A letter grade F in any course implies a failure in that course. A course successfully completed cannot be repeated for the purpose of improving the Grade point.

The F Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidates has appeared for clearance of the arrears.

A student secures F grade in any course which is listed as course as to repeat it compulsorily when the course is offered next. If it is an elective course, a student has the option

to repeat it when it is offered next or to choose a new elective if he / she is chosen in the place of failed elective failed optional will be indicated as dropped in the subsequent grade card.

If a student secures F Grade in the Project Work/ Field Work/Practical Work/ Dissertation, either he/she shall improve it and resubmit it if it involves only rewriting incorporating the clarification of the evaluators of he/she can re–register and carry out the same in the subsequent semesters for evaluation.

17. Withdrawal from the course by the student:

Within two weeks from the date of commencement of the semester.

M.Sc. SPORTS BIOCHEMISTRY Two-Year (4-Semester) CBCS Programme			
Basic Structure: Distribution of Courses			
1	Core (C)	13 Papers of 4 Credit each (Total Credit 13x4)	52
2	Elective (E) • Discipline Specific Elective (DSE) • Generic Elective Courses (GE) • Value Added Courses	2 Papers of 4 Credit Hrs. each = 8 4 Papers of 3 Credit Hrs. each = 12	20
3	Project Work Including Presentation, Comprehensive viva (D)	1 Activity of 6 credits (Total Credit 1x3)	06
4	Core Course Practical (P)	4 Activities of 3 credits each (Total Credit 4x2)	12
5	Core Course Internship (I)	1 Activity of 2 credits. (Total Credit 1x2)	02
6	Core Course Field Visit (FV)	1 Activity of 1 credit. (Total Credit 1x1)	01
	Total Credit		**93**

M.Sc. SPORTS BIOCHEMISTRY Two-Year (4-Semester) CBCS Programme
Programme Structure

Semester – I					
Course No.	**Course Title**	**Course Type**	**No. of Credit**		
			Theory	**Practical**	**Total**
MBSC101	Biomolecules	C – 1	4	0	4
MBSC102	Basic Anatomy and Physiology	C – 2	4	0	4
MBSC103	Biochemistry of Metabolism	C – 3	4	0	4
MBSE104	Discipline Specific Elective (DSE -Select any one)	E – 1	3	1	4
	Cardiorespiratory physiology				
	Neuromuscular physiology in sports				
	Science of Yoga				
	Fatigue, Injury and Rehabilitation				
MBSE105	Generic Elective Course	E – 2	3	0	3
MBSP106	Practical – I- Biomolecules – 1	P – 1	0	3	3
	TOTAL		**18**	**4**	**22**

Semester – II					
Course No.	**Course Title**	**Course Type**	**No. of Credit**		
			Theory	**Practical**	**Total**
MBSC201	Muscle Biochemistry	C – 4	4	0	4
MBSC202	Endocrine Biochemistry	C – 5	4	0	4
MBSC203	Nutritional Biochemistry and Exercise	C – 6	4	0	4
MBSC204	Research Methodology & Biostatistics	C – 7	4	0	4
MBSE205	Generic Elective Course	E – 3	3	0	3
MBSP206	Practical – II – Biomolecules-2	P – 2	0	3	3
	TOTAL		**19**	**3**	**22**

Semester – III					
Course No.	**Course Title**	**Course Type**	**No. of Credit**		
			Theory	**Practical**	**Total**
MBSC301	Sports Nutrition	C – 8	4	0	4
MBSC302	Biochemistry and Physical Performance	C – 9	4	0	4

MBSC303	Biochemistry in Health and Disease	C – 10	4	0	4
MBSE304	Discipline Specific Elective (DSE -Select any one)	C – 11	3	1	4
	Ergogenic aids and Doping				
	Exercise physiology and Gender				
	Physiological Aspects of Aging				
	Muscular Adaptations to exercise and training				
MBSE305	Generic Elective Course	E – 4	3	0	3
MBSP306	Practical – III Clinical Biochemistry	P – 3	0	3	3
MBSI307	Internship:	I – 1	0	2	2
	TOTAL		**18**	**6**	**24**

Semester – IV					
Course No.	**Course Title**	**Course Type**	**No. of Credit**		
			Theory	**Practical**	**Total**
MBSC401	Biochemical Techniques	C – 12	4	0	4
MBSC402	Drug Biochemistry	C – 13	4	0	4
MBSC403	Anti-doping and control	C – 14	4	0	4
MBSD404	Project Work including Presentation, Comprehensive Viva (Related to their Specialization selected)	D – 1	0	6	6
MBSE405	Generic Elective Course	E – 5	3	0	3
	Value Added Course				
MBSP406	Practical – IV Biochemical Techniques	P – 4	0	3	3
MBSV407	Field Visit	FV	0	1	1
	TOTAL		**15**	**10**	**25**

M.Sc. SPOTRS BIOCHEMISTRY

Scheme of Examination
Marks Distribution

Semester – I					
Course No.	**Course Title**		**Internal Marks**	**External Marks**	**Maximum Marks**
MBSC101	Biomolecules		25	75	100
MBSC102	Basic Anatomy and Physiology		25	75	100
MBSC103	Biochemistry of Metabolism		25	75	100
MBSE104	Discipline Specific Elective (DSE -Select any one)		25	75	100
	Cardiorespiratory physiology				
	Neuromuscular physiology in sports				
	Science of Yoga				
	Fatigue, Injury and Rehabilitation				
MBSE105	Generic Elective Course		25	75	100
MBSP106	Practical – I- Biomolecules – 1		40	60	100
	TOTAL		**165**	**435**	**600**

Semester – II					
Course No.	**Course Title**		**Internal Marks**	**External Marks**	**Maximum Marks**
MBSC201	Muscle Biochemistry		25	75	100
MBSC202	Endocrine Biochemistry		25	75	100
MBSC203	Nutritional Biochemistry and Exercise		25	75	100
MBSC204	Research Methodology & Biostatistics		25	75	100
MBSE205	Generic Elective Course		25	75	100
MBSP206	Practical – II – Biomolecules-2		40	60	100
	TOTAL		**165**	**435**	**600**

Semester – III					
Course No.	**Course Title**		**Internal Marks**	**External Marks**	**Maximum Marks**
MBSC301	Sports Nutrition		25	75	100
MBSC302	Biochemistry and Physical Performance		25	75	100
MBSC303	Biochemistry in Health and Disease		25	75	100
MBSE304	Discipline Specific Elective (DSE -Select any one)		25	75	100
	Ergogenic aids and Doping				
	Exercise physiology and Gender				
	Physiological Aspects of Aging				
	Muscular Adaptations to exercise and training				
MBSE305	Generic Elective Course		25	75	100
MBSP306	Practical – III Clinical Biochemistry		40	60	100
MBSI307	Internship:		100	---	100
	TOTAL		**265**	**435**	**700**

Semester – IV					
Course No.	**Course Title**		**Internal Marks**	**External Marks**	**Maximum Marks**
MBSC401	Biochemical Techniques		25	75	100
MBSC402	Drug Biochemistry		25	75	100
MBSC403	Anti-doping and control		25	75	100
MBSD404	Project Work including Presentation, Comprehensive Viva (Related to their Specialization selected)		40	60	100
MBSE405	Generic Elective Course		25	75	100
	Value Added Course				
MBSP406	Practical – IV Biochemical Techniques		40	60	100
MBSV407	Field Visit		100	---	100
	TOTAL		**280**	**420**	**700**

Cumulative Allotment of Marks for Semesters

Semester	Credits	Internal	External	Total
Semester I	22	165	435	600
Semester II	22	165	435	600
Semester III	24	265	435	700
Semester IV	25	280	420	700
Total	93	875	1725	2600

M.Sc. Sports Biochemistry (Semester I)

Biomolecules (MBSC101)

Program : MBSC101	Semester- I	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To acquaint students with the structure, function and interaction of basic biomolecules.

Learning Outcomes

Improved understanding of the role of different biochemicals in the overall health and wellness of an individual.

Suggested readings

1. Biochemistry,D.Voet and J.G.Voet,John Wiley & Sons.
2. General Chemistry,Linus Pauling,W.H.Freeman & Company.
3. Organic Chemistry,DJ Cram and GS Hammond,McGraw Hill.
4. Physical biochemistry,D Frefilder,W.H. Freeman & company.
5. Laboratory Techniques in Biochemistry and Molecular Biology,Work and work.
6. Tools of Biochemistry by T.G. cooper.
7. Genes VII,B.Lewin.Oxford University Press.
8. Biochemistry, Lubert Stryer, (1999)
9. Biochemistry, U. Satyanarayana, (2005)
10. Biochemistry, L. Verakumarai (2004)

Unit 1

Sugars-Classification and reactions, Polysaccharides-types, structural features, methods for compositional analysis. Amino acids and peptides- classification, chemical reactions and physical properties. Proteins-classification, heirarchy in structure, Ramachandran map. Protein sequencing, Glyco and lipoproteins-structure and function.

Unit 2

Proteins-classification, heirarchy in structure, Ramachandran map. Protein sequencing, Glyco and lipoproteins-structure and function.

Unit 3

Lipids-Classification, structure and functions, glycero phospholopids, sphignolopids, cholesterol and its biosynthesis. Polynucleotides: biosynthesis of purines and pyrimidines, de novo and salvage pathway.

Unit 4

Secondary metabolites in living systems: Alkaloids, Steroids and Flavonoids. Macromolecules and super molecular assemblies-like membranes, ribosome and chromosomes.

Unit 5

Hormones : - Definition, classification of hormones, Biological functions and disorders of pancreatic hormone (Insulin), thyroid hormone (thyroxin), pituitary hormone (GH, ADH) and Adrenal medullary hormones (adrenaline, Nor adrenaline).

M.Sc. Sports Biochemistry (Semester I)

Basic Anatomy and Physiology (MBSC102)

Program : MBSC102	Semester- I	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To acquaint students with the anatomy and physiology of human system.

Learning Outcomes

Improved understanding of the functions of different organs in the human system.

Suggested readings

Rerrot, T.V.: Anatomy for student and teacher of physical system.

Title, E.S.: Physiology.

Gupta, A. P. (2010). *Anatomy and physiology.* Agra: SumitPrakashan.

Gupta, M. and Gupta, M. C. (1980). *Body and anatomical science.* Delhi: Swaran Printing Press

Guyton, A.C. (1996). Textbook of Medical Physiology, 9th edition. Philadelphia: W.B. Saunders.

Karpovich, P. V. (n.d.). *Philosophy of muscular activity.* London: W.B. Saunders Co.

Lamb, G. S. (1982). Essentials of exercise physiology. Delhi: Surjeet Publication.

Moorthy, A. M. (2014). *Anatomy physiology and health education.* Karaikud i:
Madalayam,
Pblication.

Morehouse, L. E. & Miller, J. (1967). *Physiology of exercise.* St. Louis: The C.V. Mosby Co.

Pearce, E. C. (1962). *Anatomy and physiology Jar nurses.* London: Faber & Faber Ltd.

Sharma, R. D. (1979). *Health and physical education,* Gupta Prakashan.

Singh, S. (1979). *Anatomy of physiology and health education.* Ropar: Jeet Publications.

Unit 1

Introduction of Basic Concepts of Anatomy and Physiology.
Structure and functions of cell. Tissues and their classification. Basic introduction of body systems. Anatomical and Physiological difference in Male and Female.

Unit 2

Definition of physiology and its importance in the field of physical education and sports. Classification of Skeletal system. Types and structure of bones and joints. Different types of Movement around the joints. Structure and Classification of Muscle. Properties of Muscles. Types of Muscular contraction. Function of the Autonomic nervous system and Central nervous system. Reflex Action.

Unit 3

Constituents of blood and their function. Blood groups and clotting of blood,. The structure and properties of the heart. The Respiratory passage and exchange of gases in the lungs.

Unit 4

Mechanism of respiration (internal and external respiration). oxygen debt, second wind, vital

capacity. Structure and functions of the digestive system.

Unit 5

Effect of exercise and training on cardiovascular system. Effect of exercise and training on respiratory system. Effect of exercise and training on muscular system. Physiological concept of physical fitness, warming up, conditioning and fatigue.

M.Sc. Sports Biochemistry (Semester I)

Biochemistry of Metabolism (MBSC103)

Program : MBSC103	Semester- I	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To acquaint students with the metabolic pathway of various biomolecules in the human system.

Learning Outcomes

Improved understanding of how the catabolism and anabolism of various biomolecules happens in the biological system.

Suggested readings

1. Lehninger, Principles of Biochemistry Fourth Edition by David L.Nelson Michael M.CoxPublisher:W.H.Freeman; Fourth Edition (April23,2004)
2. E.S.West,W.RTodd,H.S Mason and T.J van Bruggen, A Text Book of Biochemistry , Oxford and IBH Publishing Co.,New Delhi,1974
3. Biochemistry[with CDrom](2004) by Donald Voet, Judith G. Voet Publisher: John Wiley &Sons Inc
4. Principles of Biochemistry (1995) by Geoffrey L Zubay, WilliamW Parson, Dennis E Vance Publisher: Mcgraw-hill Book Company-Koga
5. Principles of Biochemistry, 4/e(2006) by Robert Horton H, Laurenence A Moran, GrayScrimgeour K Publisher:Pearsarson
6. Biochemistry 6thEdiion (2007) by JeremyM.berg John L.tymoczko LubertStryer Publisher: B.I publications Pvt.Ltd
7. Biochemistry (2008) by Rastogi Publisher:Mcgraw Hill

Unit 1

Metabolism of Carbohydrates-glycolysis-reactions,-energetics and regulation(hormonal, allosteric and feed back) Gluconeogenesis-reactions and regulation.Coricycle, glyoxylate pathway, pentose phosphate pathway. Uronic acid pathway, phosphoketolase pathway. Metabolism of glycogen: Glycogen breakdown, synthesis, regulation. Citric acid cycle-reactions, enzymes amphibolic nature of the cycle, anaplerotic reactions. Regulation. Hormonal regulation of metabolism-Role of Insulin, glucagon, epinephrine.

Unit 2

Lipid Metabolism:Fatty acid oxidation- α, β, ω oxidation. Catabolism of unsaturated fatty acids, formation and utilization of ketone bodies. Fatty acid biosynthesis-regulation Synthesis and breakdown of traicylglycerols-regulation. Cholesterol biosynthesis and regulation. Cholesterol catabolism-Synthesis of bile acid. Lipoprotein metabolism-Chemical composition, biological functions and metabolic fate of VLDL,LDL and HDL. Arachidonic acid metabolism-leukotrienes and prostaglandins.

Unit 3

Metabolism of proteins and amino acids: Catabolism of proteins -regulation. Biosynthesis of urea-Conversion of aminoacids to histamine, polyamines, serotonin, epinephrine and norepinephrine γ aminobutyrate. Metabolism of purine and pyrimidine nucleotides-biosynthesis and catabolism-inter conversion - uric acid formation, regulation, Heme synthesis and degradation.

Unit 4

Laws of the thermodynamics, concept of enthalpy and entropy, Redox potential, Nernst equation. Bioenergetics: High energy molecules, Functional significance of the mitochondrial respiratory chain and oxidative phosphorylation, Electron transport chain: structural components of the chain, complexes, free elements; Structure and functional properties of cytochrome, ferro sulphurated proteins and CoQ;

Unit 5

Generation of the electrochemical proton gradient:Chemiosmosis ATP synthesis: structural and functional properties of ATP synthesis; Inhibitor agents and decoupling agents of the respiratory chain and ATP synthesis; Transport processes across the internal mitochondrial membrane. Photosynthetic electron transport and photophosphorylation-Transduction of light energy by photosystems. Carbondioxide fixation-Regulation of stromal enzymes by light.

MBSE104 (Theory)
Discipline Specific Elective (DSE)

a. Cardio-respiratory physiology in sports

b. Neuromuscular physiology in sports
c. Yoga in Sports
d. Overtraining , Fatigue and Rehabilitation in Sports

a. Cardio-respiratory physiology in sports (Theory)

Learning Objectives	Learn specific response of the cardiorespiratory system to sporting activities
Learning	They will be able to interpret the changes recorded on athletes during and after

Outcome training.

Unit 1 Detail structure of cardio-respiratory system including lymphatic system; electrical activity of heart, Exercise, Cardiovascular response to acute aerobic exercise, Cardiovascular response to acute resistance exercise, Vasomotor Regulation in Exercise, Circulatory Limits To Exercise, Adverse Circulatory Effects Of Exercise, Exercise and Hypertension

Unit 2 Cardiovascular adaptations to endurance and strength training, Hypertrophy, and Cardiomyopathy in Young and Older Athletes, cardiovascular and respiratory systems integrated action in exercise, respond to steady-state exercise, Heart rate training zone, Effects Of High Altitude. Sudden Cardiac Death and Exercise in Healthy Adults

Unit 3 Function and Structure of the Respiratory System, Mechanics of Breathing , Alveolar Ventilation, Blood Flow to the Lung, Ventilation-Perfusion Relationships, Changes in blood gasses and pH in exercise, Ventilatory response to exercise and its use in sports, Ventilatory threshold, Effects Of Exercise, response to steady- state exercise, Exercise-Induced Bronchoconstriction and Vocal Cord Dysfunction

Unit 4 Control of Breathing during execise; The Respiratory System under Stress, respiratory systems adaptation to long-term exercise, Adaptations to systematic Training, Effects Of High Altitude. The Importance of Exercise Training in Pulmonary Rehabilitation Non-respiratory Functions of the Lung , Methods for Cardiopulmonary Exercise Testing, Interpretation of Pulmonary Function Tests, Mechanisms and Measurement of Exertional Dyspnea.

a. Cardio-respiratory physiology in sports (Practical):

Learning objectives

To learn the skill required for testing cardiorespiratory functions.

Learning outcome

To be able to implement test sessions and interpret the data

1. Measurement of Heart rate variability during rest and exercise.
2. Measurement of blood pressure during rest, exercise and recovery,
3. Recording of ECG in rest and during exercise
4. Heart rate monitoring during sports activities.
5. Study of the relationship between Cardiovascular and respiratory systems through exercise testing.
6. Measurement of anaerobic threshold from multiple variables

7. Measurement of anaerobic threshold by Conconi test
8. Determination of Heart rate training zone
9. Assignment on application of heart rate in real life training

Suggested Reading

1. Roy J. Shephard and Henry S. Miller, Jr. (1999) Exercise and the Heart in Health and Disease. Marcel Dekker, Inc
2. Shephard, R.J. and Astrand, P.-0. (1992) Endurance in sport. Blackwell Science Ltd, USA
3. McArdle, W.D., Katch, F.I., Katch, V.L. (2006) Essentials of Exercise Physiology. Lippincott Williams and Wilkins, USA.
4. Victor F. Froelicher, Jonathan Myers (2006) Exercise and the heart. Elsevier Inc.
5. Christopher B. Cooper and Thomas W. Storer (2004) Exercise testing and interpretation- A practical approach. Cambridge University Press.
6. K. Wasserman, J Hansen, D Sue, W Stringer, B Whipp, eds (2004) Principles of Exercise Testing and Interpretation, 4th edn.. Lippincott Williams & Wilkins, Philadelphia, USA.
7. Christopher Bell. Cardiovascular Physiology in Exercise and Sport . 1st Edition. 2008; Churchill Livingstone
8. Martin Schwellnus. Olympic Textbook Of Medicine In Sport. 2008; Blackwell Publishing Ltd.
9. Michael G. Levitzky. Pulmonary Physiology, 8e. 2013; Lange. The McGraw-Hill Companies.
10. Denise L. Smith and Bo Fernhall (2011) Advanced cardiovascular exercise physiology. Human Kinetics.
11. Idelle M. Weisman, R. Jorge Zeballos. (2002) Clinical exercise testing. In *Chris T. Bolliger* (Ed) Progress in Respiratory Research. Vol. 32, Karger, Basel.

b. Neuromuscular physiology in sports (Theory)

Learning outcome To learn complex interaction between nervous system and muscles in relation to sporting activity.

Learning objectives The student would be able to understand the mechanism of skill development and the basis of neuromuscular coordination.

Unit 1	Muscle Fibers, , Motor Units, and Motoneurons; Muscle Heterogeneity; Orderly Motor Unit Recruitment, size of motor units and their excitability, Membrane Resistivity and Motoneuron Size, Other Factors Determining Action Potential Generation, Minimal Firing Rates and After hyperpolarization Durations, Motoneuron Current–Frequency Relationship and Excitability
Unit 2	Motor Unit Recruitment During Different Types of Movements; Measuring Human Motor Unit Recruitment; Influence of Task; Slow-Ramp Isometric Contractions; Maintained Isometric Contractions; Isometric Contractions Versus Movements; Lengthening Contractions; Stretch shortening cycle; Co-contraction of Agonists and Antagonists; Unilateral Versus Bilateral Contractions; Rhythmic Complex Contractions
Unit 3	Muscular Mechanisms in Aerobic Endurance Training; Neural Mechanisms in Aerobic Endurance Training, Muscle Molecular Mechanisms in Strength Training, Muscle Property Changes in Strength Training, Neural Mechanisms in Strength Training. initial responses of the neuromuscular systems to exercise; Training Adaptation of the Neuromuscular System
Unit 4	Muscle Biopsy Procedure and Interpretation, Metabolic Exploration of Muscle Biopsy; basic physiology and biophysics of EMG signal generation,
Unit 5	Electromyography and its use in sports; needle and wire detection techniques, detection and conditioning of the surface EMG signal, Computer aided Electromyography; Muscle involvement in different skilled movements in sports; myoelectric manifestations of muscle fatigue, its role in fibre composition analysis

b. Neuromuscular physiology in sports (Practical)

Learning objectives

To learn the skill involved in Electromyographic analysis of muscle involvement, muscle fibre composition and fatigue

Learning outcome

Would be able to support the athlete and coaches by providing EMG analysis of motor skill level, fatigue and suitability of athletes in particular sport.

1. Detection of Motor points by Transcutaneous neuromuscular electrical Stimulation
2. Recording of EMG signals and analysis
3. EMG recording and detection of muscle involvement patterns in selected sporting activity
4. Fatigue analysis through EMG
5. Detection of muscle boundaries and stiffness by palpation method.
6. Measurement of force applied during high jump, long jump.

Suggested reading

1. PAAVO V. KOMI (2011) Neuromuscular aspects of sport performance. John Wiley & Sons Ltd
2. Challa Sundaram (Ed)(2011) Muscle Biopsy. InTech, Croatia
3. Roger M. Enoka (2008) Neuromechanics of Human movement. Human Kinetics.
4. Desmedt J.E (1989) Computer Aided Electromyography and Expert Systems. Elsevier Science Limited.
5. Eleanor Criswel (2010) Introduction to Surface Electromyography. Jones and Bartlett Publishers
6. Phillip Gardiner. Advanced Neuromuscular Exercise Physiology. 2011; Human Kinetics.
7. Roberto Merletti and Philip Parker (Eds) (2004) ELECTROMYOGRAPHY- Physiology, Engineering, and Noninvasive Applications. John Wiley & Sons, Inc., Hoboken, New Jersey.
8. Florence Peterson Kendall, Elizabeth Kendall McCreary, Patricia Geise Provance, Mary McIntyre Rodgers, William Anthony Romani (2005) Muscles
9. Testing and Function, with Posture and Pain. Lippincott Williams & Wilkins.

C. Yoga in Sports (Theory)

Learning objectives	Learn basic philosophical and spiritual aspects of Yoga and how it could be applied to improve performance in sports
Learning outcome	Students will be able to apply Yoga to reduce stress in sports persons
Unit 1	General introduction to yoga and Indian philosophy History, Evolution of Yoga and Schools of Yoga, Basic Yoga Texts Philosophy, Patanjali Yoga Sutra, Shivasamhita, Gherandasamhita, Concept by Swami Vivekananda
Unit 2	Shodhana-Kriyas And Asanas, Hatha Yogic Practices : Hatha Yoga Practices Pranayama, Bandhas And Mudras Meditation.
Unit 3	Yoga and Sports : Ideal performance and Peak performance for sport persons; Enhancing Physical capacities; Integrated system of yoga practices to increase cognitive and motor skills with learning for performance improvement. Worm-up or loosening exercises; Strengthening poses; Relaxing postures; Yogic breathing practices, Yogic exercises like Suryanamaskar to development strength, flexibility and endurance power.
Unit 4	Yogic Management with respect to Health, Diseases & Hygiene; Diet & Nutrition; Therapeutic use; Preventive Health Care; Yogic Contribution for- Maintaining wellness, Healthy living, Stress management, Physical fitness management, increasing concentration of mind.

C. Yoga in Sports (Practical)

Learning objectives	Learn Yoga through Practice
Learning outcome	They will be able to formulate yoga programmes for sports persons

a. The following are to be practiced by the students

1. Loosening Exercise, Sukshma Vayama, Yogic Stretching Exercise (Suryanamaskar)
2. Satkarma / Cleansing Practices- Dhauti, Neti, Kapalabhati, Agnisara
3. Yogasana postures that involve - Standing, Sitting, lying in Supine and Prone, Inverted, , Balancing, forward bending, backward bending
4. Pranayama : Concept of correct breathing, Deep Breathing, Nadi Shodhana, Bharamari,
5. Bandha & Mudra : Concept of Bandha & Mudra, Jalandhar Bandha, Uddiyana Bandha, Mula Bandha, Viparitkarani Mudra
6. Meditation: Guided Meditation, Transcendental Meditation

b. Students will design Yoga programmes for different sports groups based on scientific knowledge.

Suggested Readings

- Bianca MacHliss and Simon Borg-Olivier. Applied Anatomy & Physiology of Yoga. 2005; Yogasynergy
- M. M. Gore. Anatomy and Physiology of Yogic Practices Understanding of the Yogic concepts and physiological mechanism of the yogic practices . 2017; New Age Books.

Learning objectives

To acquire knowledge about overloading, overtraining and related phenomenon that happens in athletes

Learning outcome

Be able to detect overtraining and staleness and support in developing better training programme

Unit 1

Concept of overloading, overtraining, fatigue and staleness; Sites of fatigue; Causes of fatigue; Energy depletion, Metabolic acidosis, Dehydration and hyperthermia, Potassium and calcium, Central fatigue and central regulation of performance, Central-Serotonergic system and central fatigue, Supra spinal factor and central fatigue,

Unit 2

Carbohydrate and central fatigue, Central Governor theory; Peripheral-Metabolite depletion, Phosphagens (ATP & PC), Blood glucose and glycogen, Metabolite accumulation, Lactic acid and H^+, ADP and Pi, Calcium flux,Na^+-K^+ ATPase, ATPase microenvironment hypothesis, Catastrophe theory of muscular fatigue;

Unit 3

Oxygen Uptake During Recovery: The So-Called "Oxygen Debt", Metabolic Dynamics of Recovery Oxygen Uptake-A.V. Hill's 1922 Oxygen Debt Theory,recovery oxygen uptake or xcess post-exercise oxygen consumption (EPOC), Implications of EPOC for Exercise and Recovery, Optimal Recovery From Steady-Rate Exercise and Non–Steady-Rate Exercise, Intermittent Exercise and Recovery

Unit 4

Definition, Types, Symptoms, Findings, Underlying Mechanisms, and Frequency of Overtraining and Overtraining Syndrome; Overtraining Syndrome; Monitoring overloading, Neuroendocrine System : Exercise Overload and Regeneration,Overtraining and the Central Nervous System.

Unit 5

The Interval Training Approach. Recovery-Active recovery, Deep water running,Heat and cold, Soft tissue massage, Nutrition, Psychology. Sports Injury- Causes,types, related to sports, recovery time.

- H. David Coulter (2001) Anatomy of Hatha Yoga. Body and Breath, Inc.,2114 Ames Hill Rd., Marlboro, VT 05344 USA
- Swami Vivekananda Rajayoga, Advaita Ashram, Culcutta, 2000 Woods, J.H. The Yoga System of Patanjali, M.L.B.D., Delhi, 1988
- BKS Iyenger(2005) The Illustrated Light on Yoga. Harper Collins Publishers.
- Burnier, Radha: Hathayoga Pradipika of Svatmarama, The Adyar Library publications, Chennai. 2000

- Burley, Mikel: Hatha Yoga, Its' Context Theory and Practice (M.L.B.D. Delhi, 2000)
- Gheranda Samhita: Shri Sadguru Publication, New Delhi.
- Dr R Nagarathna and Dr H R Nagendra: Yoga and Health, Swami Vivekananda Yoga Prakashana, 2002

d. Overtraining, Fatigue and Rehabilitation in Sports (Theory)

d. Overtraining, Fatigue and Rehabilitation in Sports (Practical)

Learning objectives	To learn methods of Monitoring of Training, Warm Up, and Performance in Athletes
Learning outcome	Be able to detect overtraining and suggest remedial measures
	1. Detection of abnormalities in ECG in relation to overtraining syndrome 2. Identification of overtraining through resting heart rate measurement 3. Identification of type of overtraining using resting HRV, HR, submaximal oxygen consumption 4. Identification of mental fatigue through questionnaire technique. (Profile of Mood State (POMS scale)) 5. Survey of presence of overtraining markers in athletes. 6. Measurement of selected enzyme activities and blood markers.
Suggested Reading	1. Shaun Phillips (2015) Fatigue in sport and exercise. Routledge, NY 2. Manfred Lehmann, Carl Foster, Uwe Gastmann, Hans Keizer and Jtirgen M. Steinacker(Eds) (1997) Overload, performance incompetence, and regeneration In sport. Kluwer Academic / Plenum Publishers, NY.

M.Sc. Sports Biochemistry (Semester I)

Practical – I- Biomolecules (MBSP106)

Program : MBSP106	Semester- I	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives
To acquaint students with the hand on training to estimate various basic biomolecules in the specimen.

Learning Outcomes
Improved understanding of how to interprete the values obtained in catabolism and anabolism of various biomolecules happens in the biological system.

Suggested readings

1. Laboratory Manual in Biochemistry – T.N. Pattambiraman- 3 rd edition
2. Laboratory Manual in Biochemistry – J. Jayaraman, New Age International Publishers
3. Practical clinical Biochemistry – Harold Varley, 4th edition

1. Reactions of sugars.
2. Reactions of amino acids.
3. Reactions of lipids.

M.Sc. Sports Biochemistry
(Semester II)

Muscle Biochemistry (MBSC201)

Program :	Semester- II	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To acquaint students with the structure, function and interaction of muscles during sport events.

Learning Outcomes

Improved understanding of the role of different muscles in the sports and exercises.

Suggested readings

1.Biochemistry Zubay,4th edition 1998 William C.Brown Publication.
2.Harper's Biochemistry,25th edition McGraw Hill.
3.Biochemistry,stryer,4th edition Freeman.
4. Principles of Biochemistry.Lehninger Nelson Cox Macmillan Worth Publishers,2000
5.Biochemistry.Davidson and Sittmann,NMSS 4th ed.Lippincott Williams and Wilkins,1999.
6.Biochemistry-Voet and Voet

Unit 1

Skeletal Muscle Structure, biochemical Characterization of the extracellular matrix, plasmalemma, transverse tubular system, Sarcoplasmic reticulum and myofibrils. Actin, myosin, tropomyosin, troponin, Z disc and H line components.

Unit 2

The sliding filament mechanism and subcellular ion movements during the contraction cycle in skeletal muscle, length tensions relationship.

Unit 3

Metabolic and functional classification of skeletal muscle fibers (types 1,2A,2B).Twitch speeds and myosin ATPase activities. Oxidative and anaerobic-metabolism. Enzyme, histochemical and immunoflurescence characterization of muscle fibers.

Unit 4

The motor unit and differentiation following cross insertion effect of aging and thyroid states. Skeletal muscles diseases. Specialized metabolism in cardiac and smooth muscle. All or none versu graded responses. Thick filament regulation.

Unit 5

Cyclic AMP and Hormonal sensitivity.Role of calmodulin,Phospholamban,Cardiac troponin 1,Slow Ca++ Channel Phosphorylation. Depolarization induced and calcium induced release from S.R.I,Calcium export from muscle cells. Role of sodium, effects of ouabain, timulation frequency and verapanil.

M.Sc. Sports Biochemistry (Semester II)

Endocrine Biochemistry (MBSC202)

Program : MBSC202	Semester- II	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To study of the diseases of the endocrine organs, disorders of hormone systems, and their target organs and disorders of the pathways of glucose and lipid metabolism.

Learning Outcomes

Know the unique properties of the Endocrine system
Know how exercise impacts the Endocrine rhythms
Know the connection between hormones and fuel use in exercise
Know the energy regulating mechanism

Suggested readings

1. W.J. Kraemer and A.D. Rogol. (2005) The endocrine system in sports and exercise. Blackwell Publishing Ltd
2.. William textbook of endocrinology- Wilson and Foster 8th edition
3. Harper's biochemistry- Murray et al, 25th edition.
4. Principles of Biochemistry- Mammalian Biochemistry- Smith-et at.
5. Mechanism of Hormone action- Austin and Short.

Unit 1

Basic Principles and Mechanisms of Endocrinology, Endocrine system and exercise- Importance of hormones in exercise and sports. The Endocrine System, Hormones, Control, Mechanism of Action, Implications on Immune Function.

Unit 2

Pituitary Hormones, hypothalamus and pituitary axis, Thyroid Hormone, Adrenal Hormones, pituitary- adrenocortical axis and stress theory. Pancreatic Hormones, Gonadal Hormones,

Unit 3

Oral contraceptive and exercise performance, menstrual cycle disturbance, testosterone action, Resistance Exercise and Testosterone, Exercise Response of Endorphin and Cortisol

Unit 4

Hormones and Exercise- Growth hormone and exercise, Catecholamines, Somatotropin, ACTH-cortisol, Testosterone, Insulin, Glucagon, Insulin like growth factor, Renin-angiotensis-aldosterone, ADH

Unit 5

Hormones and Metabolism-Regulation of Glucose Metabolism During Exercise- Regulation of Fat Metabolism During Exercise, Hormonal Effects on Fluid and Electrolyte Balance, Anabolic Androgenic Steroids. Exercise Influence on the biological clock mechanism.

M.Sc. Sports Biochemistry
(Semester II)

Nutritional Biochemistry and Exercise
(MBSC203)

Program : MBSC203	Semester – II	Credits: 4
Max Marks: 100	Internal :25	External : 75

Learning Objectives

Students get acquainted with chemistry, functions, metabolism and interrelationship between nutrients, energy balance and current trends of nutritional biochemistry and exercise.

Learning Outcomes

Students are able to understand the role of different nutrients in the overall health and wellness of an individual.

Suggested readings

References:

1. Mougios, V. (2006). Exercise biochemistry. Human Kinetics.
2. Poortmans, J.R. (2004). Principles of Exercise Biochemistry, 3rd edition, Karger Publishers.
3. MacLaren, D., & Morton, J. (2011). Biochemistry for sport and exercise metabolism. John Wiley & Sons.
4. Brody, T. (1998). Nutritional biochemistry. Academic press.
5. Tiidus, P., Tupling, A. R., & Houston, M. Biochemistry Primer for Exercise Science 4th Edition. Human Kinetics.

Unit 1

Enzyme chemistry and hormones in macronutrient metabolism and energy production

Enzymes: Structure; Composition; Nomenclature; Classification; Enzyme activity; Factors affecting enzyme activity; Role of co-enzymes; Enzyme kinetics; Enzyme inhibition; Drug and enzyme interactions; Regulation of enzyme activity; Enzymes of clinical significance.

Hormones: Chemistry; Regulatory system; Physiological function and nutrient interactions of Pituitary hormones (Growth Hormone, TSH, Vasopressin, Prolactin, Oxytocin, Corticotropic, Luteinizing Hormone, Follicle Stimulating Hormone); Thyroid and Parathyroid gland hormones (Thyroxine (T4), Triiodothyronine (T3), Calcitonin, Para Thyroid); Pancreatic Hormones (Glucagon, Insulin); Adrenal Glands (Adrenalin, Non-Adrenaline, Corticosteroids); Sex Hormones (Estrogen, Progesterone, Testosterone); Pineal gland (Melatonin).

Unit 2

General introduction on energy states and anabolism/catabolism: Phosphate energy (short) and oxidation-reduction reactions (long term) as energy sources; Role of glycolysis, gluconeogenesis, glycogenolysis, beta oxidation, Krebs cycle, HMP, ketone body formation, urea cycle and electron transport chain in energy (ATP) production; Biochemical changes during exercise performance; Biochemical characteristics of sub-cellular skeletal muscle during rest and activities.

Unit 3

Nucleic Acids and Gene Expression

Biosynthesis and Degradation of Nucleotides: Purine & Pyrimidine Metabolism; Bio Synthesis of Deoxy nucleotides.

DNA & RNA: Type; Structure; Metabolism; Transcription; Translation; Protein Biosynthesis and Turn Over.

Gene Expression**:** Basic Mechanisms; Regulation; Nutrient Gene Expressions

Unit 4

Free Radicals, Immune Response, Aging

Free Radicals: Introduction; Reactive Oxygen Species; Reactive Nitrogen Species; Oxidative Stress; Antioxidant defences (Endogenous & Exogenous).

Immune Response: Introduction; Types; Immune dysfunction; Effect of Malnutrition.

Aging: Theories; Damage to Mitochondria; Intervention in delaying aging; Genetic modules of aging, exercise and healthy aging, metabolic adaptation to exercise in aging.

Unit 5

Inter Relationship between Nutrients & Drug-nutrient interaction

Inter Relationship between Nutrients: Energy and B Vitamins; Fats and Vitamin A, D, E, K; Vitamin A and Zn; Vitamin E and Se; Fe and Protein; Vitamin C and Fe; Vitamin D and Ca, P; B-Complex and Mn, Mg, Co.

Drug Metabolism: Absorption; Metabolism; Excretion; Mechanism; Drugs as Anti Metabolites.

Interaction between Nutrient and Drug: Interaction between Food and Drugs; Nutrient and Drugs; Effect on Nutritional Status; Cytochrome P450; Mono Oxidase Inhibitors.

M.Sc. Sports Biochemistry (Semester II)

Research Methodology & Biostatistics (MBSC204)

Program : MBSC204	Semester – II	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To understand Research Methods, Processing & Presentation of Data and Analysis Techniques using software programmes.

Learning Outcomes

Enables Students to Learn Scientific Methods, Statistical Analysis Techniques Using Software Programmes and Manually.

Suggested readings

1. Kumar, S., & Phrommathed, P. (2005). Research methodology (pp. 43-50). Springer US.
2. Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
3. Neuman, W. L. (2013). Social research methods: Qualitative and quantitative approaches. Pearson education.
4. Marczyk, G., DeMatteo, D., & Festinger, D. (2005). Essentials of research design and

methodology. John Wiley & Sons Inc.
5. Runyon, R. P., Coleman, K. A., & Pittenger, D. J. (2000). Fundamentals of behavioral statistics. McGraw-Hill.
6. Thompson, B. (2006). Foundations of behavioral statistics: An insight-based approach. Guilford Press.

Unit 1

Introduction & Research Design

Research: Definition; Significance of research; Steps in Research Process. Scientific Methods; Selection & Defining a Research Problem; Problems Encountered by Researchers. Research Design: Features; Types of Research Designs; Basic Principles of Experimental Designs.

Unit 2

Presentation & Processing of Data Presentation of Data: Graphical presentation; Tabular; Chart; Diagrammatic presentation. Processing of Data: Measures of Central Tendency (Mean, Mode, and Median);

Unit 3

Measures of location (Quartiles, percentiles). Measures of Dispersion: Range; Minimum; Maximum value; Quartile deviation; Mean Deviation; Standard Deviation; Coefficient of Variation; Skewness.

Unit 4

Data Analysis

Correlation analysis: Sample Correlation Analysis; Partial Correlation Analysis. Correlation analysis: Multiple Correlation Analysis. Regression Analysis: Simple Regression Analysis; Multiple Regression Analysis.

Unit 5

Computers and Software Programmes Introduction, designing graphs and charts. Basics of computer operating systems; Spreadsheets. Software Programmes in Biomedical Statistics

M.Sc. Sports Biochemistry (Semester II)

Practical – II – Biomolecules-2 (MBSP206)

Program :	Semester- I	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To acquaint students with the hand on training to estimate various basic biomolecules in the urine specimen.

Learning Outcomes

Improved understanding of how to interpret the values obtained in the experiment with various diseases happen in the biological system.

Suggested readings

1. Laboratory Manual in Biochemistry – T.N. Pattambiraman- 3 rd edition
2. Laboratory Manual in Biochemistry – J. Jayaraman, New Age International Publishers
3. Practical clinical Biochemistry – Harold Varley, 4th edition

Experiments

1. Qualitative analysis of abnormal constituents of urine
2. Determination of the titrable acidity and ammonia in urine
3. Estimation of Chloride in urine

M.Sc. Sports Biochemistry (Semester III)

Sports Nutrition (MBSC301)

Learning objectives

Understanding the basic physiology and nutrition/fuelling demands specific to a sporting event.

Learning outcome

Capable of handling and providing event-specific nutritional guidance.

Unit 1

Nutrition and Physical Performance, Nutrition for weight control, Energy Systems,Muscles, and Physical Performance. Optimal Nutrition for Athletic PerformanceEnergy Intake and Exercise

Unit 2

Fuel for training, Formula to estimate calorie needs- Carbohydrate and Exercise-High-carbohydrate diets, Carbohydrate loading. Carbohydrate intake - Before exercise, during exercise, after exercise, Dietary Fat and Exercise-

Unit 3

Major Fuel source for endurance activities, High-fat diet not needed, Recommendations Protein and Exercise- Protein recommendations,

Unit 4.

Protein sources, Protein intake after exercise, Dangers of high-protein intakeVitamins, Minerals, and Athletic Performance- B vitamins, Calcium, Iron, Copper and zinc, Hydration- Fluid schedule

Unit 4.

Manu planning- Breakfast, Lunch, Dinner, Snacks, Meal timing & spacing, Training diets, Pre-exercise Meals, Nutrition during Exercise, Post-exercise Meals, Nutrition Needs of Youth in Sports-Priority on growth and development. Nutrition Supplements and Ergogenic Aids, Doping.

M.Sc. Sports Biochemistry (Semester III)

Biochemistry and Physical Performance (MBSC302)

Program : MBSC302	Semester – III	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To understand changes in the biomolecules during physical performance.

Learning Outcomes

Enables Students to learn the all biochemical parameters and changes occurring during performance in a specific sports.

Suggested readings

The Biochemical Basis of Sports Performance, Ronald J. Maughan and Michael Gleeson Second Edition.

Unit 1

Introduction: The biochemical basis of exercise and sport. Historical perspective. Evolution of records. The appliance of science.

The Weight-lifter muscle structure and function. Proteins: structural and functional characteristics. Proteins as enzymes. Energy for muscle contraction The Sprinter Anaerobic metabolism.

Unit 2

Metabolic response to very high intensity exercise. Loss of adenine nucleotides.

The cellular energy charge and the adenylate pool. Causes of fatigue in sprinting.

Post-exercise recovery: the resynthesis of phosphocreatine.

Middle Distance Events Energy and oxygen cost of middle distance running. Glycolysis. The glycolytic pathway. Oxidative metabolism of carbohydrate. Fatigue mechanisms in middle distance events. Recovery after exercise.

Unit 3

The endurance athlete. Energy supply. Aerobic power. Fractional utilization of aerobic capacity. Energy metabolism. Integration and regulation of fuel use. Fatigue in prolonged exercise.

Unit 4

The Games Player Activity patterns and work rate in games play. Metabolic responses to intermittent high-intensity exercise. Fatigue in multiple sprint sports. Exercise training, immune function, and susceptibility to infection.

M.Sc. Sports Biochemistry (Semester III)

Biochemistry in Health and Disease (MBSC303)

Program : MBSC303	Semester – III	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To understand changes in the biomolecules during health and disease contions.

Learning Outcomes

Enables Students to learn the normal values of all biochemical parameters

Suggested readings

1. Notes on Clinical Biochemistry by John K. Candlish (1992) publisher: World Scientific Publishing Company
2. Clinical Biochemistry: Metabolic And Clinical Aspects by William J. Marshall, Stephan K. Bangert, Elizabeth S.M. Ed. S.M (ed) Marshall (2008) Publisher: Elsevier Science Health Science Div
3. Biochemistry by John K. Joseph (2006) Publisher: Campus Books International.
4. Basic Medical Biochemistry: A Clinical Approach by Dawn B PH.D. Marks, Allam D. Marks colleen M. Smith (1996) Publisher; Lippincott Williams & Wilkins; illustrated edition.
5. Clinical Chemistry, 6/e Ie by William J Marshall, Stephen K Bangert(2008) Publisher: Else.
6. Tictz fundamental of clinical Chemistry, 6/e by Carl A Burits, Edward R Ashwood (2008) publisher: Else.

Unit 1

Automation in the clinical biochemistry: Precision, reliability, reproducibility and other factors in quality control. Normal values in health and diseases, radio isotopes in diagnosis; Specimen collection and processing (blood, urine and feaces); Storage of specimens; Quality control; Pre-analytical, analytical post analytical variables in quality analysis.

Unit 2

Kidney, liver and gastric function tests-Renal function tests,osmolarity and free water clearances, acute and chronic renal failure,Liver function tests : clinical features and test based on excretory functions, metabolic capacity of liver, synthetic functions of liver, serum enzymes.Gastric function tests: collection of gastric contents, examination of gastric residium, FTM, stimulation tests, tubeless gastric analysis.

Unit 3

Disorders of metabolism : Carbohydrate metabolism: Diabetes mellitus, insulin receptors and C-peptide, assay of insulin, proinsulin and insulin antibodies. Hemoglobin AIC, fructosamines, insulin tolerance test, Glycogen storage diseases, galactosemia ,fructosuria, pentosuria; plasma lipids and lipoprotein abnormalities: hypercholesterolemia- lipidosis and hypolipoproteinemias, Taysachs and Niemann Picks diseases. Disorders of nucleic acid metabolism-hypo and hyperuricemia, gout; Disorders of erythrocyte metabolism- hemoglobinopathies, thalassemias and anemias.

Unit 4

Inherited disorders of metabolism: Newborn screening: PKU, tyrosinemia, aminoacidurias,

organic acidurias, porphyrias. Biochemical monitoring of therapy; prenatal diagnosis of inborn errors of metabolism, amniotic fluid and fetal blood examination; Acetylcholinesterase and other tests on amniotic fluid; chromosomal abnormalities by cytogenetics.

Unit 5

Molecular diagnosis of genetic defects: Diagnosis of genetic diseases by molecular biology techniques (cystic fibrosis, Hemachromatosis, thalassemias, sickle cell diseases) DNA probes; restriction fragment length polymorphism (RFLP); polymerase chain reaction (PCR); amplification of mRNA. AIDS, Clinical diagnosis. Oncogenic enzymology: acid phosphatase, alkaline phosphatase, lactate dehydrogenase. Body fluid constituents of use in oncology

M.Sc. Sports Biochemistry (Semester III)
MBSE304 (Theory)
Discipline Specific Elective (DSE)

1. Ergogenic aids and Doping
2. Exercise physiology and Gender
3. Physiological Aspects of Aging
4. Adaptations to exercise and training

a. Ergogenic aids and Doping (Theory)

Learning Objectives

To learn the effects of ergogenic aids and nutritional supplements, effect of doping and doping control procedures

Learning Outcome

The students would be able to work in dope control teams

Unit 1

Ergogenic Aids Mechanical Aids; Nutritional Aids- Carbo-Loading, Fluids;Creatine, Carnitine, Amino Acids, Dietary Supplements; Antioxidants;Physiological Aids- Bicarbonate Loading, Altitude Training

Unit 2

History of Doping and Doping Control, the fundamental rights of athletesIn doping trials

Unit 3

the world anti-doping agency: transnational doping policy and globalisation; drugtesting in amateur sports, the prohibited list, substances & methods prohibited at alltimes, prohibited methods, substances & methods prohibited in-competition,substances prohibited in particular sports

Unit 4

Caffeine, Psychological Pharmacological Aids. Doping in sports, Drugs In Sports-Human Growth Hormone, Anabolic Steroids, Hormones and Related Substances,Beta-2 Agonists, Agents with Anti-Oestrogenic Activity, Diuretics and Other Masking Agents,Stimulants,Narcotic Analgesics,Cannabinoids,Glucocorticosteroids,

Unit 4

Blood Doping, Erythropoietin, Enhancement of Oxygen Transfer, Chemical and Physical Manipulation, Gene Doping; Doping Control, Anti-Doping Rules, WADA and IADA, regulation, IOC regulation, Ethical issues, Testing and Sample Analysis, In-Competition Testing, Out-of-Competition Testing.

Ergogenic aids and Doping (Practical)

Learning objectives	To learn the skills of detection of substances in urine or blood samples
Learning outcome	They will be employable in dope control laboratories.
	Determination of the effects of Creatine, Carnitine on sports performance. Determination of the effects of Amino Acids on sports performance. Determination of the effects of Carbohydrate and Fluids on sports performance. Determination of drugs in blood and urine samples. Collection of dope samples
Suggested Reading	1. William D. McArdle, Frank I. Katch, Victor L. Katch (2010) Exercise physiology nutrition, energy, and human performance. Lippincott Williams & Wilkins, Baltimore, USA. 2. Detlef Thieme and l Peter Hemmersbach (2004) Doping in Sports. Springer-Verlag Berlin 3. John O'Leary (Ed) (2001) DRUGS AND DOPING IN SPORT SOCIO-LEGAL PERSPECTIVES. Cavendish Publishing Limited

b. Exercise physiology and Gender (Theory)

Learning objectives	To develop knowledge about the issues of female athletes
Learning outcome	The student would be able to understand the problems of female athletes and suggest remedial measures
Unit 1	Women and the Olympic Games; Physiology of the Female Athlete; Anatomy of male and female, Body type and composition, Physiology of male and female reproductive system, The Prepubescent Female

Unit 2	Growth, Performance, Activity, and Training During Adolescence, Musculoskeletal system, Cardio-respiratory system, Aerobic capacity, Strength. Training adaptation. Nutrition and metabolism,
Unit 3	The female athlete triad, eating disorders, body weight control and training in female menstruation and other related factors,
Unit 4	Exercise and pregnancy.Menstruation and Menstrual Disorders,. Menopause, Hormone Replacement Therapy
Unit 5	The Breast and related injuries; protective clothing, Orthopaedic Concerns; Gender Verification

Exercise physiology and Gender (Practical)

Learning objectives	To learn techniques and methods of testing female athletes
Learning outcome	The student will be able to able to detect different disorders and condition of the female athlete 1. Determination of VO2max of male and female athletes (height, weight, age matched). 2. Determination of anaerobic power of male and female athletes (height, weight, age matched). 3. Determination of strength of male and female athletes (height, weight, age matched). 4. Determination of lung volumes and capacities of male and female athletes (height, weight, age matched). 5. Survey of issues related to female athletes Detection of eating disorder
Suggested Reading	1. Mona M. Shangold, Gabe Mirkin (1994) Women and exercise : physiology and sports medicine. F. A. DavisCompany 2. Barbara L. Drinkwater (Ed) (2000) Women in sport. The encyclopaedia of sports medicine; v. 8. Blackwell Science Ltd 3. Catherine M. Gordon and Meryl S. LeBoff (2015) The Female Athlete Triad A Clinical Guide. Springer New York

c. Physiological Aspects of Aging (Theory)

Learning objectives	To know the issues related to ageing starting from childhood to elderly
Learning outcome	Be able to relate growth and development with sporting performance. Will be able to work with masters athlete training process.
Unit 1	Growth and Biologic Maturation: Relevance to Athletic Performance; Muscle Development During Childhood and Adolescence, Relevance to Understanding Effects of Growth on Performance, Growth and Maturation: Methods of Monitoring; Body Composition Assessment in the Young Athlete
Unit 2	Theory of aging, Age related changes in different body systems, Cardiovascular Concerns in the Young Athlete, Physiologic and Health Aspects of Exercise in Hot and Cold Environments
Unit 3	Muscle Strength, Endurance, and Power: Trainability During Childhood, Aging and muscular strength, aging and joint flexibility
Unit 4	Exercise guideline for geriatric populations. Introduction to Masters sport and the study of older athletes, Aging, performance, and the role of continued involvement, Psychosocial issues in Masters sport, model of lifespan physical activity, health, and performance

Physiological Aspects of Aging (Practical)

Learning objectives	Learn procedures and safety system in testing athletes in different age groups.
Learning outcome	Be able to execute various tests

1. Determination of VO2max of young and older athletes (sex matched).
2. Determination of anaerobic power of young and older athletes (sex matched).
3. Determination of strength of young and older athletes (sex matched).
4. Determination of lung volumes and capacities of young and older athletes (sex matched).Statistical modelling of age trends

Suggested Reading	1. Helge Hebestreit and Oded Bar-Or (2008) The young athlete. Blackwell Publishing Ltd 2. Joseph Baker, Sean Horton and Patricia Weir (200) The masters athlete: understanding the role of exercise in optimizing aging. Routledge

M.Sc. Sports Biochemistry (Semester III)

Practical – IV Clinical Biochemistry (MBSP306)

Program : MBSP306	Semester- III	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To acquaint students with the hand on training to estimate various biochemical parameters in blood specimen.

Learning Outcomes

Improved understanding of how to interpret the values obtained in the experiment with various metabolic changes and diseases occurring in the biological system.

Suggested readings

1. Introductory Practical biochemistry, S.K sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi,
2. Standard Methods of Biochemical Analysis, S.K Thimmaiah (ed), Kalayani Publishers, Ludhiana.
3. Experimental Biochemistry: A Student companion, BeeduSasidharRao& Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi.
4. Practical Biochemistry, R.C Gupta &Bhargava (eds) CBS Publishers and distributors, New Delhi.
5. Practical Clinical Chemistry, Harold Varley, CBS Publishers and distributors, New Delhi.
6. Gradwhols Clinical Laboratory Techniques. Stanley & Raphael. W.E. company, London, UK

Experiments

1. **Liver function tests**
   Estimation of total proteins in serum
   Estimation of serum albumin by BCG method
   Estimation of albumin – globulin ratio in Serum
   Estimation of serum bilirubin
   Assay of SGOT& SGPT-DNPH method
   Assay of alkaline phosphatase-King &Amstrong method

2. **Renal Function tests**
   Estimation of blood urea by diacetyl monoxime method
   Urea clearance test
   Estimation of creatinine by Jaff ‘s method
   Creatinine clearance test
   Estimation of uric acid-caraway method
   Estimation of plasma bicarbonate
3. Glucose tolerance test
4. Fructose tolerance test
5. Analysis of normal and abnormal urine.
6. Check the reliability of various methods using Levy Jenning plot

M.Sc. Sports Biochemistry (Semester IV)

Biochemical Techniques (MBSC401)

Program : MBSC401	Semester – III	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To understand the instrumentations used to estimate the biochemical variables in health and disease conditions.

Learning Outcomes

Enables Students to learn the normal values of all biochemical parameters

Suggested readings

1. Wilson and Walker practical Biochemistry principles and Techniques. Cambridge University press 2000.
2. Physical Biochemistry: Application to biochemistry and Molecular Biology. Friefelder
3. Biophysical chemistry - Principles and Techniques. Upadhyay, Upadhyay and Nath Himalaya publications.
4. Modern Experimental Biochemistry. Boyer Ill Edition Benjamin Cummings.
5. Research methodology by P. Saravanavel 2003.
6. Immunology- 5 th edition Ivan Roitt, Jonathan Brostoff and David male
7. Immunology- 3 rd and 4th edition, Janis Kuby
8. Immunology- D.N. Weir
9. Immunology- A short course Eli Benjamine and Sidnet Leshkowi
10. Immunology- Stewart

Unit 1

Spectroscopy : Laws of absorption General principles, instrumentation and applications of UV-visible spectrophotometry, flourimetry, flame photometry and atomic absorption spectrophotometry. Brief account of NMR, ESR and mass spectrometry in biology.

Unit 2

Chromatography : Basic principles. Paper and thin layer chromatography. Gas liquid chromatography, Ion-exchange chromatography. Molecular sieve and affinity chromatography. HPLC.

Unit 3

Electrophoresis- General principles. Paper electrophoresis. Agarose gel electrophoresis. Pulsed field gel electrophoresis. Iso electric focusing. Polyacrylamide gel electrophoresis. SDS PAGE. Centrifugation- Basic principles of sedimentation. Principles and techniques of preparative centrifugation. Subcelluar fractionation. Density gradient centrifugation. Molecular weight determination. Ultra centrifugation.

Unit 4

Radioisotope techniques : Nature and units of radioactivity. Detection and measurement of radioactivity- Geiger and scintillation counters. Autoradiography. Radioimmuno assay (RIA), Applications of radioisotopes in biology.

M.Sc. Sports Biochemistry (Semester IV)

Drug Biochemistry (MBSC402)

Program :	Semester – IV	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To understand changes in the biomolecules during physical performance.

Learning Outcomes

Enables Students to learn the all biochemical parameters and changes occurring during performance in a specific sports.

Suggested readings

1. Immunology- An introduction, Tizzard R Jan, 1995.
2. Immunology- Roitt Ivann, Jonanthan Brastoff and David Male. 1993.
3. Text book of microbiology- Ananthanarayanan R and Yayaramman Paniker, 1996.
4. Immunology- Janis Kuby, 3rd edition.
5. Text book of pharmaceutical chemistry – Mohammed Ali CBS Publishers and Distributors, New Delhi, 1995
6. Pharmacology , An introduction to Drugs, Prentice Hall Inc, Eaglewood Cliif, New Jersey,1994.
7. Pharmaceutical chemistry- G.R. Chatual, Vol II, 1st editin, Himalaya Publishing House, Bombay, 1991.

Unit 1

Introduction and receptor concept; Introduction to drugs, Classification of drugs, Passage of drugs across biological membrane; Absorption and distribution of drugs; Binding of drugs to plasma proteins. Drug receptor interaction, Binding forces in drug receptor interaction, types of receptors, receptor theories, isolation of receptors, consequences of drug receptor interaction.

Unit 2

Drug metabolism and elimination; Drug metabolism, methods of studying drug metabolism-microsomal drug metabolism, metabolism via hydroxylation, conjugation, deamination, N- oxidation, azo & nitro reduction, non-microsomal oxidation, oxidative deamination, purine oxidation, dehalogenation, hydrolysis , action of choline esterase. Elimination of drugs from the body with reference to renal system.

Unit 3

Chemotherapy; mode of action of sulfonamides, anti-metabolites of folate, purines and pyrimidines. Antibacterials- mode of action and resistance to penicillin, streptomycin, tetracycline and chloramphenicaol. Anti viral, anti malarial and anti-TB drugs.

Unit 4

Drugs acting on CNS and Cardio-vascular system. CNS structure and mode of action of barbiturates, salicylates, MAO inhibitors and drugs for Parkinson's disease.

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Unit 5

Immunity to bacteria and viruses. Skin test; Montex and penicillin test. Resistant to tumors; NK cells; Tumour immune therapy; lymphoid tumours. Vaccination; passive and active immunization; ecombinant vaccines; DNA vaccines. Benefits and adverse effects of vaccination. CD4 cell count in HIV infection

M.Sc. Sports Biochemistry (Semester IV)

Anti-doping and control (MBSC403)

Program :	Semester – IV	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To understand the various types of doping used in various sports and to control the usage of dopings in sports.

Learning Outcomes

Enables Students to identify usage of various doping agents used in various sports events

Suggested readings

1.WADA Anti-Doping Textbook (www.antidopinglearninghub.org/en).

2. https://www.wada-ama.org/en/resources/athlete-biological-passport/athlete-biological-passport-abp-operating-guidelines.

3.www.wada-ama.org/en/what-we-do/science-medical/therapeutic-use-exemptions.

4.The Prohibited List (www.wada-ama.org/en/what-we-do/prohibited-list).

5.https://www.wada-ama.org/en/content/what-is-prohibited.

6. NADOs medication check.

7. https://www.wada-ama.org/en/resources/world-anti-doping-program/guidelines-blood-sample-collection.

8. Detecting Doping in Sport. Stephen Moston, Terry Engelberg

Unit 1

Doping- Definition of Doping, History of Doping and Anti-Doping. United Efforts and Creation of WADA. Athlete Biological Passport.

Therapeutic Use Exemptions (TUE). Applications. Granted TUE, Denied TUE and Appeals. Gene Doping. Performance Enhancement without Doping. Managing the risks of nutritional supplements.

Unit 2

Substances and methods on the Prohibited List. Anti-doping rule violations. Consequences of doping, including sanctions, health and social consequences. Doping Control procedures. Athletes' and Athlete Support Personnel's rights and responsibilities. Harm of doping to the spirit of sport.

Unit 3

Effects of Some Prohibited Substances- Alcohol, Anabolic androgenic steroids, Artificial oxygen carriers, Beta blockers, Beta-2 Agonists, Blood doping, Cannabinoids, Corticotrophins,

Unit 4

Diuretics, Erythropoietin (EPO), Gene doping, Glucocorticosteroids, Gonadotropins, Growth hormone and insulin-like growth factors, Insulin, Narcotics and Stimulants.

Unit 5

Guidelines - Blood Sample Collection, Urine sample collections, Sample collection personel, Breath Alcohol Testing, Implementing an Effective Testing Program. Results Management, Hearings and Decisions. Laboratory Test Reports.

M.Sc. Sports Biochemistry (Semester IV)

Practical – IV Biochemical Techniques (MBSP406)

Program :	Semester – IV	Credits: 4
Max Marks: 100	Internal :25	External :75

Learning Objectives

To gain an understanding of tools used in research, study sampling and the various statistical analysis for qualitative research and interpretation.

Learning Outcomes

Well-versed to carry out statistical analyses and to understand the concepts of scientific writing.

Suggested readings

1. Laboratory manual in biochemistry by Pattarbiraman and Acharya.
2. Practical biochemistry by J. Jayaraman.
3. Principles and Techniques of Biochemistry and Molecular Biology. Wolson and Walker, 7th Ed

Experiments

1. Separation of aminoacids and sugar by ascending paper chromatography.
2. Separation of lipid by TLC
3. Isolation of Chloroplast.
4. Isolation of DNA from animal tissue.
5. Agarose Gel Electrophoresis
6. Immunodiffusion and Radial Immuno-difussion tests
7. Antigen-Antibody reaction – Precipitation & Agglutination reaction tests
8. ELISA(Demonstration)
9. CLIA (Demonstration)
10. Automation of Biochemistry Analysis (Demonstration)
11. Automation of Heamtology Analysis (Demonstration)
12. High Performance Liquid Chromatography (Demonstration)
13. Gas Chromatography (Demonstration)
14. Polymerised Chain Reaction (PCR) (Demonstration)