

IMMUNOLOGY

Periods:60

Max. Marks:100

Unit - I

- 1.1 Overview of Immune system**
 - 1.1.1 Introduction to basic concepts in Immunology
 - 1.1.2 Innate and adaptive immunity
- 1.2 Cells and organs of Immune system**
 - 1.2.1 Cells of immune system
 - 1.2.2 Organs of immune system

Unit - II

- 2.1 Antigens**
 - 2.1.1 Basic properties of antigens
 - 2.1.2 B and T cell epitopes, haptens and adjuvants
 - 2.1.3 Factors influencing immunogenicity

Unit - III

- 3.1 Antibodies**
 - 3.1.1 Structure of antibody
 - 3.1.2 Classes and functions of antibodies
 - 3.1.3 Monoclonal antibodies

Unit - IV

- 4.1 Working of Immune system**
 - 4.1.1 Structure and functions of major histocompatibility complexes
 - 4.1.2 Exogenous and Endogenous pathways of antigen presentation and processing
 - 4.1.3 Basic properties and functions of cytokines

Unit - V

- 5.1 Immune system in health and disease**
 - 5.1.1 Classification and brief description of various types of hyper sensitivities
 - 5.1.2 Introduction to concepts of autoimmunity and immunodeficiency
- 5.2 Vaccines**
 - 5.2.1 General introduction to vaccines
 - 5.2.2 Types of vaccines

ZOOLOGY PRACTICAL SYLLABUS FOR VI SEMESTER

ZOOLOGY - ELECTIVE PAPER – VII-(A)

IMMUNOLOGY

Periods: 24

Max. Marks: 50

1. Demonstration of lymphoid organs (as per UGC guidelines)
2. Histological study of spleen, thymus and lymph nodes (through prepared slides)
3. Blood group determination
4. Demonstration of
 - a. ELISA
 - b. Immunoelectrophoresis



ZOOLOGY - ELECTIVE PAPER: VII-(B)

CELLULAR METABOLISM AND MOLECULAR BIOLOGY

Periods: 60

Max. Marks:100

Unit I: Biomolecules

- 1.1 Carbohydrates - Classification of carbohydrates. Structure of glucose
- 1.2 Proteins - Classification of proteins. General properties of amino acids
- 1.3 Lipids - Classification of lipids
- 1.4 Nucleic acids - DNA – Structure and function; RNA - Structure, types and functions

Unit II: Enzymes and Cellular Metabolism

- 2.1. Introduction to biocatalysis, Enzymes and their classification, Enzymekinetetics. Mechanism of action.Inhibition and Regulation
- 2.2 Carbohydrate Metabolism - Glycolysis, Krebs Cycle, Gluconeogenesis,
- 2.3 Glycogen metabolism, Review of electron transport chain

Unit - III : Cellular Metabolism and Cell Physiology

- 3.1 Lipid Metabolism - Biosynthesis and β oxidation of palmitic acid
- 3.2 Protein metabolism - Transamination, Deamination and Urea Cycle
- 3.3 Transport functions of plasma membrane – Active, passive and facilitated transport
- 3.4 Cell junctions – Tight junctions, desmosomes, gap junctions

Unit - V:Gene Expression

- 3.1 Gene Expression in prokaryotes (Lac Operon)
- 3.2 Gene Expression in eukaryotes.
- 3.3 Transcription and Translation.

ZOOLOGY MODEL PAPER FOR VI SEMESTER

ZOOLOGY - ELECTIVE PAPER: VII-(B)

CELLULAR METABOLISM AND MOLECULAR BIOLOGY

Periods: 24

Max. Marks: 50

1. Qualitative tests to identify functional groups of carbohydrates in given Solutions (Glucose, Fructose, Sucrose, Lactose)
2. Estimation of total protein in given solutions by Lowry's method.
3. Study of activity of salivary amylase under optimum conditions
4. Preparation of permanent slide to show the presence of Barr body in Human female blood cells or cheek cells
5. Mounting of salivary gland chromosomes of *Chironomus*

SUGGESTED READINGS

J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition .W.H. Freeman and Co.

Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IVEdition. W.H. Freeman and Co.

Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Karp, G. (2010), Cell and molecular biology : Concepts and experiments. VI edition. John Wiley and sons. Inc.

De Robertis, EDP and De Robertis EMF (2006). Cell and molecular biology. VIII edition. Lippincott Williams and Wilkins, Philadelphia Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

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ZOOLOGY SYLLABUS FOR VI SEMESTER

ZOOLOGY - ELECTIVE PAPER: VII-(C)

BIOINFORMATICS

UNIT I - HISTORY, SCOPE AND IMPORTANCE

(10 hours)

Important contributions - aims and tasks of Bioinformatics - applications of Bioinformatics - challenges and opportunities - internet basics- HTML introduction to NCBI data model- Various file formats for biological sequences

UNIT II - DATABASES - TOOLS AND THEIR USES

(15 hours)

Importance of databases - Biological databases-primary sequence databases; Composite sequence databases- Secondary databases- nucleic acid sequence databases - Protein sequence data bases - structure databases - bibliographic databases - specialized genomic resources- analysis packages

UNIT III - SEQUENCE ALIGNMENT METHODS

(15 hours)

Sequence analysis of biological data-Significance of sequence alignment pair wise sequence alignment methods- Use of scoring matrices and gap penalties in sequence alignments- multiple sequence alignment methods - Tools and application of multiple sequence alignment.

UNIT IV - PREDICTIVE METHODS USING DNA AND PROTEIN SEQUENCES

(10 hours)

Gene predictions strategies - protein prediction strategies - molecular visualization tools- phylogenetic analysis: Concept of trees- phylogenetic trees and multiple alignments.

UNIT V - DRUG DISCOVERY PROCESS

(10 hours)

Discovering a drug - target identification and validation - identifying the lead compound - optimization of lead compound - chemical libraries.

ZOOLOGY MODEL PAPER FOR VI SEMESTER**ZOOLOGY - ELECTIVE PAPER: VII-(C)****BIOINFORMATICS**

BIOINFORMATICS

Periods: 24

Max. Marks: 50

1. Introduction to Computers.
2. Hands on experience on NCBI databases
3. Sequence alignment with BLASTA and FASTA
4. Construction of Phylogenetic tree.
5. Demonstration of Protein visualization (if software available)

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ZOOLOGY SYLLABUS FOR CLUSTER ELECTIVE VIII-A: VI SEMESTER

MEDICAL DIAGNOSTICS

Cluster Elective Paper: VIII-A-1

CLINICAL BIOCHEMISTRY

Hours 60

Marks 100

UNIT – I: Basic Medical Laboratory Principles and Procedures: 10 Hours

Introduction to clinical biochemistry. Glassware. Solutions and Reagents – Normal, Molar, percent, buffer solutions and indicators. Equipments and Instruments – Centrifuges, Hot air oven, Incubator, Water bath, Photometer, Spectrophotometer, Analyzers. Quality Control.

UNIT – II: Clinical Biochemistry of Carbohydrates, Proteins & Lipids: 20 Hours

Elementary classification and metabolism of carbohydrates. Properties of carbohydrates. Regulation of blood sugar and Diabetes. Glucose Tolerance Test. Glycosylated Haemoglobin. General classification of proteins. Structure of proteins. Summary of protein digestion and aminoacid metabolism. Determination of serum proteins. General lipid metabolism. Primary and Secondary Dyslipoproteinemias.

UNIT – III: Clinical Biochemistry of Enzymes: 10 Hours

Enzymes as catalysts. Enzyme specificity. Factors which affect enzyme activity. Coenzymes and Isoenzymes. Enzymes classification and nomenclature. Enzymes in clinical diagnosis. Use of enzymes as reagents. Laboratory determinations of enzymes – Clinical significance of SGOT, SGPT, S.ALP, S.ACP, Serum Amylase.

UNIT- IV: Water & Mineral Metabolism and Acid-Base Balance: 10 Hours

Body fluid distribution. Factors which influence the distribution of body water. Mineral metabolism. Importance of the trace elements. Flame photometry. Action of buffer systems. Disturbances in acid-base balance

UNIT - V: Function Tests:**10 Hours**

Diseases of the kidneys. Creatine metabolism. Bile pigment metabolism. Disordered Bilirubin metabolism. Hepatic Jaundice and Post hepatic jaundice. Ischemic heart disease. Clinical significance of gastric analysis.

SUGGESTED READINGS

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
- Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House
- Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
- Guyton A.C. and Hall J.E. Textbook of Medical Physiology.
- Robbins and Cortan, Pathologic Basis of Disease, VIII Edition.
- Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

Cluster Elective Paper: VIII-A-2

HAEMATOLOGY

Hours 60

Marks 100

UNIT – I: Laboratory Preparation in Haematology:

10 Hours

Introduction to practical. Basic requirements. Collection of blood. Anticoagulants and effects of anticoagulants on blood cell morphology. Effects of storage of blood.

UNIT – II: Routine Haematology:

15 Hours

Composition of blood. Haemoglobin synthesis. Various haemoglobins. Haemopoietic system of the body. Blood cell counts. Erythropoiesis, Leucopoiesis and development of blood corpuscles. Thrombopoiesis. Laboratory technique of haemocytometry. Clinical significance of Total erythrocyte count, total leucocyte count, differential count, erythrocyte sedimentation rate and platelet count.

UNIT – III: Haemostasis and Haematological Diseases:

15 Hours

General consideration of blood coagulation. Mechanism of coagulation. The fibrinolytic mechanism. Clinical significance of routine coagulation tests. Anaemia. Various types of anaemias – Iron deficiency anaemia, Aplastic anaemia, Perinicious anaemia, Sideroblastic anaemia and Sickel cell anaemia. Other haematological diseases – HDNB, Thalassaemia, Leukaemia. Parasitic infections of blood – structure and life cycle of Plasmodium vivax, types of malaria, Structure and life cycle of Wuchereria bancrofti.

UNIT- IV: Automation in Haematology:

10 Hours

General considerations. Blood cell counters. Flow through cytochemical differential counter. Automated coagulated systems.

UNIT - V: Immunohaematology and Blood banking:

10 Hours

Human Blood Group Systems. Inheritance of blood group systems. Blood transfusion.

SUGGESTED READINGS

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
- Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House
- Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
- Guyton A.C. and Hall J.E. Textbook of Medical Physiology.
- Robbins and Cortan, Pathologic Basis of Disease, VIII Edition.
- Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

Cluster Elective Paper: VIII-A-3

CLINICAL MICROBIOLOGY

Hours 60

Marks 100

UNIT – I: Introduction to Clinical Microbiology:

10 Hours

Introduction to microbiology. Introduction to bacteriology. Classification of bacteria. Basic features of bacteria. Factors influencing the growth of bacteria. Morphology of bacteria. Normal bacterial flora of the body. Pathogenic microorganisms.

UNIT – II: Clinical Bacteriology Laboratory & Staining methods:

15 Hours

Requirements of a microbiological lab — safe disposal strategies. Safety practices to be followed in a microbiological laboratory. Sterilization and disinfection. Requirements in a microbiological lab. Microscopy. Automation in Bacteriology. Introduction to Staining. Gram Staining. Acid-Fast Staining. Capsule Staining. Transfer of bacteria.

UNIT – III: Culturing of Microorganisms and Identification of Bacteria:

15 Hours

Composition of culture media. Different types of culture media. Preparation of culture media. Inoculation of culture media. Culturing of anaerobes and different types of culture media used. Use, preparation and quality control of various culture media. Identification of bacteria – staining reactions, cultural characteristics and biochemical properties. Study of Gram Negative Bacteria – Bacilli and Cocci. Study of Gram Positive Bacteria – Gram positive Cocci, Anaerobic bacteria, study of genus – Bacillus and Corynebacterium. Study of Mycobacteria, Spirochetes and Rickettsia. Basic sterilization principles - autoclaving.

UNIT- IV: Clinical Mycology and Virology:

10 Hours

Basic morphological classification of clinically important fungi. Parasitic fungi – Superficial Mycoses and Dermatophytes, Subcutaneous Mycoses, Intermediate Superficial Deep Mycoses and Deep or Systemic mycoses. Classification based on symptomatology. Some important viruses and related diseases (Measles viruses, Influenza viruses, Rotaviruses, Polioviruses, Herpes viruses, Rabies viruses, Hepatitis viruses. . General transmission routes for viruses.

UNIT - V: Diagnostic Serology:**10 Hours**

General view of immune system. Antibodies. Harmful effect of immunity. Autoimmune diseases. Principles of Serodiagnostic tests - Flocculation test, Agglutination test, Slide agglutination test, Tube agglutination test, Complement test, Micro titration test, Precipitin test and ELISA.

SUGGESTED READINGS

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
- Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House
- Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
- Guyton A.C. and Hall J.E. Textbook of Medical Physiology.
- Robbins and Cortan, Pathologic Basis of Disease, VIII Edition.
- Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

**ZOOLOGY PRACTICAL SYLLABUS
CLUSTER ELECTIVE –VIII-A: VI SEMESTER**

MEDICAL DIAGNOSTICS

PRACTICAL – 1 CLINICAL BIOCHEMISTRY

- Collection of blood specimen and serum preparation.
- Blood glucose and urine glucose estimation.
- LFT, Kidney Function and Cardiac Profile tests.
- Determination of serum proteins, SGOT, SGPT, S.ALP, S.ACP
- Determination of sodium, potassium and chlorides

PRACTICAL – 2 HAEMATOLOGY & CLINICAL MICROBIOLOGY

- Routine haematological tests – Blood smear preparation, TC, DC, ESR, Platelet count.
- Determination of Haemoglobin.
- Determination of PCV.
- Determination of bleeding time.
- Determination of blood clotting time.
- Blood Grouping.
- Preparation of nutrient agar, culture plates and isolation of bacteria on nutrient agar plate.
- Study of permanent slides of *Candida albicans*, *Enterobacter sps*, *Pseudomonas*, *Salmonella sps*, *Shigella sps*, *Staphylococcus aureus*, *Streptococcus pyogenes* and *Vibrio cholera*.
- Staining methods – Albert's and Gram's staining methods.
- Hepatitis test and Pregnancy test using ELISA
- VDRL qualitative and quantitative test.
- WIDAL slide agglutination and tube agglutination test.

PRACTICAL - III:PROJECT WORK

Associated with a Clinical Diagnostic Laboratory.

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ZOOLOGY SYLLABUS FOR CLUSTER ELECTIVE –VIII-B:
VI SEMESTER

AQUACULTURE

Cluster Elective Paper: VIII-B-1

PRINCIPLES OF AQUACULTURE

Periods:60

Max.Marks:100

Unit – I

1.1 Introduction / Basics of Aquaculture

- 1.1.1 Definition, Significance and History of Aquaculture
- 1.1.2 Present status of Aquaculture – Global and National scenario
- 1.1.3 Major cultivable species for aquaculture: freshwater, brackish water and marine.
- 1.1.4 Criteria for the selection of species for culture

Unit – II

2.1 Types of Aquaculture

- 2.1.1 Freshwater, Brackishwater and Marine
- 2.1.2 Concept of Monoculture, Polyculture, Composite culture, Monosex culture and Integrated fish farming

2.2 Culture systems

- 2.2.1 Ponds, Raceways, Cages, Pens, Rafts and water recirculating systems

2.3 Culture practices

- 2.3.1 Traditional, extensive, modified extensive, semi-intensive and intensive cultures of fish and shrimp.

Unit – III

3.1 Design and construction of aquafarms

- 3.1.1 Criteria for the selection of site for freshwater and brackish water pond farms
- 3.1.2 Design and construction of fish and shrimp farms

3.2 Seed resources

- 3.2.1 Natural seed resources and Procurement of seed for stocking: Carp and shrimp

3.3 Nutrition and feeds

- 3.3.1 Nutritional requirements of a cultivable fish and shellfish
- 3.3.2 Natural food and Artificial feeds and their importance in fish and shrimp culture

Unit – IV

4.1 Management of carp culture ponds

- 4.1.1 Culture of Indian major carps: Pre-stocking management – Dewatering, drying, ploughing/desilting; Predators, weeds and algal blooms and their control, Liming and fertilization; Stocking management – Stocking density and stocking; Post-stocking management – Feeding, water quality, growth and health care; and Harvesting of ponds

4.2 Culture of giant freshwater prawn, *Macrobrachium rosenbergii*

Unit – V

5.1 Culture of shrimp (*Penaeus monodon* or *Litopenaeus vannamei*)

5.2 Culture of pearl oysters

5.3 Culture of seaweeds-species cultured, culture techniques, important by-products, prospects

5.4 Culture of ornamental fishes – Setting up and maintenance of aquarium; and breeding.

REFERENCES BOOKS

1. Bardach, JE *et al.* 1972. *Aquaculture – The farming and husbandry of freshwater and marine organisms*, John Wiley & Sons, New York.
2. Bose AN *et al.* 1991. *Coastal aquaculture Engineering*. Oxford & IBH Publ.Co.Pvt.Ltd.
3. Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Publ. House.
4. FAO. 2007. *Manual on Freshwater Prawn Farming*.
5. Huet J. 1986. *A text Book of Fish Culture*. Fishing News Books Ltd.
6. ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
7. Ivar LO. 2007. *Aquaculture Engineering*. Daya Publ. House.
8. Jhingran V.G. 2007. *Fish and Fisheries of India*. Hindustan Publ. Corporation, India.
9. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
10. Lovell RT. 1998. *Nutrition and Feeding of fishes*. Chapman & Hall.
11. Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
12. MPEDA: *Handbooks on culture of carp, shrimp, etc.*
13. New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.
14. Pillay TVR. 1990. *Aquaculture- Principles and Practices*, Fishing News Books Ltd., London.
15. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. 2nd Ed. Blackwell
16. Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
14. Stickney RR. 1979. *Principles of Warmwater Fish Culture*, John Wiley & Sons
15. Wheaton FW. 1977. *Aquacultural Engineering*. John Wiley & Sons.

Unit – I

1.1 Breeding and Hatchery Management

- 1.1.1 Bundh Breeding and Induced breeding of carp by Hypophysation; and use of synthetic hormones
- 1.1.2 Types of fish hatcheries; Hatchery management of Indian major carps
- 1.1.3 Breeding and Hatchery management of *Penaeus monodon*/ *Litopenaeus vannamei*
- 1.1.4 Breeding and Hatchery management of giant freshwater prawn.

Unit – II

2.1 Water quality Management

- 2.1.1 Water quality and soil characteristics suitable for fish and shrimp culture
- 2.1.2 Identification of oxygen depletion problems and control mechanisms in culture ponds
- 2.1.3 Aeration: Principles of aeration and Emergency aeration
- 2.1.4 Liming materials, Organic manures and Inorganic fertilizers commonly used and their implications in fish ponds

Unit – III

3.1 Feed Management

- 3.1.1 Live Foods and their role in shrimp larval nutrition.
- 3.1.2 Supplementary feeds: Principal foods in artificial diets; Types of feeds; Feed additives and Preservatives; role of probiotics.
- 3.1.3 Feed formulation and manufacturing; Feed storage
- 3.1.4 Feeding strategies: Feeding devices, feeding schedules and ration size; Feed evaluation- feed conversion efficiencies and ratios

Unit – IV

4.1 Disease Management

- 4.1.1 Principles of disease diagnosis and health management;
- 4.1.2 Prophylaxis, Hygiene and Therapy of fish diseases
- 4.1.3 Specific and non-specific defense systems in fish; Fish immunization and vaccination
- 4.1.4 Etiology, Symptoms, prophylaxis and therapy of common fish diseases in fish ponds
- 4.1.5 Etiology, Symptoms, prophylaxis and therapy of common shrimp diseases in shrimp ponds

Unit – V

5.1 Economics and Marketing

5.1.1 Principles of aquaculture economics – Capital costs, variable costs, cost-benefit analysis

5.1.2 Fish marketing methods in India; Basic concepts in demand and price analysis

5.2 Fisheries Extension

5.1.3 Fisheries Training and Education in India; Role of extension in community development.

5.3 Fish Genetics

5.1.4 Genetic improvement of fish stocks – Hybridization of fish.

5.1.5 Gynogenesis, Androgenesis, Polyploidy, Transgenic fish, Cryopreservation of gametes, Production of monosex and sterile fishes and their significance in aquaculture.

REFERENCE BOOKS

1. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University
2. Boyd, CE. 1982. *Water Quality Management for Pond Fish Culture*. Elsevier Sci. Publ. Co.
3. Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Publ. House
4. Conroy CA and Herman RL. 1968. *Text book of Fish Diseases*. TFH (Great Britain) Ltd, England.
5. Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.
6. Ian C. 1984. *Marketing in Fisheries and Aquaculture*. Fishing News Books.
7. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
8. Jhingran VG. 2007. *Fish and Fisheries of India*. Hindustan Publishing Corporation, India.
9. Jhingran VG & Pullin RSV. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.
10. Kumar D. 1996. *Aquaculture Extension Services Review: India*. FAO Fisheries Circular No. 906, Rome.
11. Lavens P & Sorgeloos P. 1996. *Manual on the Production and Use of Live Food for Aquaculture*. FAO Fisheries Tech. Paper 361, FAO.
12. MPEDA. 1993. *Handbook on Aqua Farming - Live Feed. Micro Algal Culture*. MPEDA Publication
13. New MB. 1987. *Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture*. FAO – ADCP/REP/87/26
14. Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ.
15. Pilley, TVR & Dill, WMA. 1979. *Advances in Aquaculture*. Fishing News Books, Ltd. England.
16. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell.
17. Ray GL. 2006. *Extension, Communication and Management*. 6th Ed. Kalyani Publ. Delhi.
18. Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna. 2005. *Text Book of Fish Genetics and Biotechnol.* ICAR
19. Reichenbach KH. 1965. *Fish Pathology*. TFH (Gt. Britain) Ltd, England.
20. Shang YC. 1990. *Aquaculture Economic Analysis - An Introduction*. World Aquaculture Society, USA.
21. Singh B. 2006. *Marine Biotechnology and Aquaculture Development*. Daya Publ. House
22. Stickney RR. 1979. *Principles of Warm water Aquaculture*. John-Wiley & sons Inc.
23. Swain P, Sahoo PK & Ayyappan S. 2005. *Fish and Shellfish Immunology: An Introduction*. Narendra Publ.
24. Thomas PC, Rath SC & Mohapatra KD. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publ.

Unit – I

1.1 Handling and Principles of fish Preservation

1.1.1 Handling of fresh fish, storage and transport of fresh fish, post mortem changes (rigor mortis and spoilage), spoilage in marine fish and freshwater fish.

1.1.2 Principles of preservation– cleaning, lowering of temperature, rising of temperature, denudation, use of salt, use of fish preservatives, exposure to lowradiation of gamma rays.

Unit – II

2.1 Methods of fish Preservation

2.1.1 Traditional methods - sun drying, salt curing, pickling and smoking.

2.1.2 Advanced methods – chilling or icing, refrigerated sea water, freezing, canning, Irradiation and Accelerated Freeze drying (AFD).

Unit – III

3.1 Processing and preservation of fish and fish by-products

3.1.1 Fish products – fish minced meat, fish meal, fish oil, fish liquid (ensilage), fish protein concentrate, fish chowder, fish cake, fish sauce, fish salads, fish powder, pet food from trash fish, fish manure.

3.1.2 Fish by-products – fish glue, ising glass, chitosan, pearl essence, shark fins, fish leather and fish maws.

3.2 Seaweed Products

3.2.1 Preparation of agar, algin and carrageen. Use of seaweeds as food for human consumption, in disease treatment and preparation of therapeutic drugs.

Unit – IV

4.1 Sanitation and Quality control

4.2.1 Sanitation in processing plants - Environmental hygiene and Personal hygiene in processing plants.

4.2.2 Quality Control of fish and fishery products – pre-processing control, control during processing and control after processing.

4.2 Regulatory affairs in industries

Unit – V

5.1 Quality Assurance, Management and Certification

5.1.1 Seafood Quality Assurance and Systems: Good Manufacturing Practices (GMPs); Good Laboratory Practices (GLPs); Standard Operating Procedures (SOPs); Concept of Hazard Analysis and Critical Control Points (HACCP) in seafood safety.

5.1.2 National and International standards – ISO 9000: 2000 Series of Quality Assurance System, *Codex Alimentarius*.

REFERENCE BOOKS

1. Balachandran KK. 2001. *Post-harvest Technology of Fish and Fish Products*. Daya Publ.

2. Bond, et al. 1971. *Fish Inspection and Quality Control*. Fishing News Books, England.
3. Clucas IJ. 1981. *Fish Handling, Preservation and Processing in the Tropics*. Parts I, II. FAO.
4. Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR.
5. Govindan, TK. 1985. *Fish Processing Technology*, Oxford-IBH.
6. Hall GM. (Ed). 1992. *Fish Processing Technology*. Blackie.
7. Huss HH, Jakobsen M & Liston J. 1991. *Quality Assurance in the Fish Industry*. Elsevier.
8. John DEV. 1985. *Food Safety and Toxicity*. CRC Press.
9. Krenzer R. 1971. *Fish Inspection and Quality Control*. Fishing News.
10. Larousse J & Brown BE. 1997. *Food Canning Technology*. Wiley VCH.
11. Nambudiri DD. 2006. *Technology of Fishery Products*. Fishing Chimes.
12. Regenssein JM & Regenssein CE. 1991. *Introduction to Fish Technology*. VanNostrand Reinhold.
13. Rudolf K. 1969. *Freezing and Irradiation of Fish*. Fishing News (Books).
14. Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.

AQUACULTURE

PRACTICAL: I

Periods : 24

Max.Marks : 50

Cultivable fishes

1. Identification and study of important cultivable and edible fishes - Any ten
2. Identification and study of important cultivable and edible crustaceans - Any five
3. Identification and study of common aquarium fishes – Any five
4. General description and recording biometric data of a given fish.

Diseases

1. Identification and study of fish and shrimp diseases - Using specimens / pictures
2. External examination of the diseased fish – diagnostic features and procedure.
3. Autopsy of fish – Examination of the internal organs.
4. Determination of dosages of chemicals and drugs for treating common diseases.

Pond Management

1. Water Quality -Determination of temperature, pH, salinity in the pond water sample; Estimation of dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, phosphates and nitrites.
2. Soil analysis – Determination of soil texture, pH, conductivity, available nitrogen, available phosphorus and organic carbon.
3. Identification and study of common zooplankton, aquatic insects and aquatic weeds – Each 5

PRACTICAL - II

Periods :24

Max.Marks : 50

Nutrition

1. Identification and study of Live food organisms – Any five
2. Formulation and preparation of a balanced fish feed
3. Estimation of Proximate composition of aquaculture feeds – Proteins, carbohydrates, lipids, moisture, ash content.
4. Gut content analysis to study artificial and natural food intake.

Post harvest Technology

1. Evaluation of fish/ fishery products for organoleptic, chemical and microbial quality.
2. Preparation of dried, cured and fermented fish products, examination of salt, protein, moisture in dried / cured products, examination of spoilage of dried / cured fish products, marinades, pickles, sauce.
3. Preparation of isinglass, collagen and chitosan from shrimp and crab shell. ?
4. Developing flow charts and exercises in identification of hazards – preparation of hazard analysis worksheet, plan form and corrective action procedures in processing of fish.

PRACTICAL - III

Project Work

Visit to a fish breeding centre / fish farms and submit a project report
or

Visit to a feed manufacturing unit and submit a project report

or

Visit to a shrimp hatchery / shrimp farms and submit a project report

or

Visit to a shrimp processing unit and submit a project report

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ZOOLOGY SYLLABUS FOR CLUSTER ELECTIVE: VIII-C

SERICULTURE

Cluster Elective Paper: VIII-C-1

GENERAL SERICULTURE, MULBERRY CULTIVATION AND MANAGEMENT

Hours 60

Marks 100

Unit - I : Introduction

- 1.1 Definition, history and present status of Sericulture
- 1.2 Types of silk worms and their food plants
- 1.3 Prospects of Sericulture in India - Sericulture industry in different states, employment, potential in mulberry and non mulberry Sericulture

Unit - II : Morphology of mulberry plant

- 2.1 Common varieties of mulberry used in India
- 2.2 Characters of root, stem and leaf
- 2.3 Anatomy of root, stem and leaf
- 2.4 Male and female reproductive organs, pollination, fertilization, development of seed.

Unit - III : Requirements for mulberry cultivation

- 3.1 Physical and chemical properties of soil and its nature
- 3.2 Soil moisture and water requirements
- 3.3 Climatic conditions - Temperature, photoperiod, humidity and rain fall

Unit - IV : Mulberry management

- 4.1 Land preparation - leveling and ploughing
- 4.2 Irrigation - drip, sprinkler or flood irrigation, weeding
- 4.3 Manuring - organic, inorganic and biofertilizers
- 4.4 Harvesting - leaf picking, shoot-leaf harvesting, branch cutting, leaf storage

Unit - V : Diseases and pests of mulberry

- 5.1 Fungal and bacterial diseases - Powdery mildew, red rust and leaf spot caused by fungi
Mulberry wilt caused by bacteria
Symptoms; mechanical and chemical control
- 5.2 Nematode and mycoplasma diseases - Mulberry root-knot and mulberry root rot (nematode diseases), Mycoplasma and viral mulberry disease, Symptoms; mechanical and chemical control
- 5.3 Caterpillars - Bihar hairy caterpillar, semilooper
Bugs - Leaf hoppers and scale insects
Beetles - Girdle beetle, powder pest beetle

- 1.1 Egg - External and internal morphology and colour changes
- 1.2 Larva - Mouth parts, legs, prolegs, spiracles, eyes, claspers, integumentary hair and sexual markings
- 1.3 Pupa – Male and female morphology and sexual dimorphism
- 1.4 Adult – Mouth parts, antennae, wings and external genitalia

Unit - II : Anatomy and physiology of Mulberry silk worm

- 2.1 Digestive system of larva - Structure and physiology of digestion
- 2.2 Silk glands of larva – Structure, development and mechanism of silk synthesis
- 2.3 Circulatory system of larva – Blood vessel, haemolymph and cells
- 2.4 Reproductive system of adult – Mechanism of egg development
- 2.5 Endocrine glands in larva and pupa, their secretions and hormonal control on development
- 2.6 Roll of pheromone in mating

Unit - III : Silk worm rearing house and appliances

- 3.1 Construction of ideal rearing house (CSB model)
- 3.2 Early age rearing appliances
- 3.3 Late age rearing appliances – Trays, ant wells, stands and racks, paraffin papers, rubber foam pads, nets, chopsticks and feathers
- 3.4 Mountages – Bamboo, plastic, nylon, balances (digital)

Unit - IV : Disinfection and feeding appliances and silk worm technology

- 4.1 Disinfection of ants, appliances
- 4.2 Disinfectant appliances – Sprayers and dusters
- 4.3 Feeding appliances – Leaf chamber, chopping knife, chopping board
- 4.4 Humidity and temperature measuring devices
- 4.5 Commercial races – Multivoltine, bivoltine and hybrid races
- 4.6 Seed collection, cards, loose eggs, incubation, hatching, brushing, rearing of early instars, rearing of late instars
- 4.7 Mounting and cocoon production
- 4.8 Harvesting and storage of cocoons

Unit - V : Diseases of silk worms and their management

- 5.1 Viral diseases – Nuclear polyhydrosis disease, infectious flacherie viral disease (symptoms, prevention, control and management)
- 5.2 Protozoan disease – Pebrine disease (symptoms, prevention, control and management)
- 5.3 Bacterial diseases – Septicemia, Toxicosis (symptoms, prevention, control and management)
- 5.4 Fungal diseases – Muscardine disease, aspergillosis (symptoms, prevention, control and management)
- 5.5 Pests – Tachinid fly, dermistid beetle (damage, control measures)

ZOOLOGY MODEL PAPER FORVI SEMESTER

Cluster Elective Paper: VIII-C-2

BIOLOGY OF MULBERRY SILK WORM AND SILKWORM REARING TECHNOLOGY

Cluster Elective Paper: VIII-C-3

SILK TECHNOLOGY, SILK MARKETING AND EXTENSION

Hours 60

Marks 100

Unit - I : Cocoons

- 1.1 Quality of cocoon, cocoon shell ratio, silk filament length, cocoon reelability and factors effecting reelability
- 1.2 Physical and chemical properties of fibre

- 1.3 Cocoon drying – Conventional and modern techniques
- 1.4 Cocoon sorting and preservation
- 1.5 Cocoon cooking

Unit - II : Reeling, silk throwing and weaving

- 2.1 Reeling appliances – Conventional and modern
- 2.2 Reeling operations
- 2.3 Rereeling
- 2.4 Raw silk testing and grading
- 2.5 Silk throwing and twisting
- 2.6 Silk weaving
- 2.7 Chemical processing of silk yarn and fabrics

Unit - III : Sericulture and management

- 3.1 Sericulture organisation at state and national levels – Development, research, training and policies
- 3.2 Role of national silk worm seed organisation in grainage
- 3.3 Sericulture services network – Basic seed facility, seed areas, grainages, nurseries, central research centers (CRCs), filature, silk exchanges and cocoon certification centers
- 3.4 Project formulation and role of credit co-operative and financing agencies in sericulture – NAARD, IDBI, Banks, IRDP etc.

Unit - IV: Marketing organizations, Cocoon and Yarn marketing

- 4.1 Sericulture marketing organisation for seed cocoon, raw silk and silk fabric
- 4.2 Traditional and regulated markets, their merits and limitations
- 4.3 Government intervention – Legislation and implication in marketing
- 4.4 Marketing institutions – Marketing boards, co-operatives and stabilization of price

Unit - V : Cocoon and Yarn marketing

- 5.1 Cocoon marketing – Gradation of seed and reeling cocoons, marketing of multivoltine, bivoltine and hybrid cocoons
- 5.2 Yarn marketing – Gradation of yarn, twisted and untwisted yarn
- 5.3 Feedback system – Surveys and types, merits and limitations
- 5.4 Silk export – Challenges and growth prospects

**ZOOLOGY PRACTICALSYLLABUS FOR CLUSTER ELECTIVE –VIII-C
VI SEMESTER**

SERICULTURE - PRACTICAL

PRACTICAL - I

1. Maps and records

- a. Preparation of a map showing extension of sericulture in the world
- b. Preparation of a map showing extension of sericulture in the India
- c. Graphical representation of cocoon and silk production by various silk worms in India

2. Morigulture

- a. Soil sampling and analysis of soil pH and moisture
- b. Preparation and study of sections of root, stem, and leaf of mulberry plant
- c. study of inflorescence, male and female reproductive parts

3. Mulberry diseases

- a. Collection, study and preservation of mulberry disease samples
- b. Microscopic preparation of mulberry fungi, virus, bacteria causing diseases

PRACTICAL - II

1. Morphology of egg, last instar larva, pupa, adult, sexual dimorphism, mouth parts, antennae, legs, prolegs and wings
2. Dissection of digestive system of larva, silk gland of larva and reproductive system of adult
3. Study of various appliances
4. Microscopic preparation of pebrine causative agents in larva and adult by Giemsa stain
5. Study of one each of viral, bacterial, protozoan diseases and pests

PRACTICAL - III

Project work

SUGGESTED READING

1. Text book of tropical sericulture. Publ., Japan Overseas Corporation volunteers – 1975
2. Silkworm rearing techniques in the tropics, Dr. S. Omura, Japan International Cooperation Agency – 1980
3. The natures and property of soils (9th edition) N.C. Brady (Mac Millan Pub. Co. Inc., New York)
4. Studies on soils of India, S.V. Govind Rajan and H.G. Gopala Rao (1970), Vikas Pub. House Pvt. Ltd., New Delhi
5. Manual on sericulture – Food and Agriculture Organisation, Rome – 1976
6. Handbook of practical sericulture : S.R. Ullal and M.N. Narasimhanna CSB, Bangalore – 1987
7. A guide for bivoltine sericulture – K. Sengupta, Director, CSR & TI, Mysore – 1989
8. Economics of sericulture under irrigated conditions : M.S. Jolly, CSR & TI, Mysore – 1982
9. China sericulture, 1972, FAO, Rome

10. Mulberry cultivation (Vol. I) written by Zheng Ting – Xing, Tan Yun – Fang, Huang Guang – Xian and Ma ben. Published by Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta
11. Silk egg production (Vol. III) written by Wang Sang – Ming published by Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta
12. Economics of silk industry, RC Rawlley, PS king and Sons ltd., London
13. Silk production processing and marketing – MM Nanavaty, VS Johari, Wiley Estern ltd., Ansari Road, New Delhi
14. Principles of sericulture – Hisao Aruga, Mohan Primlani for Oxford and IBH publishing co., Pvt., Ltd., New Delhi
