

UNIVERSITY OF MUMBAI



Revised Syllabus for

T.Y.B.Sc. (Zoology)

(with effective from the academic year 2004- 2005)

Revised Syllabus of T.Y.B.Sc. Zoology

Effective from the Academic Year 2004-2005

PAPER-I:

Unit 1: Animal types: Type study	30 Lectures
a) Invertebrate: Earthworm	
b) Vertebrate: Frog	
Unit 2: Comparative Chordate Anatomy	30 Lectures
Unit 3: Developmental Biology	30 Lectures
Unit 4: Histology and Endocrinology	30 Lectures

PAPER-II :

Unit 1: Physiology	30 Lectures
Unit 2: Homeostasis and Regulation	30 Lectures
Unit 3: Haematology	30 Lectures
Unit 4: Immunology	30 Lectures

PAPER-III:

Unit 1: Molecular Biology	30 Lectures
Unit 2: Biotechnology	30 Lectures
Unit 3: Genetics and Evolution	30 Lectures
Unit 4: Toxicology	30 Lectures

PAPER-IV:

Unit 1: Environmental Science	30 Lectures
Unit 2: Environmental Biology	30 Lectures
Unit 3: Epidemiology	30 Lectures
Unit 4: Biostatistics	30 Lectures

Note:

1. Theory paper I and II and Practical I and II are to be studied by the students opting for 3 units and for 6 units students all the four papers and practicals are compulsory.
2. Two short and one long excursions for habitat studies/visits to institutes of educational interest are compulsory.
3. Fieldwork of not less than eight hours duration is equivalent to one period per week for a batch of 15 students.

PAPER-I

Unit 1: Study of Animal types

(30)

1.1: Invertebrates: Earthworm (*Pheretima postilluma*)

External characters, body wall, locomotion, coelom, digestive system, blood vascular system, excretory system, nervous system, reproductive system, copulation and cocoon formation.

1.2: Vertebrates: Frog (*Rana tigrina*)

External characters, skeletal system (axial & appendicular) digestive system, circulatory system, structure of heart and course of circulation, respiratory, excretory, reproductive and nervous systems, sense organs (eye and ear).

Unit 2: Comparative Chordate Anatomy:

(30)

2.1: Digestive system:

Digestive tube and its evolution.
Primary divisions of the tube.
Tooth structure & position, teeth in lower vertebrates and mammalian dentition.

2.2: Respiratory system:

Cutaneous respiration (Frog).
Gills of cartilaginous & bony fish,
lungs, air sacs in birds.

2.3: Circulatory System:

Evolution of hearts in vertebrates,
Modifications of aortic arches In vertebrates.
Venous, portal and lymphatic Systems.

2.4. Nervous system.

Early development and differentiation of primary brain vesicles and their cavities, flexures of brain,
Evolution of cerebral hemispheres & cerebellum,
Brains of Shark, Frog (Covered in type study), Lizard, Pigeon & Rabbit.

2.5: Urinogenital System:

Ontogeny of kidney ducts. archinephros, pronephros, mesonephros, metanephros; urinary bladder in vertebrates, structure of glomerulus and uriniferous tubules.
Gonads and their ducts.

2.6: Structure of integument and its derivatives:

Structure of scales, feathers, hair, beaks, claws, nails, hoofs, horns, antlers & glands.

Unit 3: Developmental Biology:

(30)

3.1: Frog embryology:

Gametogenesis, structures of egg and sperm, fertilization, development in embryonic phase and post embryonic phase.

3.2: Chick Embryology:

3.2.1. Development up to 72 hours of age.

3.2.2. Extra embryonic membranes.

3.3: Types of placentae:

3.3.1. Classification of placentae on the basis of external morphology and histology.

3.4: Morphogenesis:

3.4.1. Differential cell affinity, cell adhesion, morphogenetic movements.

3.4.2. Development of tetrapod limb:

a) Formation of Limb Bud

[The limb fields, role of Hox genes and retinoic acid. Induction of apical ectodermal ridge]

b) Generation of proximal-distal axis of limb

[The apical ectodermal ridge: The ectodermal component, role of Hox genes]

c) Specification of the anterior-posterior limb axis.

[The zone of polarizing activity]

d) The generation of dorsal ventral axis.

Unit 4: Histology and Endocrinology:

(30)

4.1: Histology:

4.1.1. Histological structures of the following frog organs:

Liver, pancreas, T.S. of stomach, T.S. of intestine.

T.S. of testis and T.S. of ovary: .

4.1.2. Histological structures of the following mammalian organs: Liver, Kidney, Testis and Ovary.

4.2:Endocrinology:

- 4.2.1. Endocrine glands and hormones, classification of hormones and their mode of action.
- 4.2.2. Histology, hormones, functions of hormones and hormonal disorders of the following endocrine glands: Pituitary, Adrenal, Thyroid, & Pancreas.

PAPER-II

Unit 1: PHYSIOLOGY

(30)

1.1. Enzyme and enzyme kinetics:

- 1.1.1 Enzyme as biocatalyst
- 1.1.2. Concept of activation energy
- 1.1.3. Chemical structure of enzymes
- 1.1.4. Nomenclature and classification with numerical code
- 1.1.5. Brief study of oxidoreductases, transferases, hydrolases, lyases, isomerases and ligases.
- 1.1.6. Co-enzymes
- 1.1.7. Enzyme specificity
- 1.1.8. Mechanism of enzyme action
- 1.1.9. Basic principles of chemical kinetics (Derivation of Michaelis-Menten Equation).
- 1.1.10. Derivation of Lineweaver-Burk equation, plot and its significance.
- 1.1.11. Significance of V_{max}
- 1.1.12. Significance of K_m
- 1.1.13. Factors affecting/regulating enzyme activity: temperature, pH, substrate concentration.
- 1.1.14. Enzyme activation
- 1.1.15. Enzyme inhibition and its kinetics
- 1.1.16. Regulatory enzymes: Allosteric and covalently modulated enzymes
- 1.1.17. Isozymes and their significance.

1.2. Chemical messengers:

- 1.2.1. Introduction, concept and classification.
- 1.2.2. Neurotransmitters:
 - (a) Acetylcholine, catecholamine, Gama-amino butyric acid (GABA), Aspartic acid, Purines-ATP.
 - (b) Mode of working of transmitters.
- 1.2.3.. Neurosecretory substances:
 - (a) Neurosecretory substances and a brief account of neurosecretory system.
 - (b) Neurohormones of neurohypophysis
 - (c) X and Y organs of crustaceans.
- 1.2.4. Hormones:
 - (a) Hormones of adenohypophysis
 - (b) Adenohypophysis in relation to thyroid and adrenal

Unit 2: HOMEOSTASIS AND REGULATION

(30)

2.1. Homeostasis:

- 2.1.1. External and Internal environment
- 2.1.2. Control systems in biology
 - (a) Negative feed back
 - (b) Positive feed back
 - (c) More complex mechanism
 - (d) Control of blood glucose level as an example

2.2. Temperature regulation:

- 2.2.1. Relation between temperature and biological activities.
- 2.2.2. Temperature balance:
 - (a) Heat production: Shivering and non-shivering thermogenesis
Brown fat -a special thermogenic tissue in mammals
 - (b) Heat loss
- 2.2.3. Compensation through acclimation and acclimatization.
- 2.2.4. Adaptive response to temperature:
 - (a) Daily torpor
 - (b) Hibernation
 - (c) Aestivation

2.3. Osmotic and ionic regulation:

- 2.3.1. Maintaining water and electrolyte balance
 - (a) Ionic regulation in iso-osmotic environment
 - (b) Living in hypo-osmotic and hyper-osmotic environment
 - (c) Problems of living in terrestrial environment:
integumentary, respiratory and urinary water loss, tissue water,
water absorption, salt water ingestion and salt excretion, metabolic
water and behavioural adaptations.
- 2.3.2. Role of hormones in the regulation of water and electrolyte balance

2.4. Regulation of blood circulation:

- 2.4.1. Vascular pumps: Suction pump in open circulation and pressure pump
in closed circulation
- 2.4.2. Heart size (heart mass -Hm) in vertebrates
- 2.4.3. Heart rate/frequency (Hr) in vertebrates and invertebrates
- 2.4.4. Cardiac output
- 2.4.5. Pace maker: Neurogenic and Myogenic hearts
- 2.4.6. Electrical activity in heart muscles: Electrocardiogram
- 2.4.7. Chemical and nervous regulation of heart

2.5. Regulation of breeding cycle:

- 2.5.1. Endocrine regulation of male reproductive cycle
- 2.5.2. Endocrine regulation of female reproductive cycle
- 2.5.3. Types of female reproductive cycles (estrous and menstrual)
- 2.5.4. Endocrine regulation of pregnancy, parturition, alld lactation in
mammals

Unit 3: HAEMATOLOGY

3.1. Composition of blood:

- 3.1.1. Plasma proteins .
- 3.1.2. Inorganic constituents
- 3.1.3. Organic constituents other than proteins
- 3.1.4. Respiratory gases
- 3.1.5. Internal secretions, antibodies and enzymes

3.2. Volume of blood:

- 3.2.1. Total quantity and regulation
- 3.2.2. Haemorrhage
- 3.2.3. Blood transfusion with whole blood and other materials (saline, gumacacia and isinglass)

3.3. Erythrocytes:

- 3.3.1. Total count and ESR
- 3.3.2. Variation in number
- 3.3.3. Abnormalities in form and structure of erythrocytes
- 3.3.4. Haemoglobin-structure, function, formation and degradation
- 3.3.5. Haemolysis (Fragility test)
- 3.3.6. Erythropoiesis
- 3.3.7. Anaemia

3.4. Leucocytes:

- 3.4.1. Total count and volume
- 3.4.2. Differential count
- 3.4.3. Variation in number
- 3.4.4. Types of leucocytes and functions
- 3.4.5. Leucopoiesis
- 3.4.6. Leukemia

3.5. Haematopoietic organs and haematopoiesis:

- 3.5.1. Haematopoietic growth factors
- 3.5.2. Regulation of haematopoiesis:
 - (a) Programmed cell death
- 3.5.3. Enrichment of haematopoietic stem cells
- 3.5.4. Immune system cells:
 - (a) Lymphoid cells: B lymphocytes, T lymphocytes, Null cells
 - (b) Activities of mononuclear cells: Phagocytosis, Antimicrobial and cytotoxic activities, secretion of factors.
 - (b) Mast cells.
 - (c) Dendritic cells
- 3.5.5. Organs of the immune system:
 - (a) Primary lymphoid organs: Thymus, bone marrow
 - (b) Lymphatic system
 - (c) Secondary lymphoid organs: Lymph nodes, Spleen, Gut associated lymphoid tissue (GALT)
 - (d) Cutaneous associated lymphoid tissue

3.6. Accessory organs of blood system:

- 3.6.1. Reticulo-endothelial system
- 3.6.2. Formation of blood platelets

3.7. Blood coagulation and lymph:

- 3.7.1. Clotting mechanism.
- 3.7.2. Bleeding; and clotting time
- 3.7.3. Anticoagulants
- 3.7.4. Failure of clotting mechanism

Unit 4: IMMUNOLOGY

(30)

4.1. Definition and scope

4.2. Innate (Nonspecific) Immunity:

- 4.2.1. Definition and characteristics
- 4.2.2. Innate immunity at species, race, family and individual levels
- 4.2.3. Factors influencing the level of innate immunity in an individual:
age, hormone and nutrition.
- 4.2.4. Mechanism:
 - (a) First line of defence
 - (b) Second line of defence
 - (c) Third line of defence

4.3. Acquired (Specific) Immunity:

- 4.3.1. Definition and characteristics
- 4.3.2. Important features:
 - (a) Immune memory
 - (b) Immune specificity
 - (c) Recognition of non-self .
- 4.3.3. Passive acquired immunity:
 - (a) Natural (b) Artificial
- 4.3.4. Active acquired immunity:
 - (a) Natural (b) Artificial

4.4. Antigens:

- 4.4.1. Complete antigens and haptens .
- 4.4.2. Determinants of antigenicity: foreignness, molecular size, chemical composition and heterogeneity, susceptibility to tissue enzymes, antigen specificity, species specificity, isospecificity, organ specificity, auto-specificity, heterogenic specificity.

4.5. Immunoglobulins (antibodies):

- 4.5.1. Basic structure of immunoglobulin
- 4.5.2. Immunoglobulin classes: IgG, IgM, IgA, IgD and IgE, structure and properties.

4.6. Immune response:

4.6.1. Antigen presentation and processing, mechanism of lymphocyte activation.

4.6.2. Humoral immune response:

- (a) Pattern of antibody production
- (b) Primary and secondary responses
- (c) Fate of antigens in tissues
- (d) Production of antibodies
- (e) Factors affecting antibody production: age, nutritional status, Route of administration, size and number of doses, multiple antigens, adjuvants, immunosuppressive agents.

4.6.3. Cellular immune response (Cell mediated immunity)

- (a) Scope of CMI (cell mediated immune response)
- (b) Cell types involved in CMI and their role.
- (c) Lymphokines
- (d) Detection of CMI
- (e) Transfer factor

4.6.4. A brief account of immunological tolerance.

4.7. Antigen antibody interactions:

4.7.1. General features of antigen antibody interactions

4.7.2. Precipitation reactions:

- (a) Definition, characteristics and mechanisms
- (b) In fluids (tube test) and in gels (slide test)-Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlony method) Immunoelectrophoresis.

4.7.3. Agglutination reactions:

- (a) Definition, characteristics and mechanism
- (b) Haemagglutination (slide and micro-tray agglutination), Bacterial agglutination (tube agglutination), Passive agglutination, Coomb's test and Agglutination inhibition.

4.7.4. Complement fixation test

4.7.5. Radioimmunoassay

4.7.6. Immunofluorescence

4.7.7. Enzyme linked immunosorbent assay (ELISA)

4.8. Complement system:

4.8.1. Complement components

4.8.2. Classical and alternative pathways

4.8.3. Significance of complement

4.9. Hypersensitivity:

4.10.1. Type I (Anaphylaxis and atopy)

4.10.2. Type II (Cytotoxic)

4.10.3. Type III (Immune complex mediated)

4.10.4. Type IV (Cell mediated or delayed type)

4.10.5. Type V (Stimulatory)

(Type II, III, IV & V in brief.)

4.10. Transplantation immunology:

4.11.1. Classification of grafts

4.11.2. Immunologic basis of graft rejection:

- (a) First and second set rejection reaction
- (b) Immune mechanism in graft rejection
- (c) Precautions against graft rejection
- (d) Graft versus host disease (GVH)

4.11.3. Tissue and organ transplantation:

Corneal graft, Kidney transplant, Heart transplant,
Liver transplant, Bone marrow transplants.

4.11. Immunology of tumors

4.12.1. Clinical evidence of immune response in malignancy

4.12.2. Tumor antigens

4.12.3. Immune response to tumor antigens

4.12.4. Immunological surveillance

4.12.5. Immunotherapy of cancer.

PAPER-III

Unit 1. MOLECULAR BIOLOGY

(30)

1.1. The Nature and properties of the Genetic material:

1.2. DNA as genetic material:

1.2.1. Griffith's transformation experiment

1.2.2. Avery, Macleod and McCarthy experiment

1.2.3. Hershey-Chase experiment

1.3. RNA as genetic material:

1.3.1. Singer and Conrat experiment on TMV

1.4. DNA replication:

1.4.1. Meselson and Stahl experiment:

Semi conservative nature of DNA replication.

1.4.2. Prokaryotic & eukaryotic DNA replication

Semi discontinuous replication.

Priming, Bi-directional and unidirectional replication,

Theta mode of replication in E.coli,

Rolling circle replication in bacteriophages,

Enzymes involved in DNA replication.

PRACTICAL-I

1. Earthworm:

Dissections: Digestive, Nervous and Reproductive Systems.

Mountings: Setae, septal nephridium, blood glands, spermatheca, sperms and ovary.

2. Frog:

Dissections: Digestive, circulatory, urinogenital & sympathetic nervous systems, Brain.

Mountings: Squamous epithelium, ciliated epithelium, muscle & medullated Nerve Fiber.

Osteology: Axial and appendicular skeleton.

Embryology: Egg Spawn, 4 celled stage, 8 celled stage, Blastula, Gastrula, Neurula and Tadpole Stages.

3. Temporary mountings: Placoid, cycloid and ctenoid scales of fish.

4. Dissection: Aortic arches of shark, Cranial nerves

5. Brain: Comparative study of brains of shark, frog, lizard, bird (pigeon /fowl) & rat.

6. Dissection: Brain of shark

7. Chick Embryology:

Observations: permanent slides of whole, mounts of chick embryo at 18hrs, 22-24 hrs, 36 hrs, 48 hrs & 72 hrs of incubation.

8. Permanent preparation of Chick Embryo -upto 48 hrs of incubation.

9. Study of placentae [observation -specimen and/or slide]

Shark yolk sac placenta, different types of mammalian placentae.

10. Observation of permanent slides:

Earthworm: T .S. through pharynx, gizzard & intestine

[passing through typhlosolar region]

Frog: T.S. of stomach, intestine, liver and pancreas. Blood smear.

Mammalian tissues: liver, kidney, testis, ovary, pituitary, adrenal, thyroid and pancreas

PRACTICAL -II

Hematology:

1. Colorimetric estimation of total plasma proteins.
 3. Separation of plasma proteins by electrophoresis on agarose/PAGE.
 4. Estimation of blood glucose by 0- Toluidine method.
 5. Estimation of serum/plasma total cholesterol by FeCl₃ method.
 6. Estimation of serum/plasma total triglycerides by Phospho vanillin method.
 7. Enumeration of erythrocytes-total count
 8. Enumeration of leucocytes- total and differential count.
 9. Estimation of haemoglobin by Sahlis acid haematin method.
 10. Study of Lymphoid organs: Lymph node, Thymus and Spleen.
 11. Study of Leukemic cells fro111 permanent slide
 12. Observation of bone marrow cells.
- (Students are expected to know the preparation of blood report)

Physiology:

1. Study of Acid phosphatase activity:
 - a) Effect of substrate concentration
 - b) Effect of pH variation
 - c) Effect of enzyme concentration
 - d) Effect of inhibitor
2. To determine specific activity of succinate dehydrogenase (SOH)
3. Separation of LOH isozyme by electrophoresis on agarose/PAGE
4. Study vaginal smear to analyse female reproductive cycle.
5. Study of human ECG: Normal, Sinus tachycardia, Sinus bradycardia, Ventricular fibrillation.
6. Mounting of nerve cells and neurosecretory cells from cockroach

Immunology:

Latex agglutination test
Determination of blood group and Rh factor

REFERENCES:

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3. A Text Book of Zoology: T. J. Parker anQ W. A. Haswell, McMillan.
4. Chordate zoology:E. L. Jordan and P. S. Verina, S. Chand & Co.
5. Invertebrate Zoology: E. L. Jordan and P. S. Venna, S. Chand & Co.
Developmental biology/Embryology
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7. Developmental Biology: T. Subrarnoniarn, Narosa Publishers.
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Histology/Endocrinology

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10. General Endocrinology 3rd Ed: Turner and Bagnara, Saunders.

Physiology

11. Comparative animal Physiology: P. C Withers. thomsoq. Publishing Co.
12. Comparative animal Physiology: Prosser and Brown
13. Comparative animal Physiology: Knut Sclllnidt-Nielson, Cambridge
14. Comparative animal Physiology: William Hoer, Princitice Hall.
15. Biochemistry: S. C. Rastogi, Tata McGraw Hill
16. Biochemistry: Lehninger, Nelson and Cox. S. Chand & Co:
17. Human physiology, Vol I: Chhatterjee, Central Book Agency.
18. Immunology, 4: Ed. Janis Kuby W. H. Freman and Co
19. Immunology, 6 Ed. Ivan M Roitt .
20. Immunology, Tizzard, Thomson Publishing Co. .
21. Text Book of Microbiology, R. Ananthanarayan,. Orient Longman.

Molecular biology

22. Cell and Molecular Biology-Concept and Experiments: Gerald Karp, John Wiley & Sons Inc.
23. Molecular Biology of the Cell: Bruce Alberts and others: Garland Publishing.
24. Molecular Biology: Peter Pioletta, Tata McGraw Hill.
25. Molecular Biology: David Freifelder, Narosa Publishing House.

T .Y.B .Sc. Economic Entomology
(Applied Component)
Effective from the academic year 2005-2006

Economic Entomology Paper -I (60 Lectures)

Unit 1: General Morphology of Insects 15 Lectures

- 1.1. External morphology of head, thorax and abdomen
- 1.2. Appendages of head, thorax and abdomen, including the mouthparts and wings
- 1.3. Exoskeleton: structure, ecdysis

Unit 2: General Anatomy of insects 15 Lectures

- 2.1. Digestive system
- 2.2. Respiratory system
- 2.3. Circulatory system
- 2.4. Nervous system
- 2.5. Endocrine organs
- 2.6. Reproductive system
 - 2.6.1. General organization of male and female reproductive system
 - 2.6.2. Special modes of reproduction.
- 2.7. Development
 - 2.7.1. Types of metamorphosis
 - 2.7.2. Types of larvae and pupae

Unit 3: Insect Classification 15 Lectures

- 3.1. Key to taxonomy
- 3.2. Study of the following orders \with special reference to insects of economic importance
 - i) Thysanura
 - ii) Orthoptera
 - iii) Isoptera
 - iv) Hemiptera
 - v) Lepidoptera
 - vi) Diptera
 - viii) Hymenoptera
 - viii) Coleoptera

Unit 4: Insects in relation to their environment

15 Lectures

- 4.1. Abiotic factors
 - 4.1.1. Temperature
 - 4.1.2. Light
 - 4.1.3. Humidity
- 4.2. Mimicry in insects
- 4.3 Sound production and sound perception
- 4.4 Pheromones
- 4.5 Diapause

PRACTICAL I

1. Mountings:

- a. Head sclerites of cockroach and housefly
- b. Types of antennae (any four)
- c. Halteres
- d. Cornea
- e. Mouthparts of butterfly and bedbug

2. Dissections of Housefly

- a. Digestive system
- b. Reproductive system
- c. Nervous system

3. Identification of insects as per orders mentioned in theory (any 20 specimens, not more than three from each order)

Economic Entomology Paper -II (60 Lectures)

Unit 1: Economic importance of insects

15 Lectures

- 1.1. Useful insects: Insects as pollinators, silkworm moth, honey bee, lac insect
- 1.2. Harmful Insects: Blattella, Dysdercus, Papilio, Helicoverpa, Tribolium, Sarcophaga, Bedbug, Head louse

Unit 2: Social Insects

15 Lectures

- 2.1. Social organization in insects
- 2.2. Caste system in honeybees and termites
- 2.3. Communication in honeybee
- 2.4. Bioluminescence as a mode of communication in insects

Unit 3: Control of insect pests

15 Lectures

- 3.1. Natural control: environment as a limiting factor
- 3.2. Applied control
 - 3.2.1. Chemical control
 - 3.2.1.1. Inorganic pesticides
 - 3.2.1.2. Organic insecticides (synthetic and botanical)
 - 3.2.2. Biological control
 - a) Parasitism
 - b) Predators
 - c) Pathogens
 - d) Genetic methods
 - e) Use of pheromones and hormones
 - 3.2.3. Action of insecticides
 - 3.2.4. Resistance to insecticides
 - 3.2.5. Integrated pest control.

Unit 4: Medical Entomology

15 Lectures

Insects as vectors of diseases (transmission, epidemiology and control measures): Culex, Anopheles, Aedes, Musca, Glossina, Phlebotomus and Xenopsylla

PRACTICAL II

1. Study of the life histories of the following insects:
Silkworm, honeybee, Culex, Anopheles, Xenopsylla, Musca
2. Study of LC_{50} using a suitable insecticide
3. Effect of the following insecticides on suitable insects:
 - a. Contact poison
 - b. Fumigant
 - c. Stomach poison
4. Identification of economically important insects as per Unit 1 and 4 of theory
5. Visit to apiculture center, veterinary colleges, agricultural colleges, sericulture centers etc.
6. Submission of at least 5 species of insect pests

REFERENCES

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2. Principles of Insect Morphology -Snodgrass R.E. -TMH
3. Textbook of Entomology -Ross -John Wiley
4. General and Applied Entomology -David and Ananthkrishnan -TMH
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8. Applied Entomology -Awasthi
