SCHEME AND SYLLABUS OF EXAMINATION FOR THE PURPOSE OF FILLING UP THE POST OF JUNIOR ENTOMOLOGIST UNDER THE SIKKIM STATE SUBORDINATE ALLIED AND HEALTHCARE SERVICE.

The examination will consist of 2 papers : -

PAPERS	SUBJECT	FULL MARKS	TIME ALLOWED
PAPER - I	GENERAL ENGLLISH & GENERAL KNOWLEDGE	80 MCQ& CONVENTIONAL	02 : 00 HOURS
PAPER - II	MAIN PAPER	120 MCQ & CONVENTIONAL	03 : 00 HOURS
TOTAL 200 MARKS			

Paper – I & Paper – II will be objective type (OMR) and Conventional Mode.

1. **PAPER – I : (a) GENERAL ENGLISH (MCQ/ CONVENTIONAL MODE)**

The question will be designed to test the candidate's understanding and command of the English language. The pattern of questions would be broadly as follows:-

1. Comprehension of given passage
2. Grammar
3. Usages and vocabulary
4. Essay writing
5. Reporting writing

(b) GENERAL KNOWLEDGE :-

i. Current events of local, national and international importance
ii. National level schemes & projects undertaken by government of India/ State Government.

PAPER – II :MAIN PAPER (MCQ/ CONVENTIONAL MODE)

III. SYLLABUS FOR WRITTEN EXAMINATION FOR JUNIOR ENTOMOLOGIST: -

Sl. No.	Course	
01	02	03
01	INSECT MORPHOLOGY	Principles, utility and relevance: insect body wall structure, cuticularoutgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.
		Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites.
		Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications.
		Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors).

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02	**INSECT ANATOMY, PHYSIOLOGY AND NUTRITION**	Scope and importance of insect anatomy and physiology.
		Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.
		Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause.
		Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.
03	**PRINCIPLES OF TAXONOMY and CLASSIFICATION OF INSECTS**	Introduction to history and principles of systematics and importance. Levels and functions of systematics. Identification, purpose, methods character matrix, taxonomic keys. Descriptions- subjects of descriptions,characters, nature of characters, analogy vs homology, parallel vsconvergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.
		Classification of animals: Schools of classification- Phenetics, Cladistics and Evolutionary classification. Components of Biological Classification: Hierarchy, Rank, Category and Taxon. Species concepts, cryptic, sibling and etho-species, infra-specific categories. Introduction to numerical, biological and cytogenetical taxonomy.
		Nomenclature: Common vs Scientific names. International Code of Zoological Nomenclature, criteria for availability of names, validity of names. Categories of names under consideration of ICZN. Publications, Principles of priority, and homonymy, synonymy, type concept in zoological nomenclature. Speciation, anagenesisvscladogenesis, allopatric, sympatric and parapatric processes.
		Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained.
		Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.
		Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid-

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		Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.
04	**INSECT ECOLOGY**	History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.
		Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application toinsect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.
		Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of nicheecologicalhomologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.
		Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity-stability debate, relevance to pest management. Pest management as applied ecology.
05	**INSECT PATHOLOGY**	History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.
		Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.
		Examples of successful instances of exploitation of pathogens for pest management and mass production techniques of pathogens. Safety and registration of microbial pesticides. Use of insect pathogens in integrated management of insect pests.

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06	**BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS**	History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.
		Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria fungi, protozoa etc., their mode of action. Biological control of weeds using insects.
		Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.
		Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.
07	**TOXICOLOGY OF INSECTICIDES**	Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.
		Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action oforganochlorines, organophosphates, carbamates, pyrethroids, tertiary amines,neonicotinoids, oxadiazines, phenyl pyrozoles, new promising compounds, etc.
		Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.
		Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.
		Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.
08	**PLANT RESISTANCE TO INSECTS**	History and importance of resistance, principles, classification, components, types and mechanisms of resistance.
		Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.
		Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.
		Factors affecting plant resistance including biotypes and measures to combat them.
		Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.
		Role of biotechnology in plant resistance to insects.
09	**PRINCIPLES OF INTEGRATED PEST MANAGEMENT**	History and origin, definition and evolution of various related terminologies.
		Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.

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		Tools of pest management and their integration-legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.
10	**PESTS OF FIELD, HORTICULTURAL AND PLANTATION CROPS AND STORAGE ENTOMOLOGY**	Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.
		Insect pests of cereals and millets and their management. Polyphagouspests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.).
		Insect pests of pulses, tobacco, oilseeds and their management.
		Insect pests of fibre crops, forages, sugarcane and their management.
		Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits.
		Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, French beans, chow-chow, brinjal, okra, all gourds, gherkin, drumstick, leafy vegetables etc.
		Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc.
		Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation.
		Introduction, history of storage entomology, concepts of storageentomology and significance of insect pests. Post-harvest losses *in totovisàvis*total production of food grains in India. Scientific and socio-economicfactors responsible for grain losses.
		Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.
		Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage-types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

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		Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.
11	**INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS**	History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.
		Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.
		Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.
		Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.
		Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.
12	**COMMERCIAL ENTOMOLOGY**	Bee keeping- General colony management during different seasons. Seasonal management. Managing colonies for honey production and pollination. Artificial queen rearing. Pests and diseases of honey bees. Bee poisoning. Production and marketing of quality honey and value added honey products. Establishment and maintenance of apiaries.
		Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests and diseases of silkworms, rearing and managementof silkworms. Lac insect- natural enemies and their management.
		Economic and public health importance of insect pests in human habitation and habitats, biology, damage and control of mosquitoes, houseflies, bed bugs, ants, termites, cockroaches, flies, silverfish, head and body lice, carpet beetles, cloth moths, crickets, wasps, house dust mites, insect pests of cattle, poultry, pet animals and their management.
		Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, pre- and postconstructiontermite proofing of buildings, appliances for domestic pest control. Rodent control methods. Organic methods of domestic pest management.
13	**IMMATURE STAGES OF INSECTS**	Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects
		Comparative study of life history strategies in hemi-metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

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14	**INSECT BEHAVIOUR**	Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. History of Ethology- development of behaviorismand ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.
		Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.
		Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Selforganization and insect behaviour.
		Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.
15	**RECENT TRENDS IN BIOLOGICAL CONTROL**	Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagousinsects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.
		Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.
		Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation.
		Scope of genetically engineered microbes and parasitoids in biologicalcontrol, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.
16	**ADVANCED INSECTICIDE TOXICOLOGY**	Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.
		Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.
		Joint action of insecticides; activation, synergism and potentiation.
		Problems associated with pesticide use in agriculture: pesticide resistance mechanisms and resistant management strategies; pestresurgence and outbreaks; persistence and pollution; health hazards andother side effects.

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		Estimation of insecticidal residues- sampling, extraction, clean-up andestimation by various methods; maximum residue limits (MRLs) and theirfixation; insecticide laws and standards, and good agricultural practices.
17	**ADVANCED HOST PLANT RESISTANCE**	Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance;assembly of plant species - gene pool; insect sources – behaviour in relationto host plant factors.
		Physical and chemical environment conferring resistance in plants, role oftrypsin inhibitors and protease inhibitors in plant resistance; biochemistryof induced resistance – signal transduction pathways, methyl jasmonatepathways, polyphenol oxidase pathways, salicylic acid pathways; effects ofinduced resistance; exogenous application of elicitors.
		Biotechnological approaches in host plant resistance-genetic manipulationof secondary plant substances; incorporation of resistant gene in cropvarieties; marker-aided selection in resistance breeding.
		Estimation of plant resistance based on plant damage-screening anddamage rating; evaluation based on insect responses; techniques anddetermination of categories of plant resistance; breakdown of resistance incrop varieties.
18	**ADVANCED ACAROLOGY**	Comparative morphology of Acari, phylogeny of higher categories inmites, knowledge of commonly occurring orders and families of AcariinIndia. Diagnostic characteristics of commonly occurring species fromfamiliesTetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae,Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae,Sarcoptidae. Soil mites in India.
		Management of economical important species of mites in agriculture,veterinary and public health; storage acarology.
		Mites as vectors of plant pathogens; mode of action, structure-activityrelationships of different groups of acaricides; problem of pesticideresistance in mites, resurgence of mites.
		Predatory mites, their mass production and utilization in managing mitepests, acaropathogenic fungi- identification, isolation and utilization.
19	**MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH**	Introduction to molecular biology; techniques used in molecular biology.
		DNA and RNA analysis in insects- transcription and translocationmechanisms. DNA recombinant technology, identification ofgenes/nucleotide sequences for characters of interest. Genetic improvementof natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt*andntomopathogenic fungi.
		Genes of interest in entomological research- marker genes for sexidentification, neuropeptides, JH esterase, St toxins and venoms, chitinase,CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, Sttoxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectinsandproteases, neuropeptides. Transgenic plants for pest resistance and diseases.

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		Insect gene transformation; biotechnology in relation to silkwormsandhoney bees; introduction of lectin genes for pest suppression; DNA fingerprinting for taxonomy and phylogeny. Genetic improvement of inebriatetolerance of natural enemies.
		DNA-based diagnostics; insect immune systems in comparison tovertebrates; molecular basis of metamorphosis; Sf transgenic technologyand implications; molecular biology of baculoviruses; insecticideresistance. Resistance management strategies in transgenic crops.
20	**ADVANCED INTEGRATED PEST MANAGEMENT**	Principles of sampling and surveillance; database management andcomputer programming, simulation techniques and system analysis andmodeling.
		Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasivepests.
		Genetic engineering and new technologies- their progress and limitations inIPM programmes, deployment of benevolent alien genes for pestmanagement- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' realtime situations.
		Challenges, needs and future outlook; dynamism of IPM under changingcropping systems and climate; insect pest management under protectedcultivation; strategies for pesticide resistance management.

14/09/2021

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