SYLLABUS FOR AGRICULTURE & ALLIED SERVICES (COMBINED TECHNICAL) EXAMINATION, 2024

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SYLLABUS FOR AGRICULTURE & ALLIED SERVICES (COMBINED TECHNICAL) EXAMINATION, 2024

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1) The Examination shall consist of Written Examination and Personal Interview.

2) Written Examination will consist of 5 (five) papers, namely –

(a) Common Papers for all Services/Posts

(i)	*General English*	-	*100 Marks*
(ii)	*General Studies*	-	*100 Marks*

(b) Technical Papers

(i)	*Technical Paper I*	-	*200 Marks*
(ii)	*Technical Paper II*	-	*200 Marks*
(iii)	*Technical Paper III*	-	*200 Marks*
	Total	**-**	***800 Marks***

(c) Personal Interview - 100 Marks

Grand Total - 900 Marks

3) Written examination for each paper will be of 3 (three) hours duration. Compensatory time may be allowed for persons with benchmarked disabilities as prescribed by the Government from time to time.

4) Question papers for the written examination will be set in English.

5) Technical Papers shall have both MCQ and Conventional Essay Type Questions. MCQ shall carry 100 Marks (50 questions carrying 2 marks each) and Conventional Essay Type shall carry 100 Marks.

6) There will be more than one alternative for the answer to every MCQ.

7) For each question for which a wrong answer is given by the candidate, one-third of the marks assigned to that question will be deducted as penalty.

8) Personal interview will be conducted by the Commission and the same will carry 100 marks.

DETAILED SYLLABUS FOR WRITTEN EXAMINATION

A. COMPULSORY PAPERS

1. General English *(Matriculation or equivalent standard)*..... : 100 Marks

(a) Précis Writing..... : 14 Marks

(b) Letter Writing..... : 10 Marks

(c) Comprehension of given passages..... : 10 Marks

(d) Grammar: Parts of Speech..... : 30 Marks

(e) Correct usage and Vocabularies..... : 16 Marks

(f) Formation of Sentence..... : 20 Marks

(i) Verbs

Tenses: Present/past forms, Simple/continuous forms, Perfect forms, Future time reference

(ii) Sentence Structure

Connectors

Types of sentences: Affirmative/interrogative sentences, Negation, Exclamations

Types of Phrases and Clauses: finite and non-finite subordinate clauses, noun clauses and phrases, adjective clauses and phrases, adverb clauses and phrases

Narration (Direct and Indirect speech)

2. General Studies..... : 100 Marks

(a) Current events of state, national and international importance..... : 12 Marks

(b) History of India and Indian National Movement..... : 12 Marks

(c) Indian and World Geography - Physical, Social, Economic Geography of India and the World..... : 12 Marks

(d) Indian Polity and Governance - Constitution, Political System, Public Policy, Duties & Rights Issues..... : 12 Marks

(e) Economic and Social Development Sustainable Development, Poverty, Inclusion, Demographics, Social Sector initiatives, and other related issues..... : 12 Marks

(f) General issues on Environmental Ecology, Bio-diversity and Climate..... : 12 Marks

(g) General Science..... : 12 Marks

The topics listed above shall cover the State of Mizoram wherever applicable.

(h) General awareness on Mizo culture, its heritage and society..... : 16 Marks

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B. TECHNICAL PAPERS FOR JUNIOR GRADE OF MIZORAM AGRICULTURE SERVICE

AGRICULTURE SCIENCE PAPER-I		**-**	**200 marks**
I.	Agronomy	-	60 marks
II.	Soil Science	-	50 marks
III.	Organic farming	-	30 marks
IV.	Seed & seed production technology	-	30 marks
V.	Soil and water conservation	-	30 marks
AGRICULTURE SCIENCE PAPER-II		**-**	**200 marks**
I.	Plant pathology	-	50 marks
II.	Plant Breeding and Genetics	-	50 marks
III.	Entomology & Nematology	-	40 marks
IV.	Crop Physiology	-	30 marks
V.	Horticulture	-	30 marks
AGRICULTURE SCIENCE PAPER-III		**-**	**200 marks**
I.	Agriculture extension	-	50 marks
II.	Agriculture Economics and Marketing	-	40 marks
III.	Environmental Science	-	40 marks
IV.	Post-Harvest Management	-	40 marks
V.	Farm Power, Machinery and Equipment	-	30 marks

AGRICULTURE SCIENCE PAPER-I (200 Marks)

I. Agronomy (60 marks)

National policy on Agriculture, importance of Agriculture in national economy, principles of Agronomy, crop ecology, geography and Agricultural Meteorology. Agronomy - meaning and scope, National & International Agricultural Research Institutes in India, Agro climatic zones of India, Tillage and intercultural operations, implements for ploughing, nursery management, Precision farming, Integrated farming systems, Principles of crop ecology and crop adaptation, climate shift and its ecological implications, Agro-ecological regions in India, Geographical distribution of crop plants, Greenhouse effect, Climatic factors and their effect on plant processes and crop productivity, Role of GIS and GPS in agriculture. Weather & Climate, Atmospheric temperature and global warming, Weather forecasting.

Origin, distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of cereals, pulses, oilseeds, fiber crops, fodder & forage crops and commercial crops.

Weed management : Principles of weed management, classification, biology and ecology of weeds, crop weed competition and allelopathy, concepts and methods of weed control, Integrated weed management, classification, formulations, selectivity and resistance of herbicides, herbicide persistence in soil and plants, application methods and equipments.

II. Soil Science (50 marks)

Soil as a medium for plant growth, composition of earth's crust, weathering of rocks and minerals, components of soil - their importance, soil profile. Soil physical properties - density, porosity, texture, soil structure and their brief

descriptions. Factors affecting soil temperature, its importance in plant growth. Cation exchange capacity, anion exchange capacity, buffering of soils. Problem soils - acid, saline and sodic soils – their characteristics, formation, problems and management.

Soil fertility and fertilizers : Essential plant nutrients and their deficiency symptoms, concept of essentiality of plant nutrients, indicators of soil fertility and productivity, fertilizer materials and their availability to plants, slow release fertilizers, principles and methods of fertilizer application, Integrated Nutrient Management, methods of soil sample collection, soil testing and fertilizer recommendations. Soil classifications – major soils of India, soil micro-organisms, classification and their roles. Organic matter decomposition, C:N ratios, mineralization and immobilization process, humus, role of organic matter in soil quality. Soil erosion, types and control measures. Fertilizers and manures - classifications, NPK fertilizers, their reactions in soils, green manuring, recycling of organic waste, composting. Characteristic features of Biofertilizers.

III. Organic Farming (30 marks)

Organic farming, principles and its scope in India; Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts; Organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.

IV. Seeds & Seed Production Technology (30 marks)

Definition of seeds, seed certification techniques and processing, Seed testing laboratories, ISTA standards for seed testing, Seed village concept and Seed Act, production techniques of quality seeds, seed hybridization, principles of plant breeding and genetics, GM seeds, HYV, Hybrid seeds. Seed sampling : principles and procedures, Seed storage and packaging. Intellectual Property Rights – Protection of Plant Varieties and Farmers Act (PPVFRA) and Geographical Indications.

V. Soil and Water Conservation (30 marks)

Soil erosion and types of erosion. Quantitative soil loss estimation, universal soil loss equation and its subsequent modifications. In-situ measurement of soil loss. Field practices in controlling erosion by water and wind. Soil and Water conservation structures and their design. Gully control: vegetative measures, temporary, semi-permanent and permanent structures for gully control and reclamation and their design. Design and construction of farm pond and reservoir. Seepage theory. Design of earthen dams and retaining walls, stability analysis on slopes. Application of RS and GIS in soil and water conservation.

Concept of Soil and Water conservation, Relevance of soil and water conservation in Agriculture, Problems caused by soil erosion, factors affecting soil erosion, Types of soil erosion, mechanics of water and wind erosion, Erosivity and Erodibility

AGRICULTURE SCIENCE PAPER-II (200 marks)

I. Plant Pathology (50 marks)

Characteristics of prokaryotic and eukaryotic organisms, differences between fungi, bacteria, mycoplasmas and viruses; physical and chemical basis of heredity; chromosome structure; genes/operon concept; protein biosynthesis; transformation, recombination, Heterosis; Elements of economic botany; integrated diseases management; sterilisation, disinfection and pasteurization; Koch's postulates; etiological agents of rusts, smuts, powdery/downy mildews, wilts, yellows, mosaic, necrosis, enations, blights and witches- broom.

II. Plant Breeding and Genetics (50 marks)

Plant breeding as a dynamic science, genetic basis of Plant Breeding - classical, quantitative and molecular, plant breeding in India-limitation, major achievement, sexual reproduction (cross and self pollination), asexual reproduction, pollination control mechanism (incompatibility, sterility and implications of reproductive systems on population structure). Hybridization and selection, breeding techniques. Heterosis-concepts, estimation and its genetic basis.

III. Entomology & Nematology (40 marks)

Classification of animal kingdom up to class; distinguishing characters up to orders in class Insecta; general organization of an insect external morphology with special reference to lepidopteran larvae, coleopteran adults; and honeybee; metamorphosis and moulting; different physiological systems; insect- plant relationship; insect pests of agricultural and horticultural crops, and their stored/processed products, insect vectors of plant diseases- identification, biology, nature of damage, and their management tactics; and pests of household, medical and veterinary importance and their control; useful and beneficial insects like honeybee, lac insect, silkworm and pollinators; Nematode taxonomy, biology of important plant parasitic nematodes and their control; entomopathogenic nematodes, basic principles of insect and nematode pest management-cultural, biological, insecticidal, quarantine, and regulatory aspects; insecticide classification and insecticide resistance management; and insect protective transgenic crops.

IV. Crop Physiology (30 marks)

Plant physiology - importance in agriculture. Seed germination, viability and vigour. Photosynthesis - significance of C-3, C-4 and CAM pathway; photorespiration and its implications. Translocation of assimilates; dry matter partitioning; Harvest index of crops. Growth and development; growth analysis; crop-water relationship. Plant nutrients and their functions. Phytohormones and their physiological role. Photoperiodism, vernalisation; pollination/fertilization in flowering plants. Post-harvest physiology and its significance.

V. Horticulture (30 marks)

Meaning & definition of horticulture, branches of Horticulture, classification of fruits, vegetables. Major fruit crops and their culture, major vegetable crops and their culture, Spices and condiments, floriculture, medicinal and aromatic plants, plantation crops, kitchen gardening. Methods of plant propagation. Major pests and diseases and their control of Horticulture crops.

AGRICULTURE SCIENCE PAPER-III (200 marks)

I. Agricultural Extension (50 marks)

Extension Education - concept, meaning, principles, philosophy, scope and importance; Extension programme planning. Principles of teaching and learning, teaching and learning process, Steps in Extension teaching, Extension Teaching methods and its classification, Participatory Rural Appraisal (PRA), Monitoring and evaluation process. Diffusion and adoption, Role of women in Agriculture. Communication, principles, concepts, process, elements and barriers in teaching methods. Communication - Key elements and models of Communication, Communication through written forms, different kinds of communication methods, media and Audio Visual aids/materials. Kisan Call Centers, teleconferencing, agriculture journalism, diffusion and adoption of innovations-adopter categories, capacity building of extension personnel and farmers - training to farmers, women and rural youth.

II. Agricultural Economics and Marketing (40 marks)

Basic principles of farm management, concept of farming system and economics of farming systems, agricultural production economics-scope and analysis, factor-product relationship, marginal cost and marginal revenue, farm planning and budgeting, Agricultural finance : nature and scope. Time value of money, compounding and discounting. Agricultural credit: meaning, definition, need and classification. Credit analysis : 4R's, 5C's and 7 P's of credit, repayment plans. History of financing agriculture in India. Commercial banks, nationalization of commercial banks. Lead bank scheme, regional rural banks, scale of finance. Higher financing agencies, RBI, NABARD, AFC, Asian Development Bank, World Bank, role of capital and credit in agriculture; credit institutions, co- operatives and agrarian reforms in India.

Agricultural marketing – role, practice, institutions, problems and reforms, role of capital and credit in agriculture, crop insurance, credit institutions, cooperatives, capital formation in agriculture, agrarian reforms, globalization, WTO & its impact on Indian agriculture.

III. Environmental Science (40 marks)

Definition and scope of environmental science and its interrelationship with other sciences and agriculture; Segments : Atmosphere: Hydrosphere, Lithosphere and Biosphere; Components of environment - biotic, abiotic and social; Ecology concept – types – habitat ecology, systems ecology, synecology, autecology; Ecosystem: Structure- Functions; Communities - habitats, niches, biomes, population dynamics, species and individual in the ecosystem; Recent trends in ecology; Energy flow in ecosystems and environment; Energy exchange and productivity-food chains and food webs-ecological pyramids; Ecological succession - types and causes. Biogeochemical cycles; nutrient cycles and recycle pathways. Biodiversity concepts, levels and types, Values and Significance of biodiversity; Theories on biodiversity; Agro-biodiversity – Transgenic crops and animals – Impact on Environment. Environmental Pollution - Point and non-point sources - Atmosphere – stratification - Composition of air-; Air pollution: sources and classification, Greenhouse gases – Global warming – Ozone depletion – Acid rain – Impacts on Environment, Adaptation and mitigation strategies of climate change - Carbon sequestration and clean development mechanism.

IV. Post Harvest Management (40 marks)

Biochemical and engineering properties of biological materials; quality control & safety of raw and finished products. Principles, practices and equipments for drying, milling, separation and storage of agricultural produce and by-products; material handling equipment and operations; farmstead planning; heating & cooling load calculation; seed processing practices and equipments; food preservation methods and products development; refrigeration and air conditioning; cold stores; waste management, cost analysis & food processing plants layout, feasibility reports.

V. Farm Power, Machinery and Equipments (30 marks)

Status of Farm Power in India, Equipments for primary and secondary tillage and seed bed preparation, seeding and planting machineries, Intercultural and Plant protection equipments, Harvesting and threshing machineries, Weeders, Power Tillers and Tractors, Tractor types, Cost analysis of tractor power and attached implement, implement for hill agriculture

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C. TECHNICAL PAPERS FOR JUNIOR GRADE OF MIZORAM HORTICULTURE SERVICE

HORTICULTURE SCIENCE PAPER-I		**-**	**200 marks**
I.	Basic horticulture	-	60 marks
II.	Organic farming	-	40 marks
III.	Plant propagation and nursery management	-	20 marks
IV.	Water management	-	20 marks
V.	Soil fertility and nutrient management	-	40 marks
VI.	Weed management in horticulture crops	-	20 marks
HORTICULTURE SCIENCE PAPER-II		**-**	**200 marks**
I.	Fruit crops	-	40 marks
II.	Vegetable crops	-	40 marks
III.	Floriculture and landscaping	-	40 marks
IV.	Plantation crops	-	10 marks
V.	Spices and condiments	-	20 marks
VI.	Medicinal and aromatic plants	-	10 marks
VII.	Protected cultivation of horticulture crops	-	20 marks
VIII.	Mushroom	-	10 marks
IX.	Bee keeping	-	10 marks
HORTICULTURE SCIENCE PAPER-III		**-**	**200 marks**
I.	Post-harvest technology	-	50 marks
II.	Plant breeding and genetics	-	40 marks
III.	Plant biotechnology	-	40 marks
IV.	Crop physiology	-	30 marks
V.	Extension education	-	20 marks
VI.	Farm power & machineries	-	10 marks
VII.	Horti-business management and entrepreneurship development	-	10 marks

HORTICULTURE SCIENCE PAPER – I

I. Basic Horticulture (60 Marks)

Economic importance and scope, classification of horticultural crops and their culture, nutritive value, Horticulture zones of India, soils and climate, planning and layout, management of orchards, importance, objectives, merits and demerits, clean cultivation, planting systems and planting densities, Canopy management of fruit crops, types and use of growth regulators in horticulture, cropping systems, inter cropping, multi-tier cropping, mulching, bearing habits, factors influencing fruitfulness and unfruitfulness, rejuvenation of senile orchards.

Growth and development-definitions, components, photosynthesis productivity, leaf area index (LAI) – optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, growth analysis in horticulture crops. Plant bio-regulators-auxin, gibberellins, cytokinin, ethylene

inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit development, fruit drop and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neural plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climateric and non-climateric fruits.

II. Organic farming (20 Marks)

Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues; Soil improvements and amendments; Integrated disease and pest management – use of biological agents, bio-pesticides, pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation process, marketing, exports, organic farming for Sustainable horticulture.

III. Plant Propagation and Nursery Management (20 Marks)

Plant propagation - sexual and asexual methods of propagation, advantages and disadvantages. Propagation methods and various techniques. Techniques of propagation through specialized organs (corm, runners, suckers etc.). Apomixes – monoembrony, polyembrony, chimera & bud sport. Seed dormancy (scarification & stratification) internal and external factors, nursery techniques, Propagation structures: Mist chamber, humidifiers, greenhouses, poly-houses, nursery (tools and implements), use of growth regulators in seed and vegetative propagation,. Physiological & biochemical basis of rooting, factors influencing rooting of cutting and layering, graft incompatibility. Selection and maintenance of mother trees, collection of scion wood, scion-stock relationship, and their influences, bud wood certification, Hardening of plants in nurseries. Nursery Registration Act. Pest and disease management.

IV. Water Management (20 Marks)

Importance of water, and water resources in India. Water requirement of horticulture crops – factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation, their suitability, merits and limitations, economic use of irrigation water. Water management problem, quality of irrigation water, irrigation management practices for different soils and crops. Layout of different irrigation system – surface and sub-surface systems.

V. Soil fertility and nutrient management (40 Marks)

Essential plant nutrients and their deficiency symptoms, Criteria of essentiality of plant nutrients, indicators of soil fertility and productivity. Soil classifications – major soils of India, soil micro-organisms, classification and their roles. Manures and Fertilizer – classifications and their roles, green manuring, recycling of organic waste, composting. Characteristic features of Biofertilizers. Role of microorganisms in organic matter decomposition-humus formation, minerals and their availability to

plants, principles and methods of fertilizer application, Integrated Nutrient Management, methods of soil sample collection, soil testing and fertilizer recommendations. Organic matter decomposition, C:N ratios, mineralization and immobilization process, humus. Soil erosion, types and control measures.

VI. Weed Management in Horticulture crops (20 Marks)

Introduction, harmful and beneficial effects, classification, reproduction and dissemination; Crop-weed association, crop-weed competition and allelopathy. Concepts of weed prevention, control and eradication; Losses caused by weeds, herbicide classification, formulations, weed management, common herbicides used in horticultural crops, time and rate of applications, types of herbicide, Integrated Weed Management, advantages, limitations, resistance of herbicides, herbicide persistence in soil and plants. Compatibility of herbicides with other agro chemicals.

HORTICULTURE SCIENCE PAPER – II

I. Fruit crops (40 Marks)

Classification of economic importance, export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, self-incompatibility and pollinisers. Water and nutrient management and special horticulture techniques (plant growth regulators, canopy management etc.) Harvest indices, Post harvest technology, harvesting methods, Physiological disorders. Disease and pest management of tropical, sub-tropical, temperate, dry land and minor fruits.

II. Vegetable Crops (40 Marks)

Economic importance, export potential, varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices and transplanting of vegetable crops, planting system, water and weed management, nutrient management. Pest and disease management. Physiological disorder. Cropping system, harvest, yield and seed production, post-harvest handling and storage of vegetables (including roots and tubers) - tropical, sub-tropical and temperate regions.

III. Floriculture and Landscaping (40 Marks)

Scope of gardening, aesthetic values, types of gardens, landscaping, Importance of floriculture industry. Landscaping - basic principles and components. Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden etc. Types of Trees, their design values in landscaping, propagation, planting shrubs and herbaceous perennials, propagation, planting, climbers and creepers, palms, ferns, grasses and cacti, succulents. Flower arrangement: importance, Bonsai. Parks and public gardens.

Scope and importance of commercial floriculture, varieties, production techniques of ornamental plants, bulbous flowers and commercial flowers for domestic and export market, growing of flowers under protected environments (glass house, polyhouse, etc.,). Disease and pest management. Harvesting, post-harvest technology of commercial cut flowers, dehydration techniques for drying of flowers.

IV. Plantation Crops (10 Marks)

Scope and importance, export and important potential, role in national and state economy, uses, industrial importance, by-products utilization, soil and climate, varieties, propagation techniques, planting systems and method, gap filling, mulching, shade regulation, weed and water management, nutrient management, soil management, canopy management, physiological disorders, insect pest management, harvesting, post-harvest handling and processing, packaging, marketing and yield.

V. Spices and Condiments (20 Marks)

Scope and importance, uses, export potential and role in national economy. Classification of spices, soil and climate, propagation, methods of planting. Nutrient and water management, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Disease and pest management. Harvesting, post-harvest management, storage, value added products, methods of extraction of essential oil and oleoresins.

VI. Medicinal and Aromatic Plants (10 Marks)

Scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance and uses, climatic and soil requirements, propagation and nursery techniques, cultural practices, training and pruning, nutrient and water management. Disease and pest management, harvesting, post-harvest management and processing (methods of extraction of essential oil and oleoresins).

VII. Protected cultivation of horticulture crops (20 Marks)

Scope and importance, problems and prospects of protected cultivation in India, Protected and growing structures – green house, polyhouse, net house etc., basic considerations in establishment and operation of Protected and growing structures, maintenance, advantages of growing plants in a Protected and growing structures, functioning and maintenance, water and nutrient management.

VIII. Mushroom (10 Marks)

Species of Mushroom, Importance and uses, Precautionary measures, Production Practices, Pest and diseases of mushroom and their management, Spawn production.

IX. Bee Keeping (10 Marks)

Importance and scope of apiculture, different species of bees, life cycle, bee keeping equipment, reproduction, queen rearing, seasonal management, bee pasturage, economics of bee-keeping, Bee-enemies, disease of bee, role of bees in increasing the productivity of horticulture crops in India economy, bee products and their uses.

HORTICULTURE SCIENCE PAPER – III

I. Post-harvest technology (50 Marks)

Importance of post-harvest technology in horticultural crops. Maturity indices, harvesting, handling, grading, packaging and storage. Physiological changes in horticulture crops after harvest. Pre-harvest treatment and post-harvest treatments of horticultural crops. Types of containers, cushioning materials, modes of transportation etc.

Importance and scope of fruits and vegetable preservation industry in India. Processing of plantation crops. Food pipe line, losses in post-harvest operations, unit operations in food processing, principles and methods of preservation (heat pasteurization, canning, bottling, sugar and chemicals, candies, crystallized fruits, chemical preservatives, preservation with salt and vinegar, pickling, chutneys, sauces, freezing etc.) . Methods of preparation of juices, squashes, syrups, cordials and fermented beverages, jam, jelly and marmalade. Spoilage in processed food, quality control of processed products, Govt. policy on import and export of processed products. Food Law.

II. Plant Breeding and genetics (40 Marks)

Plant breeding as a dynamic science, genetic basis of Plant Breeding, quantitative and molecular, Plant breeding in India - limitations, major achievements. Sexual reproduction (cross and self pollination), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure). Genetic components of polygenic variation and breeding strategies, selection as a basis of crop breeding. Hybridization and selection - goals of hybridization, selection of plants; population developed by hybridization – simple crosses, bulk crosses and complex crosses. Breeding techniques. Heterosis – concepts, estimation and its genetic basis.

III. Plant Biotechnology (40 Marks)

Concepts, scope and importance; Plant tissue culture and plant genetic engineering, Totipotency and morphogenesis, Techniques of *in vitro* culture, micro-propagation. Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Applications and achievements; Somaclonal variation; Protoplast isolation; Somatic hybrids and cybrids- application in crop improvement. Genetic engineering; Restriction enzymes; Gene cloning and gene transfer methods; Cryopreservation; Biosafety Rules and Intellectual Property Rights.

IV. Crop Physiology (30 Marks)

Role of water in plant metabolism, osmosis inhibition, diffusion water potential and its components, measurement of water potential in plants, absorbtion of water, mechanism of absorbtion and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Photosynthesis; Photorespiration; Phytohormones, physiological role in controlling plant processes. Osmotic pressure, guttation, stem bleeding, transpiration methods and mechanism and factors affecting transpiration. Different types of stresses - water, heat and cold tolerance; mechanism of tolerance. Plant nutrition - Essentiality, mechanism of absorbtion and its role in plant metabolism, nutritional disorders.

V. Extension Education (20 Marks)

Meaning, definition, nature, scope, objectives, principles, approaches and history. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like Lab to Land Programme (LLP), national demonstration (ND), Front line demonstration (FLD), Training and visit (T&V) system, Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR. Scope and importance of Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA). Concepts of human resource development (HRD), rural leadership.

Communication – Key elements and models of Communication, Communication through written forms, different kinds of communication methods, media and Audio Visual aids/materials. Capacity building of extension personnel and farmers - training to farmers, women and rural youth.

VI. Farm Power and Machineries (10 Marks)

Basic concepts of various forms of energy, unit and dimensions of force, energy and power. Internal combustion (IC) engines: Basic principles of operation of compression, ignition and spark ignition engines, two stroke and four stroke engines, cooling and lubrication system, power transmission system, broad understanding of performance and efficiency, tractors, power tillers and their types and uses. Tillage: objectives, methods of ploughing. Primary tillage implements, secondary tillage implements. Sowing and transplanting equipment. Grafting, pruning and training tools and equipments. Inter-culture equipment, crop harvesting equipments.

VII. Horti- Business Management and Entrepreneurship Development (10 Marks)

Definition, nature, characteristics and scope of farm management. Farm management principles, production function, technical relationships, cost concepts, factors relationship, product relationship. Cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farm planning, budgeting, organizations and management. Financial management and project management.

Globalisation and emerging business/ entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; SWOT analysis; Govt. schemes and incentives for promotion of entrepreneurship. Export and import policies relevant to horticulture sector. Venture capital; Contract farming and joint ventures, public- private partnership. Overview of Horticulture inputs industry.

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D. TECHNICAL PAPERS FOR JUNIOR GRADE OF MIZORAM ANIMAL HUSBANDRY & VETERINARY SERVICE

AH & VETY Paper - I	**200 Marks**	**3 hours with compensatory time of 20 minutes per hour for person with benched mark disabilities.**
1) Livestock Production Management	**40**	
2) Animal Genetics and Breeding	**40**	
3) Animal Nutrition	**40**	
4) Veterinary and Animal Husbandry Extension Education	**40**	
5) Livestock Products Technology	**40**	
AH & VETY Paper - II	**200 Marks**	**3 hours with compensatory time of 20 minutes per hour for person with benched mark disabilities.**
1) Veterinary Microbiology	**40**	
2) Veterinary Pathology	**40**	
3) Veterinary Public Health and Epidemiology	**40**	
4) Veterinary Physiology and Biochemistry	**40**	
5) Veterinary Parasitology	**40**	
AH & VETY Paper - III	**200 Marks**	**3 hours with compensatory time of 20 minutes per hour for person with benched mark disabilities.**
1) Veterinary Anatomy	**40**	
2) Veterinary Surgery and Radiology	**40**	
3) Veterinary Medicine	**40**	
4) Veterinary Gynaecology and Obstetrics	**40**	
5) Veterinary Pharmacology and Toxicology	**40**	

AH&VETY PAPER–I

1. LIVESTOCK PRODUCTION MANAGEMENT (40 marks)

Demographic distribution of livestock and role in Indian economy. Common animal Husbandry (Glossary). Body conformation and identification. Common vices of animals. Selection and purchase of livestock. Judging and BCS for body parts of livestock. Selection of site, housing systems, layout and design of different buildings for various species, *viz.* cattle, buffalo, sheep, goat, pig and poultry. Breeds of domestic animals, pet animals and pet birds and their characteristics. Care and management of different domestic animals and birds. Principles of incubation and hatchery management practices. Selection and care of hatching eggs and hatchery hygiene. Candling, sexing, grading, packing and disposal of hatchery waste. Animal waste management, pollution and environmental issues. Breeds of cattle, buffalo, sheep, goat, pig and poultry and their characteristics. Care and management of cattle, buffalo, sheep, goat, pig and poultry including ducks and Japanese Quail. Common farm managemental practices for cattle, buffalo, sheep, goat, pig and poultry. Restraining of cattle, buffalo, pig. Importance and selection of laboratory animal, care and housing standards of mice, rats, hamster and guinea pigs. Status

and conservation practices of wild life in India. Restraining, handling, physical examination of captive animals.

2. ANIMAL GENETICS AND BREEDING (40 marks)

Mitosis vrs Meiosis. Chromosome numbers and types in livestock and poultry. Overview of Mendelian principles. Modified Mendelian inheritance. Pleiotropy, Penetrance and expressivity. Multiple alleles; lethals; sex-linked, sex limited and sex influenced inheritance. Sex determination. Linkage, crossing over and construction of linkage map. Mutation, Chromosomal aberrations. Cytogenetics, Extra-chromosomal inheritance. Molecular genetics. Gene concept, DNA and its replication. Introduction to molecular techniques.

Population Genetics: Introduction to population genetics; individual vrs population. Genetic structure of population: Gene and genotypic frequency. Hardy-Weinberg law and its application. Forces changing gene and genotypic frequencies (eg. Mutation, migration, selection and drift). Quantitative vrs qualitative genetics; concept of average effect and breeding value. Components of Variance. Concept of correlation and interaction between Genotype and Environment. Heritability and Repeatability. Genetic and Phenotypic Correlations.

Livestock and Poultry Breeding: History of Animal Breeding. Classification of breeds. Economic characters of livestock and poultry and their importance. Selection, types of selection, response to selection and factors affecting it. Bases of selection. Method of selection. Classification of mating systems. Inbreeding, outbreeding, etc. Systems of utilization of heterosis; Selection for combining ability (RS and RRS).Breeding strategies for the improvement of dairy cattle, buffalo, sheep, goat, swine and poultry. Sire evaluation. Open nucleus breeding system (ONBS). Development of new breeds or strains. Current livestock and poultry breeding policies and programmes in the state and country. Methods of conservation-livestock and poultry conservation programmes in the state and country.

3. ANIMAL NUTRITION (40 marks)

Importance of nutrients in animal production and health. Composition of animal body and plants. Nutritional aspect of carbohydrates, protein and fats. Role and requirement of water, metabolic water. Importance of minerals (major and trace elements) and vitamins in health and production, their requirements and supplementation in feed. Common feeds and fodders, their classification, availability and importance for livestock and poultry production. Measures of food energy and their applications. Protein evaluation of feeds - Measures of protein quality in ruminants and non-ruminants, biological value of protein, digestible crude protein. Calorie protein ratio. Introduction to feed technology- Feed industry; Processing of concentrates and roughages. Various physical, chemical and biological methods for improving the nutritive value of inferior quality roughages. Preparation, storage and conservation of livestock feed through silage and hay and their uses in livestock feeding. Feed additives in the rations of livestock and poultry and their uses.

Importance of scientific feeding. Feeding experiments. Digestion and metabolism trial. Feeding standards, their uses and significance. Balanced ration and its characteristics. General principles of computation of rations. Formulation of rations and feeding of dairy cattle and buffaloes during different phases of growth and production (neonate, young, adult, pregnant, lactating and dry animals; breeding bull) and working animals. Formulation of ration and feeding of sheep and

goat during different phases of growth and production (milk, meat and wool).Feeding of high yielding animals and role of bypass nutrients. Metabolic disorders and nutritional interventions.

Nutrient requirements in poultry, swine - Energy and protein requirement for maintenance and production. Feeding standards for non-ruminants and poultry. Formulation of rations as per BIS and ICAR specifications. Feeding of swine and poultry with conventional and unconventional feed ingredients. Feeding of ducks. Nutrient requirements of mice, rat, rabbit and guinea pig. Nutrient requirement and feeding of different categories of dogs and cats; peculiarities of feeding cats.

4. VETERINARY AND ANIMAL HUSBANDRY EXTENSION EDUCATION (40 marks)

Classification of farming. Early extension efforts in India. Extension education: Concept, levels, objectives and dimensions. Principles, philosophy and functions of extension education. Teaching learning process and steps in extension teaching. Rural development and importance of rural development programmes for poverty alleviation. Panchayati Raj System. Rural society. Characteristics and differences among tribal, rural and urban communities. Social control. Social stratification. Social institutions in rural society. Social change and social groups. Salient features of recent livestock census, livestock insurance scheme, national livestock mission. Introduction to animal welfare, ethics and rights.

Communication and its functions. Types of communication. Elements of communication. Barriers of communication. Individual contact methods, Group contact methods, Mass contact methods. Selection and use of extension teaching methods. Information kiosk, E-learning, CAD, virtual class room, virtual reality, multi-media etc. Cyber extension- problems and prospects in livestock extension. Computer networking. Technology-Concept, generation process, application, merits and de-merits. Adoption and diffusion of innovations . Programme planning. Dairy development programmes. Concept of cooperation, Rochdale principles of cooperation, objectives of cooperative, Amulpattern of dairy cooperative system and Operation Flood. Transfer of technology projects of ICAR, KVK, ATIC, ATMA, NAIP, RKVY, etc. Different on-going central and state government animal husbandry development programmes being run related to sheep, goat, poultry, piggery, fodder production etc.

Introduction to Economics and Livestock Economics: definition and scope. Important features of land, labour, capital and organization. Theories of demand, supply and cost. Theories of production. Concept of market. Market price and normal price, price determination under perfect competition in short and long run. Definition of entrepreneur, entrepreneurship, enterprise and manager. Types, characteristics and functions of an entrepreneur. Business plan for enterprise. Institutions promoting entrepreneurship in India

5. LIVESTOCK PRODUCTS TECHNOLOGY (40 marks)

Milk industry in India. Layout of milk processing plant and its management. Composition and nutritive value of milk and factors affecting composition of milk. Physico-chemical properties of milk. Microbiological deterioration of milk and milk products. Collection, chilling, standardization, pasteurization, UHT treatment, homogenization, bactofugation. Dried, dehydrated and fermented milk. Preparation of cream, butter, paneer or chhanna, ghee, khoa, lassi, dahi, ice-cream. Common defects of milk products and their remedial measures. Packaging of milk and milk

products. Good manufacturing practices and implementation of Food safety standards for milk and milk products.

Layout and management of rural, urban and modern abattoirs. FSSAI standards on organization and layout of abattoirs. Animal welfare and pre-slaughter care, handling and transport of meat animals including poultry. Procedures of Ante-mortem and post mortem examination of meat animals. Slaughtering and dressing of meat animals and birds. Evaluation, grading and fabrication of dressed carcasses including poultry. Abattoir by-products. Skin and hides. Treatment of condemned meat and carcasses. Management of effluent emanating from abattoir.

Prospect of meat industry in India. Structure and composition of muscle (including poultry muscle).Conversion of muscle to meat. Nutritive value of meat. Fraudulent substitution of meat. Preservation of meat and poultry; drying, salting, curing, smoking, chilling, freezing, canning, irradiation and chemicals. Ageing of meat. Modern processing technologies of meat and meat products. Packaging of meat and meat products. Fermentation of meat products. Basics of sensory evaluation of meat products. Nutritive value, preservation, packaging of egg and egg products. Laws governing national or international trade in meat and meat products.Organic and genetically modified meat and poultry products.

AH &VETY PAPER– II

1. VETERINARY MICROBIOLOGY (40 marks)

Introduction and history of Microbiology ; Classification and nomenclature of bacteria; Microscopy; Bacterial stains and techniques; Structure and morphology of bacteria; Growth and nutritional requirement of aerobic and anaerobic bacteria; Types and sources of infection, method of transmission of infection. Pathogenicity, virulence, determinants of virulence, Epizootic and enzootic diseases, bacteremia, septicaemia and toxaemia, endotoxins, exotoxins, antitoxins, toxoids; Bacterial genetics (Mutation, Transformation, Transduction and Conjugation), plasmids and antibiotic resistance. Study of important pathogenic bacteria epidemiology, pathogenicity, diagnosis, prevention and control of bacterial diseases such as Staphylococcus, streptococci, corynebacterium,actinomycetes, Listeria, Erysipelotrix, Bacillus, Clostridium, Mycobacterium, Enterobacteriaceae (*E.coli*, Kleibsiella, Salmonella,Yersinia, Proteus), Pseudomonas and Burkholderia, Vibrio, Actinobacillus, Pasteurella, Mannheimia, Haemophilus, Brucella, Campylobacter, Bordotella, Moraxella. Leptospira, Coxiella, Rickettsia (Indian Tick Typhus and Scrub typhus), Chlamydia and chlamdophilla.

History of Virology; Introduction to viruses; Structure of Viruses; Classification of Viruses; Genetic viral interactions; Viral Pathogenesis, Oncogenesis, latency and immunopathology. Studies of important Viruses such as Poxviridae (Cowpox virus, Lumpy skin disease), Asfaviridae- African swine fever, Herpesviridae - human herpes virus 1&2, bovine mammilitis, IBR, Mareks disease, ILT, Adenovirridae- Bovine adenovirus, porcine adenovirus, Fowl adenovirus, Egg drop syndrome, Papillomaviridae - Human, bovine, canine papilloma virus, Parovoviridae- FPV, Canine parvovirus, Circoviridae- PCV, Hepadnaviridae- Hepatitis B virus, Retroviridae- Bovine, Reoviridae- Blue tongue, Rota virus, Birnaviridae-IBD, Paramyxoviridae- Newcastle disease, canine distemper, rinderpest, Rhabdoviridae- Vesicular stomatitis, Rabies, Bovine Ephemeral fever, Bornaviridae,

Orthomyxoviridae- Influenza virus A/B/C, Coronoviridae- Transmissible gastroenteritis virus, Arterivirdae-PRRS, Picornaviridae- FMD, swine vesicular disease, Classical swine fever, Bovine viral diseases in Livestock and Poultry, their Epidemiology, ClinicalSigns, Diagnosis, Prevention and Control. Epidemiology, clinical signs, diagnosis and control of livestock fungal diseases **(**Candidiasis, Crytococcocis, Aspergillosis, Histoplasmosis, Blastomycosis, Rhinospordiosis).

History of Immunology; Lymphoid organs, tissues and Cells: Types of Immunity. Antigens & Antibody. Major histocompatibility complex (MHC).Antigen processing and presentation. Complement system. Cytokines. Hypersensitivity. Autoimmunity; Immunotolerance; Concept of Immunity to Microbes, Vaccines and other biological. Basic concepts and scope of Recombinant DNA technology; Application of molecular and biotechnological techniques: Polymerase chain reaction.

2. VETERINARY PATHOLOGY (40 marks)

Introduction and scope of Veterinary Pathology. Causes of disease. Haemodynamic disorders. Glycogen overload, amyloidosis and fatty changes. Cell injury- degenerations, necrosis and its types, apoptosis, differences between post-mortem autolysis and necrosis, gangrene and its types. Pigments and calcification. Photosensitization. Disturbances in growth. Inflammation. Wound healing. Immunopathology. Animal Oncology- Definitions, general characteristics and classification of neoplasms. Pathology of various types of tumours in domestic animals. Veterinary Clinical Pathology: Haematology, Urinalysis, etc. Biopsy and cytology. Necropsy. Pathological changes affecting Digestive, Respiratory, Musculoskeletal, Cardiovascular, Haematopoietic, Lymphoid, Urinary, Reproductive, Nervous, Endocrine systems, Skin and Appendages, Ear and Eye.

Pathology of viral infections: Pathogenesis, gross and microscopic pathology of viral infections. Pathology of prion diseases. Pathology of bacterial infections: Pathogenesis, gross and microscopic pathology of bacterial infections. Pathogenesis, gross and microscopic pathology of fungal infections and mycotic diseases. Pathogenesis, gross and microscopic pathology of parasitic infections. Pathological changes of nutritional imbalances (in brief) due to carbohydrates, proteins, fats, minerals and vitamins and metabolic diseases.

Avian Inflammation. Pathogenesis, gross and microscopic pathology of poultry viral diseases. Pathogenesis, gross and microscopic pathology of poultry bacterial diseases. Pathogenesis, gross and microscopic pathology of Mycoplasma infections, chlamydiosis. Pathogenesis, gross and microscopic pathology of fungal and mycotic diseases. Miscellaneous diseases and common vices.

3. VETERINARY PUBLIC HEALTH & EPIDEMIOLOGY (40 marks)

Aims and scope of Veterinary Public Health. One Health concept and initiatives. Principles and concepts of food hygiene and safety. Milk hygiene. Hygienic and safe milk production practices. Cleaning, sanitation and hygiene of milk plant, meat plant, abattoir and dairy equipments. Pathological conditions associated with the transport of food animals. Hygiene in abattoirs and meat plants. Detection of conditions or diseases and judgements during ante mortem and post mortem inspection. Meat as a source of disease transmission. Sources of contamination of meat and methods of carcassde contamination. Occupational health hazards in abattoir and meat plants. Foodborne infections and intoxications associated with

foods of animal origin such as (*Bacillus cereus*, Campylobacteriosis, *Clostridium botulinu*m, *Clostridium perfingens*,*E. coli*, Listeriosis, Non typhoidal salmonellosis, *Staphylococcus aureus*, Shigellosis, *Vibriocholerae*, *Vibrio parahaemolyticus*, Q fever, Poliomyelitis Hepatitis A, Aflatoxicosis. Toxic residues (pesticides, antibiotics, metals and hormones) in foods and associated health hazards.Types of biohazards. Hazard analysis and critical control points(HACCP) system. International food safety standards: OIE, WTO agreements and Codex Alimentarius Commission. Sanitary and phytosanitary measures in relation to foods of animal origin. Food Safety and Standards Act and Regulations. Role of FSSAI, BIS, etc.

Epidemiology- Principle, definition of epidemiological terms, application of epidemiological measures in the study of diseases and disease control. Strategies of disease management: prevention, control and biosecurity. National and international regulations on livestock diseases. Zoonosis-Definition, history and socio-economic impact of zoonotic diseases. Classification, prevention and control of zoonoses such as Bacterial Zoonoses (Anthrax, Bartonellosis, Borreliosis, Brucellosis, Campylobacteriosis, Cat scratch disease, Erysipelas, Glanders, Helicobacter gastritis, Leptospirosis, Listeriosis- Listeria monocytogenes, Melidiosis, Rat Bite fever, Tetanus, tuberculosis, Plague).Viral zoonoses (Monkey pox virus, Rota virus, Colorado tick fever, Newcastle disease, Hendra and Nipah virus, Rabies, Swine influenza, Avian influenz, CCHF, rift valley fever, Sandfly fever, Hantavirus, Lymphocytic Choriomeningitis virus, Foot Mouth Disease, Enchephalomyocarditis, Chikungunya, Yellow fever virus, Dengue, West Nile fever, Japanese Encephalitis fever, Kyasanur forest disease, Hepatitis E virus).Prions (Scrapie/ bovine spongiform encephalopathy, Kuru/Creutzfeldt Jacob disease).Fungal (Candidiasis, Crytococcocis, Aspergillosis, Histoplasmosis, Blastomycosis, Rhinospordiosis), Parasitic: -(Toxoplasmosis, Cryptosporodiosis, Leishmaniosis, VLM, CLM, Ancylostomiasis, Trichinosis, Taeniasis and cysticercosis, Diphyllobothriosis, Cercarialdermatidis, Fasciolopsis, Paragonimiasis, Scabies). Rickettsia (Indian Tick Typhus and Scrub typhus), Chlamydia and chlamdophilla.

Emerging, re-emerging and occupational zoonoses. Roleof domestic, wild, pet and laboratory animals and birds intransmission of zoonoses. Bioterrorism. Epidemiology, clinical manifestations and management of zoonoses.

Environmental contaminants in food chain-bioaccumulation, biomagnifications and persistent organic pollutants. Environmental pollution Air pollution. Air borne diseases. Water contamination. Water qualities. Water purification methods. Water borne diseases. Soil, marine and thermal pollution. Noise pollution. Nuclear hazards or radiological hazard). Disaster management and mitigation. Biomedical waste management. Global warming and greenhouse effect. Carcass disposal.

4. VETERINARY PHYSIOLOGY & BIOCHEMISTRY (40 marks)

Blood constituents and their functions. Haemostasis. Resting membrane potential and action potential. Conductive systems of the heart. Cardiac cycle. Electrocardiograph. Haemodynamics of circulation. Neuro muscular junction. Mechanism of muscle contraction in skeletal, cardiac, and smooth muscles. Organization of the nervous system. Autonomic nervous system. Types of neurons and their functions. Synapse. Special sense organs.

Prehension, mastication, and deglutition. Regulation of secretory functions of salivary glands, stomach, liver, pancreas, and intestine. Digestion and absorption of carbohydrates, protein, and fats in monogastric and polygastric animals. Digestion

in birds. Mechanics of breathing. Transport of blood gases. Neural and chemical regulations of breathing. Adaptation of respiration during muscle exercise. Respiration in birds.

Formation of dilute and concentrated urine in mammals. Acid-base balance. Formation and excretion of urine in birds. Synthesis, secretion, and transport of hormones. Mechanism of action of hormones. Hormones of the hypothalamus, pituitary glands, thyroid glands, parathyroid glands, adrenal glands, pancreas, testes, and ovaries. Gametogenesis. Folliculogenesis.

Puberty. Estrous cycle. Ovulation. Fertilization. Pregnancy. Parturition. Biosynthesis of milk constituents. Galactopoiesis. Lactogenesis. Growth curves. Growth in meat-producing animals. Thermoregulation in farm animals. Responses of animals to heat and cold. Effect of different environmental variables (temperature, humidity, light, radiation, and altitude) on animal performance. General adaptive syndrome. Circadianrhythm. Neurophysiology of behaviors. Types of behavior. Communication.

Scope and Importance of Biochemistry. Structure of Biological Membranes and Transport across Membranes. Donnan Membrane Equilibrium. Dissociation of Acids, pH, Buffer Systems, Biochemistry of Carbohydrates. Biochemistry of lipids. Fat indices. Structure and functions of prostaglandins. Biochemistry of proteins. Amino acids. Biochemistry of nucleic acids: Chemistry of purines, pyrimidines, nucleosides and nucleotides. Biological significance of nucleosides and nucleotides. Structures and functions of deoxyribonucleic acid (DNA) and atypical ribonucleic acid(RNA).

Enzymes: Definition and classification. Properties. Factors influencing enzyme action. Enzyme units. Enzyme inhibition. Respiratory chain or electron transport chain, oxidative phosphorylation, inhibitors, uncouplers and other factors influencing electron transport chain. Carbohydrate metabolism. Lipid metabolism. Protein metabolism. Deamination, transamination and decarboxylation of amino acids. Ammonia transport and urea cycle. Nucleic acid metabolism. DNA and RNA biosynthesis and regulation. Regulation and Integration of metabolism. Disorders of Carbohydrate Metabolism: Diabetes mellitus, Ketosis, Bovine Ketosis, Pregnancy toxemia, hypoglycaemia in baby pigs, hyperinsulinism in Dogs. Hormonal control of carbohydrate metabolism and regulation of blood sugar. Biochemical tests for the detection of disturbance in carbohydrate metabolism. Plasma Proteins and clinical significance. Lipid Profile in disease diagnosis. Liver function tests. Biochemical tests of renal function. Disturbance in acid base balance and its diagnosis. Biochemistry of digestive disorders.

5. VETERINARY PARASITOLOGY (40 marks)

Types of parasites, types of hosts and vectors, modes of transmission of parasites and methods of dissemination of the infective stages of various parasites. General harmful effects of parasites including various tissue reactions caused by parasites, pathogenesis, epidemiology and general control measures (chemo- and immunoprophylaxis). Introduction, and general account of flukes such as *Fasciola*,amphistomes, *Opisthorchis* and *Paragonimus*;tapeworms such as *Dipylidium*, *Taenia*, *Echinococcus* and *Diphyllobothrium*; round worm such as *Ascaris*, *Toxocara* and *Strongyloides*, *Oesophagostomum*, hook worms, gastrointestinal nematodes of ruminants (GIN), *Thelazia, Spirocerca*, *Dirofilaria*, *Trichinella* and *Trichuris.* Study of anthelmintic resistance and its types.

Introduction and general life cycles of arthropods. Important morphological features, general bionomics, vector potentiality, pathogenesis and control of arthropods affecting animals and birds. *Musca*, *Stomoxys*, *Chrysops*, bottle flies/myiasis, lice and fleas. General account of soft ticks (*Argas, Ornithodoros* and *Otobius*). Hard ticks (*Hyalomma*, *Haemaphysalis*, *Rhipicephalus* (*Boophilus*) and *Amblyomma*). Mites (*Demodex*, *Notoedres*, *Sarcoptes*, *Psoroptes*, *Chorioptes*, *Cnemidocopte s*and *Otodectes*). Study of insecticide or acaricide resistance.

Introduction and general life cycle of protozoa of veterinary importance. Important morphological features, life cycles, modes of transmission of the following parasites such as *Trypanosomaevansi*, *Histomonas*, *Entamoeba* and *Giardia*. Coccidiosis of poultry and domestic animals. Cyst forming coccidia (*Toxoplasma*, *Sarcocystis and Neosporacaninum*) including *Cryptosporidium*. Piroplasms (canine and bovine *Babesia*spp., bovine*Theileria*spp.) and *Anaplasma, Cytauxzoon* and *Ehrlichia*.

AH & VETY PAPER–III (200marks)

1. VETERINARY ANATOMY (40 marks)

Introduction to anatomy and branches of anatomy and descriptive terms used. General Osteology, Arthrology and Myology: Study of properties and structure of bone. Classification of skeletons, classification of bones. Introduction to arthrology, classification of joints, structure of diarthrodial joints. Introduction to myology, classification of muscles, etymology of muscles. Description of tendon, ligaments, aponeurosis, synovial bursa and synovial sheath. General Angiology, Neurology and Aesthesiology: Introduction to angiology. Structure of heart. General plan of systemic and pulmonary circulations, lymphatic and venous systems. Introduction to neurology and parts of central, peripheral and autonomic nervous system and sense organs. Different surface regions, joint regions, Palpable Bony areas or prominences of the body of the animal. Palpable Lymph nodes and Arteries of the body and Surface veins for Vene puncture. General Splanchnology: Introduction, boundaries of thoracic, abdominal and pelvic cavities, topography of different organs of digestive, respiratory, urinary, endocrine, male and female reproductive systems of domestic animals and fowl.

Fore limb: Bones of fore limb of ox and differences. Joints, ligaments, stay apparatus, major blood vessels, nerves, veins and lymph nodes of fore limb. Head and neck: Cranial and facial bones, cervical vertebrae of ox and differences. Articulations and special ligaments of the head and neck. Muscles of face, mastication, eye, ear. Teeth, hard and soft palate, tongue, pharynx, larynx, thyroid, parathyroid and salivary glands and differences. Cranial nerves, blood vessels and lymph nodes of head and neck regions. Study of sense organs, trachea and oesophagus. Sites for Tracheotomy, Esophagotomy, Cornual, Importance of Cornual nerve and superficial Temporal artery in Amputation of Horn in cattle.

Thorax: Thoracic vertebrae, ribs and sternum of ox and differences in dog, pig and fowl. Joints, special ligaments, blood vessels, nerves. Organs of thorax and differences. Pleura, its reflections and mediastinum. Areas of auscultation and percussion of heart and lungs. Abdomen: Bones of abdomen of ox and differences. Joints, special ligaments blood vessels, nerves of abdomen region. Blood and nerve supply to abdominal viscera. Peritoneal reflections, organs of digestive, urinary,

male and female reproductive systems present in abdomen and differences. Mammary glands in cow and differences. Spleen of ox and differences. Major veins, lymphvessels, lymphnodes and endocrine glands of abdomen. Boundaries and Clinical importance of the flank and Para Lumbar Fossa. Sites for Laparotomy, Rumenocentesis, Rumenotomy, Caesarean Operation.

Hind limb and pelvis: Bones of hind limb and pelvis of ox and differences in horse, dog, pig and fowl. Joints, ligaments, blood vessels, lymph nodes and nerves of hind limb, pelvis and tail region and pelvic viscera. Pelvic peritoneal reflections, organs of digestive, urinary, male and female reproductive systems present in pelvic cavity and differences in horse, dog, pig and fowl. Boundaries of the inguinal canal and structures of the spermatic cord, pre pubic tendon and its importance. External genital organs.

Cytology, cell junctions, study of basic tissues. Microscopic structures of digestive, circulatory, urinary, respiratory, nervous, lymphatic, endocrine, male and female genital systems and mammary glands of domestic animals. Microscopic structure of sense organs i.e. eye, ear and integument. Introduction to embryology, gametogenesis, fertilization, cleavage, types of eggs, morula, blastulation, gastrulation, types of implantations, twinning. Formation of foetal membranes in mammals and birds, Placenta and its classification. Different germ layers and their derivatives. Development of organs of digestive system including accessory structures i.e tongue, teeth, salivary glands, liver and pancreas.

2. VETERINARY SURGERY AND RADIOLOGY (40 marks)

Introduction: Historical perspective, Definitions, classification of surgery, tenets of Halsted. Pre-operative, intraoperative and post operative considerations: Sterilization and disinfection. Sutures. Treatment of acute and chronic inflammation. Haemostasis. Basic surgical affections. abscess, tumour, cyst, hernia, haematoma, necrosis, gangrene, burn and scald, frost bite. Veterinary anaesthesiology: Introduction: Development of anaesthesiology, Terminology, classification and indications. General considerations of anaesthesia: Painandits management in animals. Local and regional anaesthesia. Preanaesthetics. General anaesthesia. Dissociative anaesthesia. Toxicity, antidote and reversal agents.

Introduction to Radiology-General terminology of radiology, Physical properties of X-Rays, cope and uses of Radiology, Directional terms for veterinary radiology. Radiation hazards and safety measures. Production of quality diagnostic radiograph. Contrast radiography. Diagnostic ultrasonography. Advanced diagnostic imaging tools- The brief introduction to the use and limits of some advanced imaging techniques, Canine lameness. Bovine lameness. Fracture. Luxations. Spinal trauma, diagnosis and its management.

Regional Surgery of Head and Neck: Affections of lips, cleft palate, tongue, cheek, and their treatment. Affections of teeth and jaws and their treatment. Affections of nose, face, ear, head and horn and their treatment. Affections of eye and their treatment. Oesophagus and their treatment. Affections of larynx and Trachea. Thoracic affections: Surgical approaches, perforated wounds, pyothorax, pneumothorax, pneumocele, Diaphragmatic hernia and traumatic pericarditis in cattle .Abdominal affections: Surgica approach to the abdomen indifferent animal species. Surgical affections of the stomach in large animal and their management. Surgical affections of small intestines, large intestine and their management. Urinary system. Genital system: Surgical affections of male and female genital system and their management.

3. VETERINARY MEDICINE (40 marks)

History and scope of Veterinary Medicine, concept of animal diseases. Concepts of diagnosis, differential diagnosis, treatment and prognosis. General systemic states, hyperthermia, hypothermia, fever, septicemia, toxemia, shock, allergy, anaphylaxis, oedema ,coma, anaemia, common clinical poisonings and dehydration.

Etiology, clinical manifestations, diagnosis, differential diagnosis, treatment, prevention and control of the following diseases of cattle, buffalo, sheep, goat, pig, dog, cat and poultry: Diseases of digestive, respiratory, cardiovascular, urinary, nervous, musculoskeletal, haemopoietic, and lymphatic systems, skin, sense organs including affections of peritoneum, liver and pancreas. Emergency medicine and critical care. Diagnosis and management of diseases caused by deficiency of iron, copper, cobalt, zinc, manganese, selenium, calcium, phosphorus, magnesium, iodine, vitamin A, D, E, B complex, K and C. Diseases of neonates, Aetiology, clinical manifestations, diagnosis, differential diagnosis, treatment prevention and control of metabolic or production and endocrine diseases of cattle, buffalo, sheep, goat ,pig dog, cat and poultry.

Aetiology, epidemiology, clinical manifestations, diagnosis, treatment, prevention and control of bacterial, fungal and rickettsial diseases of livestock. Aetiology, epidemiology ,clinical manifestations, diagnosis, treatment, prevention and control of viral and parasitic diseases of diseases of cattle, buffalo, sheep, goat, horse, pig, dog, cat and poultry. Principles of zoo hygiene, public health problems arising from zoos.

Legal duties of veterinarians, laws related to medicine, evidence, common offences against animals and laws related to these offences. Examination of living and dead animals in criminal cases. Cruelty to animals and bestiality. Legal aspects of: Examination of animals for soundness, examination of injuries and post-mortem examination. Causes of sudden death in animals. Provincial and Central Acts relating to animals. Glanders and Farcy Act1899 (13 of 1899).Dourine Act 1910 (5 of 1910), Laws relating to offences affecting Public Health. Laws relating to poisons and adulteration of drugs. Livestock importation act, liability and insurance. Code of conduct and ethics for veterinarians - the regulations made under the Act. Animal welfare. Animal Welfare organizations and its role in animal welfare.

4. VETERINARY GYNAECOLOGY AND OBSTETRICS (40 marks)

Veterinary gynaecology. Bovine: Applied clinical anatomy and embryology of female reproductive tract- Applied reproductive physiology and endocrinology of oestrouscycle. Transportation and survivability of gametes in female reproductive tract – Follicular Dynamics-ovulation and aberrations of ovulation-Incidence causes, diagnosis treatment and prevention of ovulatory failures-Fertilization. Pathological affections of ovary, uterine tubes, uterus, cervix, vagina and external genitalia. Clinical management of specific and non-specific forms of infectious infertility. Role of nutrition, climate and stress on reproductive efficiency-Infertility-Anoestrus and repeat breeding syndrome. Herd reproductive health management and fertility parameters in individual animals and in herds. Assisted reproductive techniques. Techniques of Pregnancy diagnosis. Phantom pregnancy – Medical termination of pregnancy– Aberrations of oestrous cycle- Methods of Population control by medical and surgical techniques. Principle, procedure and application of ultrasonography in farm and pet animal reproduction.

Veterinary obstetrics. Farm and pet animals - Maternal recognition of pregnancy – Applied Endocrinology of pregnancy– Pregnancy diagnosis – Duration of pregnancy-Implantation, Placentation. Wandering of ovum- Telegony-Superfetation and Superfecundation – Clinical management of specific and non specific causes of abortion, mummification, maceration, cervicovaginal prolapsed, uterinetorsion. Parturition. Lactational disorders - Puerparium and factors affecting puerparium - Postpartum care of the dam and neonate in different species of farm and pet animals–Dystocia. Fetotomy. Cesarean section in small and large animals–Maternal obstetrical paralysis - Retention of fetal membranes, Total uterine prolapse and common metabolic diseases of puerperal period– Injuries incidental to parturition – Post partum uterine infections – Postpartum resumption of ovarian activity.

Veterinary andrology and A.I. Farm and pet animals - Comparative clinical reproductive anatomy and endocrinology of the male reproduction - - Sexual behavior and libido- Sperm transport, erection and ejaculation –Coital injuries and vices in male animals - Semen and ejaculate – Semen collection techniques-Structure of Spermatozoa - Semen evaluation - Semen extenders, dilution, preservation and post thaw evaluation - Artificial insemination techniques in farm and pet animals - Forms of male infertility. Breeding soundness evaluation of bull – In vitro tests for evaluation of male fertility -Medical and surgical techniques for population control of the male reproduction – Surgical procedure on the male reproductive tract in farm and pet animals.

5. VETERINARY PHARMACOLOGY AND TOXICOLOGY (40 marks)

Introduction, Principles of drug activity: Pharmacokinetics & Pharmaco dynamics. Adverse drug reactions, drug interactions. Drugs acting on digestive system. Rumen pharmacology. Drugs acting on cardio vascular system. Drugs acting on respiratory system. Drugs acting on urogenital system. Pharmacological basis of fluid therapy. Pharmacotherapeutics of hormones. Drugs acting on skin and mucous membranes.

Neurohumoral transmission, Pharmacology of neurotransmitters. Autacoids pharmacology. Classification of drugs acting on CNS. History, mechanism and stages of general anaesthesia. Inhalant, intravenous and dissociative anaesthetics. Hypnotics and sedatives; psychotropic drugs, anticonvulsants, opioid analgesics, non-steroidal anti-inflammatory drugs, analeptics and other CNS stimulants. Drugs acting on somatic nervous system: Local anaesthetics, muscle relaxants Euthanizing agents.

Antimicrobial agents: Classification, general principles in antimicrobial chemotherapy, antimicrobial resistance, combined antimicrobial therapy Antitubercular drugs. Antifungal agents. Antiviral and anticancer agents. Anthelmintics. Antiprotozoal agents. Ectoparasiticides. Antiseptics and disinfectants. Pharmacology of drugs of abuse in animals. Pharmacology of indigenous medicinal plants.

General Toxicology: Sources and classification of toxicants, factors modifying toxicity, general approaches to diagnosis and treatment of poisoning. Toxicity caused by metals and non-metals. Poisonous plants. Toxicity caused by Agrochemicals. Fungal and bacterial toxins. Venomous bites and stings.

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E. TECHNICAL PAPERS FOR FISHERIES EXTENSION OFFICER

Technical Subject Paper - I : 200 Marks

1) Principles of Aquaculture and Freshwater Aquaculture : 30 marks
2) Taxonomy of Fin Fish and Shell Fish : 20 marks
3) Limnology : 20 marks
4) Soil and Water Chemistry : 20 marks
5) Aquaculture in Reservoir : 20 marks
6) Aquatic Ecology, Biodiversity and Disaster Management : 20 marks
7) Fisheries Extension & Education : 10 marks
8) Statistics and Economics : 10 marks
9) Ornamental Fish Production and Management : 20 marks
10) Finfish Hatchery Management : 30 marks

Technical Subject Paper - II : 200 Marks

1) Anatomy and Biology of Fin Fish and Shell Fish : 30 marks
2) Physiology of Fin Fish and Shell Fish : 30 marks
3) Genetics and Breeding : 30 marks
4) Freshwater and Coldwater Fisheries : 20 marks
5) Fish Food Organisms : 20 marks
6) Aquaculture Engineering : 30 marks
7) Fish in Nutrition : 20 marks
8) Fishing Crafts and Gears : 20 marks

Technical Subject Paper - III : 200 Marks

1) Food Chemistry and Biochemistry : 40 marks
2) Fish immunology, Disease and Management : 40 marks
3) Microbiology of Fish and Fishery Products : 40 marks
4) Fish Processing Technology : 40 marks
5) Fish Population Dynamics and Stock Assessment : 40 marks

TECHNICAL SUBJECT PAPER – I

1) Principles of Aquaculture and Freshwater Aquaculture (30 marks)

Basics of aquaculture, definition and scope. History of aquaculture: Present global and national scenario. Aquaculture vs Agriculture. Systems of aquaculture - pond culture, pen culture, cage culture, running water culture and zero water exchange system,. Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water inland saline and marine water. Principles of organic aquaculture. Pre-stocking and post stocking pond management. Carrying capacity of pond, factors influencing carrying capacity. Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture: freshwater, brackish-water and marine. Monoculture,

polyculture and integrated culture systems. Water and soil quality in relation to fish production. Physical, chemical and biological factors affecting productivity of ponds.

Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs etc. Nursery, rearing and growout ponds preparation and management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding. Water quality management. Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods-Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and biofertilizer in aquaculture. Composite fish culture system of Indian and exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfish and murrels.

Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/ horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.

2) Taxonomy of Fin Fish and Shell Fish (20 marks)

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Introduction to modern taxonomic tools: karyotaxonomy, DNA barcoding, protein analysis and DNA polymorphism.

Study of external morphology and meristic characteristics of crustacea and mollusca. Classification of crustacea and mollusca up to the level of species with examples of commercially important species.

3) Limnology (20 marks)

Introduction to limnology: inland water types, their characteristics and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes - their origin and diversity. Famous lakes of the world and India; nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity: Aquatic plants: characteristics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role. Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships

in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

4) Soil and Water Chemistry (20 marks)

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve; nomograph.

Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. Composition of waters: surface water, ground water and sea water. Dissolved gasses: Factors affecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples. Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture.

Soil Chemistry: origin and nature of soils. Physical properties of soil; soil colour. texture, structure, pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soil samples. Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture.

5) Aquaculture in Reservoir (20 marks)

Definition of reservoirs in India; nature and extent of reservoirs, topography and species diversity; importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production; trophic phases in reservoir; pre-impoundment and postimpoundment stages and their significance in establishment of reservoirs fisheries.

Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production.

Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs

Role of cage and pen culture in enhancement of fish production from reservoirs; history of cage culture, advantages of cage culture; selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system. Integration of cage culture with other farming systems.

History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens. Suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture.

6) Aquatic Ecology, Biodiversity and Disaster Management (20 marks)

Aquatic environment, Flora and fauna: Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries. Conservation programmes for endangered species, ex situ and in situ conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India. Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and effects of disasters. Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and nonstructural mitigation measures. During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices. Postdisaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation. Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global levels. Sea safety and health. Acquaintance with fire-fighting devices. Life saving appliances and first-aid. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counselling.

7) Fisheries Extension & Education (10 marks)

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations; Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation.

8) Statistics and Economics (10 marks)

Definition of statistics, Concepts of population, sample, Census and sample surveys, Classification of data, frequency and cumulative frequency table. Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and Ogives. Important measures of central tendency - arithmetic mean median and mode. Relative merits and demerits of these measures. Important measures of dispersion, Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures. Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis.

Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem. Introduction to statistical inference, general principles of testing of hypothesis, types of errors. Tests of significance based on Normal, t, and Chi-square distributions. Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression, Length weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production Contribution of fisheries sector to the economic development of the country. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost. Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalization: dimensions and driving Forces. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

9) Ornamental Fish Production and Management (20 marks)

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filteration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration.

Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

10) Finfish Hatchery Management (30 marks)

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carps, mahaseers, trouts, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea hourse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps.

TECHNICAL SUBJECT PAPER - II

1) Anatomy and Biology of Fin Fish and Shell Fish (30 marks)

Study of external and internal anatomy of important groups of finfish. Study of oral region and associated structures. Digestive system and associated digestive glands. Food and feeding habits of commercially important fishes. Qualitative and quantitative methods of analysis of gut contents. Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology. Age and growth determination by direct and indirect methods. Fish migration - type and significance. Tagging and marking.

Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. Food and feeding habits, growth, moulting, length – weight relationship. Reproductive biology, larval stages. Age and growth determination by direct and indirect methods.

2) Physiology of Fin Fish and Shell Fish (30 marks)

Water as a biological medium. Gas exchange; Circulation; Excretion; Osmoregulation; Reproductive physiology; Muscle physiology; Sense organs; Energy and nutrient status of food; Nitrogen balance; Standard and active metabolism; Energy utilization; Effect of environmental factors on physiology of fin and shellfishes. Stress related physiological changes. Structure and functions of important endocrine glands.

3) Genetics and Breeding (30 marks)

Principles of genetics and breeding, Gene and chromosome as basis of inheritance, Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. Sex - linked genes, sex influenced and sex limited traits. Linkage and crossing over. Introduction to population genetics. Hardy- Weinberg law and its significance. Chromosomal structure and aberrations. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Sex determination. Cross breeding (hybridization) – types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability. History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

4) Freshwater and Coldwater Fisheries (20 marks)

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India. Potential of inland water bodies with reference to respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears. Major riverine and estuarine systems of India. Major brackish water lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Flood-plain capture fishery present status of their exploitation and future prospects. Cold water fisheries of India.

5) Fish Food Organisms (20 marks)

Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials - proximate composition of live feed. Biology, culture requirements and methodology of important live food organisms; Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish.

6) Aquaculture Engineering (30 marks)

Fish Farm- Definition, objectives, types of farms; fresh water, brackish water and marine farms. Selection of site for aqua farm- site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristics.

Land Surveying- definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due the incorrect chain length. Chain surveying- definitions, instruments used for setting out right angles, basic problems in chaining, cross staff survey. Compass surveying - definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. Leveling - definitions, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling. Plane table surveying- instruments required, working operation, methods. Contour surveying- definition, contour interval, characteristics of contour, contouring methods and uses of contour.

Calculation of area of regular and irregular plane surfaces, Trapezoidal and Simpson's rule, volume of regular and irregular shape as applied to stacks and heaps, calculation of volume of pond. Earth work calculations- excavation, embankment, longitudinal slope and cross slope, calculation of volume of earth work as applied to roads and channels.

Soil and its properties- classification of soil; soil sampling methods; three phase system of soil, definitions of soil properties and permeability of soil. Ponds - classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fish ponds, layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds; Types of ponds; nursing ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry; shape, size, bottom slope of pond etc., construction ponds viz., marking, excavation etc., Dykes, types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes.

Water distribution system- canal, types of canals; feeder canal, diversion canal etc., Pipe line system, Water control structures- types of inlet and out let and their construction. Water budget equation, Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms- tide fed, pump fed farms, site selection - topography, tidal amplitude, soil and water sources etc., Hatcheries- site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries- brood stock ponds, artemia hatching tanks, sheds etc, Raceway culture system- site selection, layout plan, types of raceway culture system viz.,parallel system, series system etc., Aerators- principles, classification of aerators and placement aerators. Pumps purpose of pumping, types, selection of pump, total head, horse power calculation. Filters-types and constructions.

7) Fish in Nutrition (20 marks)

Composition of fish with emphasis on nutritional value. Concept of Biological value, Protein Efficiency ratio, Net protein utilization. Amino acids of fish and shellfishes and importance of essential amino acids. Fish lipids: fatty acids, nutritional quality. Role of fish lipids in human nutrition. Non-protein nitrogen substances in fishes. Vitamins in fish: water soluble, fat soluble, significance in human nutrition. Minerals in fish: micro- and macro-elements, trace elements, significance in human nutrition. Other functional bio-molecules in fish – peptides, collagen and squalene. Effect of different kinds of cooking fish ie. curry, frying, steaming, smoking, fermentation on nutrition value.

8) Fishing Crafts and Gears (20 marks)

Introduction: History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History & development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes Calculation of longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels- longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT). Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance of fishing vessels. fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminium boats. Introduction of Outboard and inboard engines.

Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear and methods of the world; International Standard Statistical Classification of Fishing gear (ISSCFG).

Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns. Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test.

Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order; Construction of ropes and their higher order; construction of braided netting twines. Yarn numbering system - direct system: Tex system Denier system and calculation of resultant tex value. Indirect system : British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing;, advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond; square hexagonal and their measurement.

Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velacity, weather resistance, melting point and visibility. Chemical and Biological properties.

Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation.

Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board.

TECHNICAL SUBJECT PAPER - III

1) Food Chemistry and Biochemistry (40 marks)

Composition of food and nutritional value. Moisture in foods. Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation. Carbohydravtes: Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic. Lipids: metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Proteins: metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. Deamination reactions and nitrogen excretion with special reference to fish. Fish muscle proteins, chemical changes in muscle during contraction. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturised proteins. Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. Role of fibre in human nutrition.

2) Fish immunology, Disease and Management (40 marks)

Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types. epitopes, haptenes. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions. Antigen-antibody interactions- principle, antigenrecognition by B-cells and T cells. Antigen-antibody reaction - Precipittin reactions, agglutination reactions, Microorganisms associated with fishes in health and disease. Defense mechanism in finfish and shellfish-specific and non specific immune system. Pathogenicity and virulence. Sources of infection, transmission of disease producing organisms, portals of infection. Immunity to bacteria, fungi and parasites Role of stress and host defense mechanism in disease development. Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. Serological methods in disease diagnosis. Immunostimulants –types, mechanism of action, modes of administration. Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

General characteristics, life cycle, diagnosis, prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Vaccines, Immuno-stimulants, Bioremediation, Probiotics, Crop rotation, Good and Best management practices. SPF and SPR stocks –development and application. Bio-security principles, Sanitary and phytosanitary Agreement, Disease control through environmental

management. Importance of Biofilm, Biofloc, Periphyton in aquatic Health Management, Zoonotic diseases. Principles of disease diagnosis, conventional, molecular and antibody based diagnostic methods, Rapid diagnostic methods.

Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms used and classification of AMA. Antibacterial agents, mode of action, general principles, classification, Antibiotics, different classes and their mode of action, properties etc. Antibiotic resitance. Antiseptics and disinfectants. Antiparasiticides: Ectoparasites, Endoparasites and Protozoanes. Antibiotics used in aquaculture Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders and dosage. Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anaesthetics, flesh color enhancers, Chemicals of therapeutic value, Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices, list of the drugs used in aquaculture with therapeutics.

3) Microbiology of Fish and Fishery Products (40 marks)

Introduction and history of microorganisms in foods. Role and significance of microorganisms in nature and in foods. Sources and types of microorganisms in fish and fishery products. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food.

Enumeration of microorganisms in food by conventional and rapid techniques. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. Microbiology and spoilage of fresh, semi processed and processed fish and fishery products. Indicators of microbiological quality of fish and fishery products.

Food borne pathogens involved in infective and intoxication type of food poisoning – Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter and Staphylococcus aureus – their occurrence, growth, survival, pathogenicity and prevention. Other biological hazards associated with fish and fishery products-marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

4) Fish Processing Technology (40 marks)

Principle of fish preservation and processing. Processing of fish by traditional methods– salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting–wet salting and dry salting. Drying and dehydration-theory, importance of water activity in relation to microbial growth. Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt cured fish. Quality standard for salted and dry fish. Fish preservation by smoking-chemical composition of wood smoke and their role in preservation. Methods of smoking and equipments used for smoking. Carcinogenic compound in wood and method store move them. Hurdle technology in fish preservation and processing. Marinaded and fermented fish products–role of acid sin marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Fermented fish products of Southeast Asia. Principles and methods of preparation of various fish paste products like fish sausage, fish

ham, surimi, fish cake, kamaboko etc. Fish muscle structure, my ofibriller protein and their role in elasticity formation. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products. Value addition. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc. And imitation products. HACC Pin safe products production.

5) Fish Population Dynamics and Stock Assessment (40 marks)

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Cario simulation model and ECOPATH model. Estimation of total fishing and natural mortality. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

Note : The pattern of the Technical Papers shall be as follows:

(a) Technical Papers I, II and III shall be divided into 2 Sections. Section-I shall be MCQ carrying 100 marks and Section-II shall be conventional essay type carrying 100 marks.

(b) Section-I shall have 50 MCQs each carrying 2 marks and cover the whole syllabus evenly or based on the mark distribution of different units in the syllabus.

(c) The pattern of conventional essay type questions in Technical Papers I, II and III shall be broadly as prescribed/specified in the Examination Regulations/Syllabus for a particular post. In the absence of specific instructions, there shall be a total of 8 questions in each paper, out of which a candidate shall attempt 5 questions carrying 20 marks each. Each question may contain multiple questions by sub-dividing 20 marks.

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