

ANNEXURE-A

SYLLABUS AND SCHEME OF EXAMINATION FOR THE POST OF FISHERY OFFICER, TFFS Grade I

TOTAL MARKS-180

1. General Fisheries

Fisheries in India and its importance in national economy, food security and employment. History of world and Indian fisheries and aquaculture development. National and state fisheries set up; central and state sponsored schemes and implementation. National and Tripura state fisheries resources, production, productivity. Major technologies of Inland and brackish water fisheries of India and Tripura. National fisheries policies and inland fisheries regulations, Recent sustainable development in fisheries and aquaculture. Fisheries education, research and extension institutes of national importance. Climate change and impacts on fisheries. Different Agro-climate and ecological Zones of India related to fisheries. Major endemic, economically important and exotic fin fish and shell fishes of India and importance.

2. Fisheries Resource Management courses

2.1. Taxonomy of fin and shell fishes

Principles and importance of taxonomy, Nomenclature, types. Classification and inter relationships. Criteria for generic and specific identification. Morphological, morpho metric and meristic characteristics of taxonomic significance. Major taxa of inland and brackish water and commercially important marine fishes up to family level. Commercially important fresh water and brackish water 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 and identification of commercially important crustacea and Mollusca. Classification of crustacean and Mollusca up to the level of species with examples of commercially important species.

2.1. Anatomy, Biology and Physiology of Finfish and shell fish

Study of external and internal anatomy of important groups of fin and shellfish. Study of oral region and associated structures. Digestive system and associated digestive glands, Food and feeding habits of commercially important fin & shell 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 and methods. Fish migration, Tagging and marking of fin and shell fishes.

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.

2.2. Reproductive Biology and Endocrinology:

Sex ratio, Age and Size at maturity, maturity stages, gonadosomatic index, fecundity, development of gametes, vitellogenesis, types of egg, spawning developmental biology of commercial important freshwater finfishes and shellfishes. Natural breeding, seasonality, parental care, mechanism of hatching. Modes of reproduction, secondary sexual characters and maturation process, Endocrine glands-pituitary, thyroid, interreginal, ultimobranchial, gonad-hypothalamus-hypophysial complex, X and Y organ.

2.3. Fisheries resources

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. Fisheries resources of North-east region special reference to Tripura. Estimation of inland fish catch data and problems, 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. Beel/wetland fisheries and importance, Cold water fisheries of India and prospect.

2.4. Fish Population Dynamics and Stock Assessment

The concept of population and unit stock. Biological structure of fisheries resources 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 stocks assessment. Population age structure.

Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte cario sinulaion model and ECCPATH model. Estimation of total fishing and natural mortality. 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. Analytical models of fish stocks.

3. Biochemistry and Microbiology:

3.1. Biochemistry:

Carbohydrate, lipid and protein chemistry: Structure, classification, functions isomerism and mutarotation. Metabolism of carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle and its role in metabolism. Classification, structure, function and properties of protein, lipid, and amino acids and fatty acids. Essential and non-essential amino acids and fatty acids. Amphoteric property. Biuret reaction and xanthoproteic reaction. Digestion and absorption of proteins. Phospholipids and cholesterol, Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids. Enzymes: nomenclature; classification; specificity mechanism of enzyme action Steroid and peptide hormones- chemistry and function. Vitamins and minerals- classification- functions. Nucleic acids: Structure function and importance genetic code. Transcription and translation. Reversible and irreversible reactions in metabolism.

3.2 Microbiology:

Scope and history of microbiology; Microscopy- principle, types and application, General features, types and importance of bacteria, virus, fungi and parasites Microbial Techniques- types of media, types of sterilization, cultivation of microorganisms, staining techniques; Identification . of microorganisms- biochemical, serological and molecular techniques; Aquatic microbiology- role of microbes in the production and breakdown of organic matter, nutrient cycles- carbon, nitrogen, sulphur, and phosphorus cycles; Bio-remediation.

4. Aquatic environment:

4.1. Inland: Soil and water chemistry- sample collection, preservation and analysis; Soil and water quality parameters- criteria and requirements for aquaculture, Inland water ecosystem-classification, distribution, physic-chemical

and biological characteristics of ponds, lakes, streams, rivers, reservoirs and wetlands; Biological communities- plankton, benthos, nekton, algae, macrophytes, periphyton; Biological productivity- food chain, food web, trophic dynamics.

4.2 Aquatic pollution: Organic, inorganic and radioactive pollutants in water bodies and their effects- bioaccumulation, biomagnifications; Eutrophication, bioindicators: Point and non-point sources, Sewage treatment and aquaculture effluent management.

5. Social Sciences:

5.1. Fisheries Economics: Introduction to fisheries economics, basic economics terminologies, micro economics- Theory of demand and supply, elasticity of demand, farm production economics, cost and returns, profit maximization, break even analysis, Macroeconomics- Introduction to national income, accounting, measurement, and determinants of national income, contribution of fisheries to GNP, globalization, WTO agreement, fisheries subsidies, IPR, Concepts and principles of cooperatives, cooperative movement in fisheries in India, role of cooperatives in fisheries, Fisheries finance, classification of loan, credit need in fisheries and aquaculture, micro credit and micro finance. NABARD and other financing institution, Insurance in fisheries sector, Market, marketing functions, classification of markets, marketing channels, middlemen, marketing cost, margin, price spread and marketing efficiency, Marketing management, marketing strategy, product development and product mix, marketing infrastructure, export import policies relevant fisheries sector.

5.2. Fisheries Extension Education:

Introduction to extension education and fisheries extension- concepts, objects and principles; Theories of learning, learning experience, learning situation; Basic concepts in rural sociology and psychology and their relevance in fisheries extension; Social change, social problems, social conflicts in fisheries and conflict resolution, fisheries co-management; gender issues in fisheries; Communication process, feedback and barriers to communication; Extension teaching methods; Communication skills: Oral, written, presentation, public speaking; Audio visual aids-definition, advantages, classification and choice of A.V aids; IT and its importance; ICT-enabled fishery extension services; 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 process and tools; History and role of fisheries extension in fisheries development; Important TOT programs in fisheries; Role of FFDA, BFDA, NATP, ATMA etc. In fisheries extension; role of NGOs and SHGs in fisheries;

5.3 Fisheries Administration and Legislation

Introduction to public administration, Orangogram of state department of fisheries in different states as well as central government, Central and State responsibilities for fisheries development; Role of Central and State Government in the regulatory activities of Aquaculture and fisheries; Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897, Laws relating to conservation and management of fishery resources in marine and inland sectors, Laws relating to fish products and marketing. State reservoir fishery policy.

5.4 Fishery Statistics:

Measures of central tendency-mean, median, mode, measures of dispersion-range, mean deviation, standard deviation, variance, coefficient of variation (CV), skewness and kurtosis, probability, concept of theoretical distribution binomial, poisson, normal and their fitting to fisheries data. Sampling methods-random stratified, cluster, method of data collection- census and survey, Testing of hypothesis, z-test, t-test, F-test and Chi square test, nonparametric tests, correlation, simple regression,

6. Aquaculture

6.1. Principles of aquaculture: Definition and scope of aquaculture. History of aquaculture and present global scenario. Major statistics and trends of global and Indian aquaculture. Types of aquaculture systems, site and species selection, Principles of nutrient cycling and detritus food chain, primary productivity, Use of agro-industrial waste and biofertilizer in aquaculture, Principles of Organic Aquaculture.

6.2. Ornamental Fish Production and Management

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 aquarium. Water quality management. Water

filtration system-biological, mechanical and chemical. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

6.3 Aquatic environment management: Soil quality in different regions suitable for fish culture, Soil and water quality management; physicochemical and biological indices of aquaculture ecosystem. Pond preparation, stocking and post-stocking water quality management, Species diversity and control of unwanted fishes. Insects and weed control in fish ponds. Nutrient management. Eutrophication, contamination, Bioremediation. Bio-fertilization. Carrying capacity and associated factors, strategies to enhance carrying capacity, Sustainability, Stratification, abiotic and biotic factors affecting primary productivity and fish productivity, Salient physico-biochemical characteristics of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs.

6.4. Inland aquaculture: Extensive, semi-intensive and intensive culture; pond, cage, pen, recirculatory, running water, zero water exchange culture system, waste water, bheel and gheri, culture in perennial and seasonal water bodies, Traits of important cultivable fish and shellfish, Candidate species for aquaculture (freshwater, brackish water and mariculture)- carps (Indian major carps, exotic carp), cat fishes, air breathing fishes, mahseer, trouts, seabass, mullets. Milkfish, freshwater prawn, shrimp, crabs, mussels, clams, and aquatic plant. Monoculture, mono-species culture, polyculture, mixed culture and composite fish culture. Agricultural crop and livestock integration in aquaculture practice, sewage-fed fish farming. Ornamental fish culture and pearl culture, Reservoir aquaculture and culture-based fisheries. Estimation of growth, survival and pond productivity.

6.5 Fish food organism and Fish nutrition: Candidate species of live food organisms, culture methodology of important live food organisms; Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerans, tubifex, brine shrimp, chironomids; feeding behaviors and nutritional requirements of cultivable shellfishes and fin fishes; digestion; assimilation and conversion of feed. Nutrition bioenergetics of fish. Complete and supplementary feeding, Different types of feeds, wet feed, moist feed and dry feed, larval, grow-out and brood diet. Conventional

and nonconventional Feed ingredients, probiotics, essential amino acids. Feed processing and feed dispersal. Anti-nutritional factors, stress elements, Feed additives, Feed formulation, feed production technology, feed storage and transportation, feed utilization and its evaluation.

6.6. Seed production and hatchery management:

Freshwater fish seed resources. Natural breeding of finfishes. Sexual maturity and breeding season of various cultivable species. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympatric breeding. Hypophyisation 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. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Spawn rearing techniques. Seed production and hatchery management of Indian major carps, minor carps, exotic carps, air breathing fishes, indigenous fishes, mahseer, trouts, fresh water prawns, pearl oyster, fresh water mussel and crabs. Seed quality indices. Off-season and multiple breeding of carps. Breeding and seed production of common ornamental fishes.

6.7 Genetics and Biotechnology:

Mendelian genetics, gynogenesis, androgenesis, polyploidy, sex reversal, selective breeding, hybridization. Inbreeding and its consequences. Cryopreservation of gametes. Quantitative traits, polygenic traits, heritability. Nucleic acids-structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications, gene and gene action, Genetic characterization (karyotyping, RAPD, PCR, Isozymes), transgenic fish, molecular and immunological techniques-PCR; immune blotting; ELISA.

6.8 Fish Health Management:

Host-pathogen-environment interaction; Disease development process; Stress in aquaculture and its role in disease development; Defense mechanism in fish- innate and specific immunity; Common infectious (parasitic, bacterial, fungal and viral) and non-infectious (nutritional and environmental) diseases of finfish and shellfish- clinical signs and diagnostic features; Prevention and control of diseases - disinfectants, antibiotics, anti-parasitic and anti-fungal agents, vaccines, immunostimulants, probiotics, Quarantine and health monitoring.

6.9 Aquaculture Engineering:

Surveying and leveling, soil quality in different regions suitable for fish culture; site selection, design and construction of fish farms, 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, 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 and power calculation. Design and setting of aquaria for ornamental fishes.

7. Harvest and Post-Harvest Technology

7.1. Fishing crafts and gear:

Classification of fishing crafts; Dimensions and design of boats; Safety and stability of fishing boats; Care and maintenance of boats; Fishing accessories and deck equipment; Fishing methods of India, Modern commercial fishing methods- trawling, gill netting and long lining. Acoustic fish detection and monitoring device. Classification of gears, yarn numbering, construction and types of twine and ropes, Natural and synthetic material for fishing gears and choice of net materials. Design and fabrication of fishing gears, floats, sinkers, anchors and buoys. Care and preservation of fishing gears.

7.2. Biochemistry of fish and shellfish: Fish muscle chemistry structure, Proximate composition of fish and shellfish. Classification and nutritional value of Fish and shellfish: Proteins, Lipids, vitamins and minerals. Post mortem changes: Rigor mortis, autolysis, lipid oxidation and microbial putrefaction.

7.3. Freezing of fish and fishery products: Spoilage of fresh fish and shellfish, Low temperature preservation and importance: Chilling, super chilling, refrigeration and freezing. Chilling on board, Stowage methods, quantity of ice needed on board. Spoilage microflora associated with iced/chilled fish. Refrigeration-Fundamentals of refrigeration, Refrigerants and classification of refrigerants, refrigeration of fish; Freezing-Principles of freezing, Nucleation, freezing curve, freezing time, freezing velocity. Different types of freezers-air blast freezing, indirect contact freezing, immersion freezing, cryogenic freezing; cold store, cold chain, anteroom; Effects of freezing and frozen storage on the quality changes in fish-physical, biochemical, microbiological and sensory changes; Assessment of fish quality- sensory methods, biochemical, physical and microbiological methods. Thawing of fish: methods of thawing-air, water, vacuum, dielectric and microwave.

7.4. Canning and packaging technology: Principle of canning, concept of appertization, history of canning, Cans and lids- steel, tin-free steel (TFS), black plate, Aluminium; Different containers- three piece and two pieces, can ends; steps in canning- Raw material, pre-treatment of raw material, precooking, packing, filling, exhausting, seaming, thermal processing, cooling and storage. Principles of thermal processing- classification of food based on acidity, thermal death rate/decimal reduction time, thermal death time and the methods of estimation of heat resistance, thermal death time curve (TDT)- 'z' value, 'F' value, '12' D concept, cold point; spoilage in canned fish-Physical, chemical and microbiological.

Packaging materials for fish and fishery products application: Packaging material used for- chilled fish products, dried and smoked fish products, refrigerated and frozen fish and fishery products. Modified atmosphere packaging; Retort pouch packaging; Biodegradable packaging material used for fish and fishery products.

7.5. Fish products and by-products technology: Principle and methods of salting, drying, smoking of fish; marinades; fermentation and spoilage aspects associated. Carcinogenic compounds associated with smoked fish and methods to minimize the deposition on fish. Minced based technology; surimi and its preparation- importance of myofibrillar protein; development of value-added fish products- Coated/enrobed products- Functions of coating, battering and breading; Imitation products- crab, shrimp and scallop analogue products; Extrusion based fish-based products. Hurdle technology-concept of preservation.

Fishery by-products/secondary products: Fish meal and fish silage. Fish body oil and fish liver oil. Chitin, chitosan, glucosamine hydrochloride. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate. Fishmaws, isinglass, shark leather, fish glue, fish gelatin, pearl essence, shark fin rays, beach-de-mer. Utilization of seaweeds: agar agar, algin, carrageenan.

7.6. Microbiology and Quality assurance of fish and fish products: Food borne pathogens involved in infective and intoxication type of food poisoning - Vibrio cholera, 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.

Risk assessment; Food laws and standards, national and international legislation, mandatory and non-mandatory standards; GOI notifications on fish and fishery products; Prerequisites to HACCP and HACCP. Codex Alimentarius Commission- general subject committees and commodity committees, ISO- ISO 9000 series, FDA; FSSAI- guidelines for fish and fishery products; Role of MPEDA and EIA in export of fish and fishery products.