VIDYASAGAR UNIVERSITY

AQUACULTURE MANAGEMENT
(Honours)

Under Graduate Syllabus
(3 Tier Examination Pattern)
w.e.f. 2014-2015

REVISED

Vidyasagar University
Midnapore 721 102
West Bengal

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AQUACULTURE MANAGEMENT
(HONOURS)

Basic Structure: [Theory – 500 marks and Practical – 300 marks]

Part-I : Theory – 200 Marks

Part-II : Theory – 200 Marks and Practical 100 Marks

Part-III : Theory – 100 Marks and Practical 200 Marks

[Examination of theory papers (90 marks): 4 hours duration and Practical papers (100 marks): 6 hours duration]

Course Design:

PART – I

Paper – I: Theory : 100 Marks (90 + 10)

Group – A: Taxonomy & Fish Biology (45+5 = 50 marks)

Group – B: Inland and Marine Capture Fisheries (45+5 = 50 marks)

Paper – II: Theory : 100 Marks (90 + 10)

Group – A: Aquaculture Management (45+5 = 50 marks)

Group – B: Fish Genetics, Biotechnology, Endocrinology, Reproductive Biology & Hatchery management (45+5 = 50 marks)

PART – II

Paper – III: Theory : 100 Marks (90 + 10)

Group – A: Feed Technology, Fish Nutrition & Diseases (45+5= 50 marks)

Group – B: Biochemistry & Microbiology (45+5 = 50 marks)

Paper – IV: Theory : 100 Marks (90 + 10)

Group – A: Fishery Hydrography (45+5 = 50 marks)

Group–B: Harvesting and Post harvesting Technology (45+5=50 marks)

Paper – V: Practical: 100 Marks

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PART – III

Paper – VI: Theory : 100 Marks (90 + 10)

Group – A: Fisheries Statistics, Economics & Computer application co-operative, Banking and Marketing Management (45+5 = 50 marks)

Group – B: Fisheries Extension, Rural Sociology, Fishery Microbiology and Quality Management (45+5 = 50 marks)

Paper – VII: Practical: 100 Marks

Paper – VIII: Practical: 100 Marks

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PART-I

Paper -I: Theory 100 Marks (University Exam. - 90, Internal Assessment-10)

Group – A (Taxonomy & Fish Biology)

1. TAXONOMY OF FINFISHES AND SHELL FISHES:

Principles of taxonomy, Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Method employed in phylogenic studies. Phylogenic tree. Fish identification and fish bar-coding. Major taxa of inland and marine fishes (up to order level). Commercially important fishes of the World. Other important groups of aquatic vertebrates. Study of external morphology and classification (up to Sub-class) of Crustacea, Bivalvia, Gastropoda and Cephalopoda.

2. ANATOMY OF SHELLFISHES AND FINFISHES:

Study of internal anatomy of shell fishes and fin fishes having commercial importance. Study of the oral region and associated structures, (teeth, gill rakers, buccopharyngial region, Digestive system; Oesophagus, stomach, intestine and rectum).Associated digestive glands (liver, pancreas, gall bladder). Circulatory system, respiratory system, nervous system and urinogenital system / reproductive system of fishes and shellfishes. Osteology of fishes.

3. BIOLOGY OF FINFISHES AND SHELLFISHES:

Study of food and feeding habits of commercially important fin fishes and shell fishes. Age and growth of commercially important fin fishes and shell fishes. Marking and tagging; Lengthweight relationship. Water as a biological medium; respiration, digestion, excretion, osmoregulation and reproductive physiology Reproductive biology – maturity stages, gonado

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somatic index, sex ratio, spawning and fecundity. Eggs and larval stages and developmental biology of fin fishes and shellfishes.

Group – B (Inland and Marine Capture Fisheries)

1. INLAND CAPTURE FISHERIES:

Present scenario and problems of inland fisheries. Trends in Indian aquaculture. Inland fisheries resources, major river systems of India and their fisheries. Freshwater fishery regions of the world and their major fisheries; species composition; global inland fish production statistics. The inland capture fishery resources of India and their potentials and problems. Major riverine and estuarine fisheries of India. Major brackish water bodies and their fisheries. Fisheries of major reservoirs / natural lakes of India. Coldwater fisheries of India. Shellfish fisheries of brackish waters and estuarine.

2. MARINE CAPTURE FISHERIES:

Capture fisheries, inshore, offshore and deep sea fisheries of Indian Sea. The major important fin fish and shell fish resources and their economic management. Marine fisheries development in India. Classification and definition of fishery zones and fishery resources. Overview of marine fishery resources of the world and those of the Indian Ocean. Traditional, motorized and mechanized fisheries according to major gears. Offshore and deep-sea fisheries. The concept of total catch and catch per unit effort. Potential marine fishery resources of India. Exclusive Economic Zone. Conservation of marine fishery resources. Remote sensing and potential fishing zones (PFZ).

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Paper -II: Theory 100 Marks (University Exam. - 90, Internal Assessment-10)

Group - A (Aquaculture Management)

1. FRESHWATER AQUACULTURE:

Different freshwater aquaculture systems. Use of fertilizers and manures. Preparation and management of nursery and rearing ponds. Control of aquatic weeds and algal blooms. Monoculture and polyculture of carps, stocking density and ratio, supplementary feeding. Criteria for selection of candidate species for aquaculture. Technology of semi-intensive, intensive and super intensive systems of aquaculture. Aquaculture in running water system, recirculatory systems, cages and pens. Air breathing fish culture. Recent developments in culture practices of *Clarias, Heteropneustes, Anabas* and murrels. Culture of coldwater fishes: trout, mahaseer, etc. Culture of freshwater prawns. Definition, history and scope of integrated aquaculture. Principles of organic recycling and detritus food chain. Integration of crop, livestock and fish farming as complimentary activities. Wastewater aquaculture and Paddy-cum fish culture.

2. MARINE WATER AQUACULTURE:

Resources of marine species for shore-based aquaculture and sea farming in India. Cultivable traits of important candidate species of fish and shellfish with notes on their biology (Sea bass, Mullets, Milkfish, Groupers, Tiger shrimp, Mud crab, Mussels, Clams, Oysters etc.). Shore-based aquaculture systems: traditional (Pokkali, Bheries), semi-intensive aquaculture practices of commercially important species. Management of marine fisheries.

3. ORNAMENTAL FISH CULTURE:

Ornamental fish culture as hobby. Setting up of freshwater and marine aquaria. Selection of suitable species, species combination. Use of natural

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and artificial aquatic plants and decorative toys. Use of biological filters, aerators, heaters etc. Commercial breeding and culture of ornamental fishes. Methods of production of live and artificial feeds. Common diseases of ornamental fishes and their control. Transport of live ornamental fishes and Aquascaping.

Group-B (Fish Genetics, Biotechnology, Endocrinology, Reproductive biology & Hatchery Management)

1. FISH GENETICS AND BIOTECHNOLOGY:

Principles of genetics; Concepts of biotechnology. Genes and chromosomes, gene interaction. Linkage and crossing over. Chromosome maps, sex determination, chromosomal aberrations. Gene mutation; genome manipulation: gynogenesis, androgenesis, polyploidy. Transgenic fish, Sex-reversal, inbreeding & hybridization.

2. FISH ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY:

Modes of reproduction. Secondary sexual characters and maturation process. Different endocrine glands. Ecological and hormonal influence on maturation and spawning; Breeding behaviour; Pheromones in fishes. Gametogenesis, Fertilization, Cleavage, Gastrulation, Organogenesis. Development of fish and prawn.

3. BREEDING AND HATCHERY MANAGEMENT:

Natural breeding and seed production of fishes. Significance of propagation, sexual maturity, season of reproduction, place of propagation, parental care. Types of fish eggs and mechanism of hatching. Riverine spawn collection site, gears used for collection, methods of spawn collection, behaviour of spawn in relation to hydrological and hydro-biological factors. Technology of seed production in warm water

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fishes; brood stock management, techniques of inducing ovulation. Multiple carp spawning. Chinese technique using spawning pool and incubation / hatching pools. Cryopreservation of fish gamete. Breeding technique for Indian major caps and other exotic carps.

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PART-II
Paper -III: Theory 100 Marks (University Exam. - 90, Internal Assessment-10)
Group - A (Fish Nutrition, Feed Technology & Diseases)

1. FISH NUTRITION AND FEED TECHNOLOGY:

Natural and artificial feeds. Nutritional requirements of cultivable fishes and prawns. Digestion, assimilation and conversion of feed. Nutritional bioenergetics of fish. Feed formulation, storage, use of preservatives and anti-oxidants, and evaluation of nutritional scoring. Feeding techniques. Nutritional pathology and anti-nutritional factors. Use of feed attractants and probiotics. Microparticulate and micro-encapsulated diets.

2. FOOD CHEMISTRY AND FISH NUTRITION:

Chief components in foods and their important functions. Digestion, absorption and metabolism of nutrients; nutritional deficiency diseases and dietary allowances; Nutritive value of foods; energy value of food and energy requirements; Effect of processing on food nutrients. PER, B. V., NPU values; Pepsin digestibility. Other aspects – food pigments, food additives and food hazards. Vitamins in fish. Live fish food organisms and their significance.

3. FINFISH AND SHELLFISH DISEASES:

Significance of fish diseases in relation to aquaculture practices and fish farm management. Introduction to bacterial, fungal, viral, protozoan and metazoan agents of disease in fish and their biology, morphology, life cycle and epidemiology. Non-infectious and nutritional diseases. Environment in relation to disease. Principles of disease diagnosis and fish

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health management. Treatment and control methods. Specific and non-specific defence system in fish. Introduction to fish immunization and vaccine production. Important disease problems of cultured shellfish and their control.

Group - B (Biochemistry & Microbiology)

1. BIOCHEMISTRY:

Classification of carbohydrates. Structure and properties of maltose, lactose, sucrose, starch, glycogen and pectin. Classification and general structures of amino acids, properties due to carboxyl and amino groups of amino acids. Secondary, tertiary and Quaternary structures of proteins. Classification of lipids. Structures of palmitic acid, stearic acid, oleic acid, linoleic acid, arachidonic acid, lecithin and cephalin.Composition and metabolism, autoxidation and antioxidants, changes during processing and storage, rancidity, indices of rancidity. Effect of processing and storage on fish proteins, non-protein nitrogenous components in fish. Denaturation of proteins. Bioenergetics – free energy, ATP cycle, oxidative phosphorylation, electron transport system in mitochondria. Enzymology: Classification of enzymes, Enzyme kinetics, Functions of co-enzymes.

2. MICROBIOLOGY AND IMMUNOLOGY:

Protozoa, algae, fungi, bacteria and virus. Biological characters of bacteria, virus and fungi. Differences of bacteria from virus. Morphology of bacteria, bacilli, cocci, spirals and coma shaped organisms, filamentous forms. Capsules – flagella, fimbriae. Autotrophic and heterotrophic and facultative bacteria, Cultivation of bacteria – culture media – common ingredients in media. Different types of media. Synthetic and non-

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synthetic media. Bacterial growth – growth phase and multiplication rate – effect of temperature and medium on growth. Microbial regeneration of nutrients – nitrogen fixation – microbial digestion of food in fishes – role of microbes in food chain and microbial corrosion. Antigen and antibody. Classification of immunity. Humoral and cell mediated immunity. Different types of immunoglobulins. Antigenantibody reaction, Macrophages.

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Paper-IV: Theory 100 Marks (University Exam. - 90, Internal Assessment – 10)

Group - A (Fishery Hydrography)

1. HYDROGRAPHY AND SOIL CHEMISTRY:

Properties of water; physical and chemical characteristics of water. Common method of physical and chemical analysis of water: Quantitative tests, titrimetry – gravimetric. Physical properties of soil: constituents of soil, soil texture, soil structure. Chemical nature of soil: soil organic matter – soil colloids, soil reaction and pH. Soil types: classification of soils – distribution of different types of soil in India, soil types found in specific regions and their peculiarities. Manures and fertilizers: plant nutrient elements – organic manures, natural synthetic and fertilizers – their interaction with soil and plants. Soil management: acid and acid sulphate soils – sodic alkaline soils – other problem soils – liming and amelioration of problem soils management of soil quality for aquaculture. Soil quality of land areas in respective regions suitable for fish culture – their location and soil qualities.

2. LIMNOLOGY:

Physical properties of inland waters: morphometry, pressure, density, viscosity, water movements, temperature, light, colour turbidity and surface film. Biological communities of inland waters: common groups of phyto and zooplankton distribution of plankton in time and space. Macro vegetation – distribution and limnological significance. Lakes: origin, diversity, distribution and classification; ecology of reservoirs, lake stratification and eutrophication. Ponds: physical, chemical and biological conditions. Streams: Physical, chemical and biological conditions. Estuary: Ecology of estuarine ecosystem. Physical, chemical and

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biological indices of water quality in relation to fisheries. Classification of pollution physical, chemical and biological classification of water pollution descriptions of terminologies. Sewage and domestic wastes: composition and pollution effects – sewage treatment and its reuse. Organic detritus pesticides – short and long term effects of pesticides. Sources and impact of oil pollution in water and in aquatic organisms. Physical and chemical nature of possible effluents from major industries in India. Bioaccumulation and biomagnifications, biodegradation. Biological assessment of pollution.

Group- B (Harvesting and Post harvesting Technology)

1. CRAFTS AND GEARS:

Natural fibre, yarns, twines, ropes its properties and identification methods. Synthetic fibres, fibre types , yarns, twines ropes – its properties, raw materials of synthetic fibres. Identification of synthetic fibres, tests, visual test, water test, burning test, solubility test. Twists in twines and ropes – braided ropes – leaded ropes – floated ropes. Floats and sinkers. Sinkers - types, materials, properties – negative buoyancy. Hooks ; types, materials, specification, numbering system, jigs, spoon hooks. Maintenance and storage of gear and gear materials. Preservation of netting and other accessories. Selection of gear materials for different gear. Parts of a trawl net, purse seine, gill net and tuna long lines. Classification of fishing vessels. Country craft and mechanized boats of maritime states of India. Merits and demerits of wood, steel, aluminum, ferro-cement and fibre glass reinforced plastic. Design and construction of wooden fishing craft. Maintenance of fishing craft.

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2. FISHING TECHNOLOGY:

Traditional fishing techniques: Grappling and wounding and wounding gear, stupefying devices, Line fishing, traps, bag nets etc. Modern commercial fishing methods: Trawling, Pelagic, bottom midwater, stern, side trawling, bull trawling, out rigger trawling. Line fishing: Pole and line, Tuna long lines, squid. Fishing accessories and Deck equipments. Types of winches, Net haulers, Line haulers, Power blocks, fish pumps, otter boards, Thimbles, shackles etc.

3. FISH PROCESSING TECHNOLOGY:

Introduction to freezing technology; characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganisms; handling of fresh fish; sanitation in processing plants; principles of low temperature preservation. Methods and equipment for chilling; icing – quality of ice, ice-making; refrigerated of chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Objectives of packaging requirements. Characteristics of various packaging materials – metals, paper and paperboard, corrugated fibre board, plastics, multiplayer and – testing of packaging materials and containers. Sun drying, Curing, Wet curing and Smoking. Colombo curing, Artificial drying, Solar drier, Tunnel dryer, Freeze dryer, Water activity and its relation to fish preservation. Fish by-products and value added products.

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Paper – V: Practical 100 Marks

1. Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features.
2. Dissection of different finfishes (Channa sp; Clarias sp; Anabas sp; Tilapia sp) and Shell fishes (Prawns, Cephalopods, Gastropods and Bivalves) to understand their internal organization. Preparation of fish endo-skeleton.
3. Study of external morphology, collection, preservation and identifications of prawns-crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats.
4. Analysis of gut contents. Study of food and feeding habits of finfishes and shellfishes, Estimation of age and growth by direct and indirect methods. Classification of maturity stages, estimation of fecundity. Identification of eggs and larval stages of commercially important species. Study of early developmental stages. Tagging and marking.
5. Analysis of species composition of commercial catches at landing and assembly centers, sampling and familiarization of commercially important groups. Observations and experimental operations of selected fishing gears in inland / estuarine waters, maintenance of records on catch statistics and observations.
6. Visit to a fish landing centers, observation and analysis of catches by major craft and gears. Field collection of samples of fishes, crustaceans and molluscs, and their analysis for biological characteristics. Participations in fishing trips and research cruises.

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PART –III

Paper – VI: Theory 100 Marks (University Exam. - 90, Internal Assessment – 10)

Group - A (Fisheries statistics, Economics and Computer application, Co-operative Banking and Marketing Management)

1. FISHERIES STATISTICS AND COMPUTER:

Definition of sample, population in biometry: Frequency distribution, histogram, bar diagram, pie diagram. Measures of central tendencies (Mean, Median and Mode), Dispersion (SD, SE and Variance). Introduction to computers, types of computers, computer generations, input output devices, memory unit, arithmetic and logic unit, secondary storage devices; Introduction to Operating systems – DOS and windows 95; Concept of Local Area Network (LAN), Wide Area Network (WAN) and E-mail, application software packages in fisheries statistics and stock assessment.

2. FISHERIES ECONOMICS:

Introduction to economics, definition, scope and significance; Nature and role of fisheries economics. Concepts and application of economic theories to fisheries; consumption, utility and demand; elasticity – price, income and cost; consumer's surplus, production function, laws of returns, laws of returns to scale and economics of scale; law of supply, profit maximization.

3. CO-OPERATIVE, BANKING AND MARKETING MANAGEMENT:

Co-operative, principles and objectives of cooperative, co-operative movement in fisheries in India, structure and functions of fishermen co-operatives, status of fisheries co-operatives in India, problems in fisheries co-operatives and remedial measures. Financing agencies; indigenous and

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institutional; Introduction to marketing and fish marketing.

Group – B (Fisheries Extension, Rural Sociology, Fishery Microbiology and Quality Management):

1. FISHERIES EXTENSION:

History of fisheries extension, concept, principles, philosophy – scope and objectives. Role of fisheries extension in fisheries development in India. Teaching and learning Extension teaching methods. Participatory rural, appraisal / Rapid rural appraisal. Extension administration. Recent developmental programmes KVK, FFDA – conceptual background. Broad based extension system. Role of NGOs in fisheries development. Extension programme planning. Training and education.

2. RURAL SOCIOLOGY:

Meaning, scope and importance in fisheries extension, socio-economic conditions and demographic profile of fisherfolk communities and their relationship with fisheries resources, informal and formal rural institutions. Women in fisheries.

3. FISHERY MICROBIOLOGY & QUALITY MANAGEMENT:

Microbial standards for fish. Encapsulation – Endospores – Formation of cell aggregates. Proteolytic and putrefactive bacteria, Lipolytic and saccharolytic bacteria. Mesophiles – Thermophiles and Psychrophiles – Halophiles. Micro-flora of fresh and processed fish products, spoilage organisms control measures to reduce microbial load in fish. Bacteria of public health significance, *E.coli, Botulinum*, *Staphylococcus*, *Clostridium*, *V. cholera, Listeria*, *Salmonella*, Disease caused and control measures. Quality control fundamentals. Quality Management. Additives in fish processing: waste management in fish processing industries.

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Quality management: fundamentals, identification of critical control points and HACCP.

Paper-VII: Practical -100 marks

1. FRESHWATER AQUACULTURE:

Study of cultivable species of fin fishes and shellfishes. Collection and study of predatory fishes, weed fishes, their eggs and larvae from fish ponds. Collection and study of aquatic weed and aquatic insects from fish ponds. Practical experience in the preparation and management of nursery, rearing and stocking tanks. Study of effect of liming, manuring and fertilization on hydrobiology of fish ponds and on growth of fishes. Effect of supplementary food on the growth of fishes. Estimation of planktonic and benthic biomass. Study of algal blooms and their control.

2. CULTURE OF ORNAMENTAL FISH:

Identification of common ornamental fishes and plants. Setting and maintenance of aquaria. Designs and construction of indoor aquaria. False floors, filters. Identification of fish diseases and prophylactic measures. Culture of ornamental fishes. Transport of live ornamental fishes.

3. FISH BREEDING:

Selection of breeders of carps and catfishes. Collection and preservation of pituitary glands in fishes. Preparation and administration of pituitary gland extract. Use of synthetic compounds for induced breeding of fishes. Study of hatchery technology of fishes. Care of eggs, spawn and fry. Identification of eggs and larvae of common cultivable fishes. Detailed study of design and operation of Chinese circular hatchery and funnel shaped hatchery. Study of seed production technology of Indian carps/Cat fishes, Tilapia.

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4. CULTURE OF LIVE FISH FOOD ORGANISMS:

Methods of isolation and identification of different live feed organisms. Laboratory scale culture (batch and continuous) of selected live feed organism. Evaluation of live feed organisms. Mass culture of live fish food organisms.

5. FISH DISEASE:

Methods of isolation and culture of bacteria and fungus. Identification methods of common bacterial and fungal pathogens of fish.

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Paper - VIII: PRACTICAL (100 Marks)

1. HYDROGRAPHY:

Physical analysis of soil, water, moisture, texture, conductivity and pH. Quantitative estimation of organic carbon, available phosphorus, available nitrogen, total nitrogen, potassium. Lime requirement – Determination of pH, conductivity and residue. Estimation of carbon dioxide, acidity, alkalinity, hardness, and dissolved oxygen. Testing of colour, odour, turbidity and pH of polluted water samples. Estimation of biological oxygen demand, chemical oxygen demands.

2. LIMNOLOGY:

Physical properties of water – temperature and transparency. Study of plankton; periphyton, benthos, aquatic insects and macro-vegetation. Estimation of primary productivity.

3. GEAR TECHNOLOGY:

Identification of synthetic and natural fibres by various methods – Calculation of buoyancy – negative buoyancy – Identification of fibres, twines, ropes, iron wares, fish hook – Specifications of ropes and wire ropes. Iron wares, rigging materials.

4. FISH PROCESSING TECHNOLOGY AND MICROBIOLOGY:

Freezing, Drying, Curing, Smoking and Canning. Total plate count. Determination of coliforms. Familiarization with techniques of isolation and identification of important pathogenic bacteria. Organoleptic assessment of fish freshness and quality of different fishery products – use of score sheets; physical, chemical and microbiological tests to determine freshness of fish and quality of fishery products; assessment of sanitation in fish processing plant.

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5. MICROBIOLOGY:

Sterilization techniques, preparation of culture media, nutrient agar slants, nutrient agar plates; use of microscope, staining technique; motility of bacteria, purification of bacteria, biochemical tests employed for the identification of bacteria, anaerobic bacterial culture, slide culturing of fungi.

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