

INFORMATION BROCHURE

SKUAST-Jammu CET (Ph.D)- 2019



**Sher-e-Kashmir University of Agricultural
Sciences & Technology of Jammu**

IMPORTANT DATES FOR SKUAST- J CET (Ph.D.) 2019

Commencement of submission of online application forms	10.00 AM of 04-12-2019
Last date for submission of online application forms	05.00 PM of 24-12-2019
Last date for submission of online application form with late fee of Rs. 1000/=	05.00 PM of 26-12-2019
Date & Time of Common Entrance Test (CET)	17-01-2020 (Friday) 11.00 AM
Reporting Time	10.00 AM
Test Center	SKUAST-Jammu Main Campus, Chatha, Jammu
Application Fee for CET (Ph.D) 2019	Rs. 2000/

HOW TO APPLY

Application Form will be accepted **Online ONLY** through University website www.skuast.org.

DISCLAIMER

The information contained in this brochure is of general nature for the candidates who aspire for admission in various programmes offered by the University. It is neither an exhaustive nor a legal document. The statements and all other information presented herein the brochure is believed to be correct at the time of publication. However, the competent authority reserves the right to make additions or alterations in the regulations, conditions governing admissions, the code of conduct of students, requirements for the degree or the diploma, fees and any other information or statement/rule at any time without notice.

Competent authority may delete any programme of studies at any time without notice or reduce or enhance the number of seats. No responsibility shall be accepted by the University for any hardship encountered or expenses incurred by the students or any other person for such changes, additions, omissions or errors, no matter how they are caused.

The students are advised to refer to the Academic Regulations, and other statutory/administrative provisions applicable on a particular point of time on various aspects, viz., system of education, residence in the University, Hostels, enrolment in NSS/NCC, award of scholarships, stipends, fellowships, medals, certificates of honour, and conduct in the premises of the University and alike.

The students should also note that the provisions of the Act, Statutes, Academic Regulations and other legal/administrative notifications, orders, instructions, and guidelines etc can be changed by the competent authorities at any time without assigning any reason or prior notice. Though every effort and care is taken to stick and follow the instructions and schedule of dates given hereunder, yet under certain compelling circumstances, if there has to be a deviation, University shall not be responsible for any inconvenience, losses or ill consequences arising there from. Admission to the University entails acceptance of all provisions given in the University Act, Statutes, Regulations and admission policy and changes that are made from time to time therein.

Jurisdiction

Jurisdiction for all disputes is at Jammu city.

PRELUDE

The Sher-e –Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST –Jammu) was established by the Government of Jammu and Kashmir on September 20, 1999 by amending the Act of Sher-e–Kashmir University of Agricultural Sciences and Technology of Jammu and Kashmir of 1982 and promulgated vide SRO No 408 dated 20-09-1999.

The University is mandated to develop new, refine the existing and disseminate approved agricultural technologies to the stakeholders in the state in general and Jammu Division in particular. It also steers innovation, in location specific and problem solving research in agriculture and its allied sectors. The other important obligation delegated to the University is to produce competent human resource that can sustain and improvise the phenomenal growth of

agriculture and allied sectors with an eye on maintenance of biodiversity and addressing the environmental concerns, while doing so the faculty, students and scholars of the university are manning the frontier of life sciences, environmental sciences, food and energy system along with community and economic development.

On the facet of human resource and capacity development, the university strives to provide congenial learning ecosystem at graduate as well as at postgraduate levels in the realm of Agriculture Sciences, Veterinary Sciences, Animal Husbandry and Biotechnology, and at postgraduate levels only in the areas of Food Science, Sericulture, Agricultural Engineering, Microbiology, Agribusiness & Management, and Forestry. The quality education being imparted by the University is fashioning the students to get placed in the most coveted services like scientists in the universities and research organizations of repute both in and out of the state, Indian administrative services, Indian forest services, Kashmir administrative services, public and private banking and others sectors besides the primary sectors like agriculture, horticulture, sheep & Animal husbandry.

UNIVERSITY CAMPUSES

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu is a multi-campus University with its headquarter located at Chatha, Jammu at a distance of 8 km from Jammu- Pathankot NH-1A, 12 km from the Jammu Railway Station, 14 km from the General Bus Stand and 6 km from the Air Port, Jammu.

The University has extensive infrastructure within its jurisdiction and command. The main campus at Chatha is spread over 578 acres. The Faculty of Agriculture, Faculty of Basic Sciences and School of Biotechnology are located at it. Faculty of Veterinary Sciences & Animal Husbandry at R.S.Pura has an extent of 84 acres. The total land possession with the University (including Research Stations/Sub-Stations and KVKs) is 1139.12 acres. There are six Research Stations/ Sub-Stations and seven KVKs in the University that are located in different agro-

climatic zones of Jammu region for catering to location-specific needs of the farming community. University pursues high standard of location specific and problem-solving research through research projects funded by various central, state agencies & other funding agencies. At the faculty level the emphasis is on imparting of quality education by providing congenial atmosphere in the campus. The inception of high-tech infrastructure involving computer-based facilities, internet connectivity and modern administrative dispensation are vital characteristics of this University.

The University has highly structured infrastructure facilities in terms of buildings, laboratories, lecture rooms, instructional and research farms, modern instruments/equipments, farm machinery, transport and library facilities. It has distinguished and qualified faculty positioned at all the campuses and regional research stations. The faculty members and the post-graduate students of the University have won numerous national and international recognitions in the forms of awards, honours and fellowships awarded by the prestigious professional scientific bodies/societies.

ELIGIBILITY REQUIREMENTS AND INTAKE

Master's degree in respective/related subjects with 6.50/10.00 or equivalent OGPA/equivalent percentage (65%) of marks at Master's Degree, and 6.00/10.00 or equivalent OGPA/equivalent percentage (60%) of marks at Master's Degree for SC/ST/PH category.

For Ph.D programme in Microbiology, the eligibility shall be M.Sc (Ag) Microbiology/M.Sc Microbiology/Biotechnology/Environmental Science/Molecular Biology and Biotechnology/Life Sciences/Plant Pathology (with specialization in Microbiology)/Soil Microbiology.

DISCILIPNE WISE INTAKE

A	Ph.D. Agriculture and allied sciences	Intake
1	Agricultural Economics	01
2	Agricultural Engineering (Farm Machinery)	03
3	Agricultural Extension & Communication	04
4	Agronomy	05

5	Entomology	03
6	Food Science & Technology	01
7	Forestry	03
8	Fruit Science	03
9	Genetics & Plant Breeding	02
10	Plant Pathology	03
11	Sericulture	01
12	Soil Science & Agricultural Chemistry	03
13	Vegetable Sciences	03
B	Ph.D. Biotechnology	
1	Biotechnology	04
C	Ph.D Basic Sciences	
1	Biochemistry	02
2	Statistics	02
3	Plant Physiology	03
4	Microbiology	02
D	Ph.D. Veterinary Sciences	
1	Animal Genetics and Breeding	02
2	Animal Nutrition	02
3	Livestock Production and Management	02
4	Livestock Products Technology	02
5	Veterinary Anatomy	02
6	Veterinary and Animal Husbandry Extension Education	01
7	Veterinary Biochemistry	01
8	Veterinary Gynaecology & Obstetrics	02
9	Veterinary Medicine	02
10	Veterinary Microbiology	Nil
11	Veterinary Parasitology	02
12	Veterinary Pathology	02
13	Veterinary Pharmacology & Toxicology	02
14	Veterinary Physiology	02

15	Veterinary Public Health & Epidemiology	02
16	Veterinary Surgery & Radiology	02

Note:

- i. One supernumerary seat in each discipline is reserved for in-service teachers of SKUAST-J.
- ii. Candidates should have completed their Masters' degree by or before **25-01-2020.**

GENERAL INFORMATION AND INSTRUCTIONS

It is expected that the candidates shall behave responsibly while appearing in the entrance examination and shall not adopt any unfair/ fraudulent/ mischievous means. The candidates, therefore, are sternly warned not to resort to any unfair/fraudulent means or act of impersonation. In case a candidate is found resorting to such acts, criminal proceedings shall be initiated against him/ her, besides debarring him/ her permanently from appearing in the entrance examination in future.

The candidates seeking admission to SKUAST-J common entrance test are advised to:

- i. Go through this information brochure carefully and acquaint themselves with all the requirements, rules and regulations
- ii. Satisfy themselves about the eligibility criteria prescribed for appearing in the entrance examination.
- iii. Strictly adhere to the last date of submission of application form.
- iv. Write complete address with Postal Pin Code, Telephone No., Mobile No, e-mail address, in the application form.

SKUAST-J employees' admission: All employees of SKUAST-J shall have to appear & qualify the entrance test for admission to Ph.D programme.

For in-service teachers of SKUAST-J, there is one supernumerary seat in each division. However, they have to apply for admission in pursuance to this advertisement and should qualify the examination as envisaged in the brochure.

Admission of employees other than the teachers in SKUAST-J, who do not fulfil the conditions under FIP, shall be consider as per J&KCSR norms. But, they have to earn seat through prescribed norms of SKUAST-J CET (Ph.D.) 2019 after seeking prior permission from the employer.

Teachers/other than Teachers who do not qualify w.r.t. the length of service as elucidated SKUAST-J Statutes/J&KCSR can be considered for deputation to pursue

Ph.D. without salary. But they have to earn the seat through prescribed norms of SKUAST-J CET (Ph.D.) 2019 after seeking prior permission from the employer.

INSPIRE, GATE, SRF and other fellowship holders are exempted for appearing in CET 2019 and would be admitted against supernumerary seat up to the extent of 01 in each discipline in case there are more than one candidate under this category in a stream, the merit obtained at the Master's level degree shall be considered for selection. However, they have to apply for admission in pursuance to this advertisement.

The recommendation for selection of the candidates in all the categories shall be subject to production of all the relevant certificates in original by the candidates and the verification of the University. The selection made by SKUAST-J to a course shall be provisional till final determination of eligibility of the candidates.

The University shall have the right to review the provisional selection list at any time, notwithstanding the fact that the selected candidate has completed his/ her admission formalities. Mere appearing of name in selection list does not confer any right to admission of the candidate if he/ she is otherwise found ineligible.

Since University is neither an appellate authority nor an investigating agency, the complaints against certificates, including those of reserved categories, will not be entertained. Responsibility for submission of complete and proper documents by the prescribed date shall be with the candidate. Non- submission of documents by the due date or non-production of original documents at the time of counseling shall make a candidate ineligible for admission. No representation will be entertained for rejected forms and forms received after the due date.

The candidates applying for admission, if found eligible, will be required to appear in the 'SKUAST-J Common Entrance Test' at their own expenses. No candidate will be allowed to sit in the 'SKUAST-J Common Entrance Test' without valid admit card in original issued by the University. In case the candidates do not receive the admit cards two days before the entrance examination, they should contact I/c Examination Cell, SKUAST-J for issuing the duplicate admit card. Permission of candidates to appear in 'SKUAST-J Common Entrance Test' shall be provisional, subject to their being eligible for admission to the course(s) applied for. Complaints relating to certificates, particularly those of reserved categories will not be entertained, as University is not an appellate authority or an investigating agency.

The SKUAST-J CET for Ph.D. shall be compulsory and the qualifying marks for the test for admission to various programmes of Ph.D. should be 50% of the total marks of SKUAST-J CET. The question paper of SKUAST-J CET (Ph.D.) shall be based on 50% of Research Methodology and 50% of specific subject.

Syllabus for the entrance examination is appended in the Information Brochure.

Ragging is banned in the University

INSTRUCTIONS/ PROCEDURE FOR FILLING UP ONLINE APPLICATION FORM

Candidates are advised to read carefully the following instructions before they fill in the admission form:-

- i. Candidates have to log on to www.skuast.org to apply online, and click the link **Common Entrance Test (CET-Ph.D)-2019**.
- ii. The candidates must, in their own interest, download the Information Brochure and understand eligibility criteria and other required information before filling the Application Form.
- iii. Application Form will be accepted Online ONLY through University website www.skuast.org from 10.00 AM of 04-12-2019 to 5.00 PM of 24-12-2019. However, application forms along with late fee of Rs. 1000/= will be accepted from 5.01 PM of 24-12-2019 to 5.00 PM of 26-12-2019.
- iv. The name should be filled in **BLOCK LETTERS** and should be the same as given in the certificate of the last examination passed.
- v. Before applying online, candidate must ensure that he/she has scanned image of his photograph, signature and thumb-impression in JPEG/JPG format saved on the computer; uploading all of these is MANDATORY. Candidate should also have his/her payment mode details handy.
- vi. Open the first link, and fill in Part-I of the on-line application form (personal details).
- vii. While filling up the application form, the candidates shall prefer to write his own contact No(s), email Id for receiving Admit cards/updates from time to time.
- viii. After submission of personal details at Part-I, you will be directed to second link and fill-in the Part II of application form (academic details).

- ix. After submitting Part-II, programme will automatically take you to Part III for uploading of Photograph, signature and thumb impression. Upload images of photograph, signature, and thumb impression in JPEG format.
- x. Once successfully done, candidate will be shown his/her complete details as recorded at part- IV of the form. Candidate is required to thoroughly check all the details.
- xi. At the bottom of the page candidate will have the options of printing application form. Take a print out of the application form for your record.
- xii. Candidate can make online payment through any Credit Card/Debit Card/Net Banking. Take print out of confirmation page(s) of online application format and preserve it for future reference.
- xiii. Admission form incomplete in any respect shall be rejected.
- xiv. Seeking admission on the basis of false identity, misrepresentation by submitting false certificates/ documents or suppression of any material fact is unlawful and will result in cancellation of admission.
- xv. The applicant can check the status of his/her fee online (www.skuast.org) one week after depositing the fee.
- xvi. In case the status remains unpaid even after one week, candidate can approach SKUAST Jammu with the copy of their Confirmation page of online payment.
- xvii. For any assistance please call 9419226376. Before you call please make sure that you have read all the conditions properly and have gone through the Information Brochure in totality. All the topics/issues covered in the Information Brochure/instructions herewith will not be replied.

ADMISSION PROCEDURE AND DETERMINATION OF MERIT

The candidates fulfilling the eligibility criteria will have to appear in the SKUAST-J Common Entrance Test. The selection will be purely based on the marks secured in the SKUAST-J Common Entrance Test and a merit list will be drawn based on the score obtained in the test. However, the candidates scoring less than 50% marks in the CET shall not be considered for admission, and therefore shall not be included in the merit list. All the selections made by the University to Ph.D programme shall be provisional till final determination of eligibility of the candidates by the University authority. In case there is tie in the merit of SKUAST-J CET (Ph.D.), candidate having higher marks in the Master's level shall be placed at higher rank. However, in case there is again tie in the master's programme, the candidate higher marks in graduation level shall be placed higher in the rank. Any subsequent vacancy caused by whatsoever reason in any category shall be filled from the waitlisted candidates.

The University shall have the power to review the provisional selection list in case of any bonafide error, lapse, mistake, fraud, misrepresentation or glaring injustice that occurs or is brought to its notice before completion of the selection process or after the selection/admission process, the selection list shall be amended accordingly. Mere figuring in the selection list does not confer any right to admission of the candidate if he/she is otherwise not found to be eligible on detection of an error/ mistake/ fraud/ misrepresentation/ impersonation.

ADMIT CARD

Only for those candidates who fulfill the admission requirements for the programme, to which they have applied, will be issued the photo Admit Cards depicting roll no, name of Centre of Examination, date and timing of the test. The Admit Card can be downloaded from the University web site www.skuast.org. No admit card shall be sent by post. If Admit Card is not downloaded two days before the date of the Entrance Test, the candidate may contact the office of the Assistant Registrar, Examination Cell, SKUAST Jammu, Chatha,

DECLARATION OF RESULT

The University shall make available the answer key on its website next day after the examination. No intimation, whatsoever about non-selection will be sent individually and no correspondence in this regard shall be entertained. The result will, however, be available in the office of the Registrar, SKUAST-Jammu. The result will also be available on University website, www.skuast.org.

Fee Structure

S. No.	Particulars	Ph.D.
A. At the time of I st admission		
1	Admission fee	8000
2	University Registration fee	6000
3	Caution/Security Money for Library (refundable)	3000
4	College Laboratory Development charges	1000
5	Semester Registration fee	1000
6	Tuition fee	5000
7	Examination fee	1000
8	Extra Curricular Activities fee	500
9	Medical Examination fee	200
10	Medical Insurance	1183*
11	Magazine fund (per annum)	200
12	Identity card	100
13	Placement and counseling fund	NIL
14	Educational Tour	Nil
Total (A)		27183
B	Hostel Charges	
	Hostel Charges (Room rent) Per Semester	
1	Single seater	3500
2	Dormitory	2500
3	NRI Rooms	5000
4	Hostel Security (refundable) for fresh admission	4000
5	Mess security in case of Hostel inmates for fresh admission (refundable)	4000
6	Hostel maintenance fund per Semester	500
7	Utensils crockery breakage fund	150
8	Common Room Fund (Hostellers)	300
9	Electricity charges Per semester	2000
10	Generator charges Per Semester per Students	3000
	Total (B)	
	Single seater	17450
	Dormitory	16450
	NRI Rooms	18950
	G Total (A+B)	
	Single seater	43450
	Dormitory	42450
	NRI Rooms	44950
Optional Charges (Per Semester)		
a	Refrigerator in room	800

b	Air Cooler	2500
c	Electric Blower	2500
d	Air Conditioner	12000
C. Recurring Semester Fee (Per semester)		
(A)	Recurring Semester fee	
1	Semester Registration fee	1000
2	Tuition fee	8000
3	Examination fee	1000
4	Extra Curricular Activities fee	1500
5	Medical Examination fund/fee	200
6	Magazine fund (per semester)	100
7	Amalgamated fund	600
8	Library Fee	300
9	Infrastructure development fund	500
10	Student Welfare Fee	500
11	Water Charges	100
Total (A)		13800
(B)	Hostel Charges (Room rent)	
1	Single seater	3500
	Dormitory	2500
	NRI Rooms	5000
2	Hostel maintenance fund	500
3	Utensils crockery breakage fund	150
4	Common Room Fund	300
5	Electricity charges	2000
6	Generator charges	3000
Total (B)		
	Single seated	9450
	Dormitory	8450
	NRI Rooms	10950
G. Total (A+B)		
	Single Seated	23250
	Dormitory	22250
	NRI Rooms	24750

Fee structure for Self-financing seats in addition to normal semester fees

S.No	Programme	Category	Semester fee (Rs.)	Self financing fee per Semester (Rs.)	Total fee of 1 st Semester (Rs.)
1.	Ph.D (Biotechnology)	Self Financing	27183	30000	57183
2.	Ph.D.(Microbiology)	Self Financing	27183	30000	57183

** Health & Accidental (Medical) insurance shall be paid annually*

GENERAL INSTRUCTIONS FOR TEST

- i. Entrance Examinations will start at **11:00 AM sharp** and will be for ninety minutes duration. The candidates must reach the Centre of Examination at **10:00 AM sharp**.
- ii. Candidates arriving late by more than half an hour will not be permitted to appear in the test.
- iii. Calculator, log tables, pager, note book or written notes, pamphlets, slide rules, protractors, rulers, highlighters dictionary etc. are not allowed inside the Examination Hall. Any violation would amount to disqualification of candidature.
- iv. Mobile phones are not allowed inside the examination hall. The candidates will be responsible for safekeeping of their mobile phones.
- v. Any candidate who creates disturbance of any kind during the Test or otherwise misbehaves in or around the Examination Centre or changes his/her seat with any candidate will be expelled from the Test.
- vi. Any candidate having in his/her possession or accessible to him/her papers/books or notes which may possibly be for providing assistance, or copying from any paper/book or note or allowing any other candidate to copy from his/her answer sheet or found writing on any other paper, or using or attempting to use any other unfair means will be expelled from the Test.
- vii. The decision of the Centre Superintendent/Coordinator/Controller of Examinations to expel a candidate from the examination centre shall be final.
- viii. If a candidate puts any identification mark on the answer sheet, the same shall be cancelled. The decision of the Controller of Examinations in this regard will be final.
- ix. If impersonation in the Entrance Test is detected, the candidature will be cancelled and a case will be registered with the police.
- x. Disabled students shall be granted an extra **20** minutes time in the entrance tests.

CANDIDATES MUST BRING

- i. Two ball point pens (**black/blue colour**)
- ii. Admit card issued by the University

SYLLABUS for SKUAST (CET) Ph.D. 2019

The question paper of SKUAST-J CET (Ph.D.) shall be:

Subject Specific: 50% Weightage

Research Methodology: 50% Weightage

Agriculture & Allied Sciences

Subject: AGRICULTURAL ECONOMICS

Theory of Consumer Behaviour, Consumer surplus, Elasticity of demand, Theory of Production - Production functions – Returns to scale and economies of scale, Law of Supply – Producers' surplus, Market Equilibrium - Perfect Competition, Monopoly- Monopolistic – Oligopoly, Welfare Economics, Social welfare criteria - Social Welfare functions.

Nature and Scope of Macro Economics, National Income - Concepts and measurement, Consumption function- Investment and savings, Concept of Multiplier and Accelerator, Unemployment and Full employment, Money and classical theories of Money and Price, Supply of Money - Demand for Money -Inflation: Nature, Effects and control, Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy - Central banking.

Nature, scope and significance of agricultural production economics- assumptions of production functions, Factors of production, Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination, Cost functions and cost curves, components, and cost minimization, Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement.

Agricultural Marketing, Definition, Meaning, Market intermediaries and their role, Marketable & Marketed surplus estimation. Marketing Efficiency, Marketing Co-operatives – APMC Regulated Markets, Contract farming and Retailing - Supply Chain Management, Market research-Market information service, price forecasting, Price policy and economic development, Price discovery, speculation and hedging.

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. NABARD and Commercial Banks and RRBs, Micro-Financing and Role of NGO's and SHG's, concept of 3 C's, 7 P's and 3 R's of credit, Balance Sheet, Cash Flow Statement and Profit and Loss Account, project identification, preparation, appraisal, financing and implementation of projects, Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR, crop insurance schemes - yield loss and weather based insurance and their applications.

Subject: AGRICULTURAL ENGINEERING (FARM MACHINERY)

Research and development procedure in farm equipment and agricultural tractors. Mechanical and hydraulic, selection, design analysis. Analysis of linkages. Reliability criteria. Dynamic properties of soil related to tillage and traction. Design considerations for tillage tools. Soil vehicle models. Testing types, Test Procedures and various Test codes. Concept of dimensional analysis. Algorithm design, program composition, quality control. Approximation, round off errors, truncation errors. Simulation of simple discrete systems. Solving differential equation on computers- modeling engineering systems with ordinary differential equations- solution techniques using computers. Strain -stress, strain relationship. Strain gauges. Measuring devices for displacement, velocity, force, torque and power. Active and passive transducers. Cost analysis of farm machinery use and operations. System engineering function. System approach in farm machinery management. Equipment replacement and inventory control. Work space design. Modeling of optimum mechanization systems. Modern trends in tractor design and development, special design features of tractor in relation to Indian agriculture. Parameters affecting design of tractor engine and their selection. Design of engine components and tractor systems. Mechanics of tractor. Human factors in system development. Anthropometry. Man-Machine system concept. Safety standards at workplace. Physical characteristics- of different food grains, fruits and vegetables. Rheology, terms, physical states of materials, visco-elasticity, creep stress relaxation, Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, aero dynamics of agricultural products, drag coefficients, terminal velocity, Thermal properties, Electrical properties.

Subject: AGRICULTURE EXTENSION & COMMUNICATION

Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education. Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University. Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development. Current Approaches in Extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centres, NAIP.

Communication process –elements and communication– Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication –Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media – Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications. Agricultural Journalism, Techniques of writing scripts for Radio and TV.

Diffusion – concept and meaning, elements; traditions of research on diffusion; innovation-development process; tracing the innovation-development process, The adoption process-concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation. Adopter categories – Innovativeness and adopter categories, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption. Diffusion effect and concept of over adoption, opinion leadership measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions –Consequences of Innovation-Decisions – Decision making – meaning, theories, process, steps, factors influencing decision – making. Research– Meaning, importance, characteristics.

Behavioral sciences research – Meaning, concept and problems in behavioral sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature –Research problem –Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem Variables Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, Hypothesis –types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity and Reliability, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximinon Principle, Sampling – Types of sampling and sampling procedures. Research Designs –Data Collection devices - Enquiry forms and Schedules –Questionnaires – pre – testing of the questionnaires or Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Observation –Case studies –Social survey –Data processing – Meaning, coding, and preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.

ICTs- Concept, definition, tools and application in extension education. ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in field of extension- Community Radio, Web, Tele, and Video conferencing. Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts. ICT Extension approaches-pre-requisites, information and science needs of farming community. SWOT analysis of ICT:

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Growth and Recruitment, Career planning; social and Organizational Culture: Indian environment perspective on cultural process and social structure, Organizational and Managerial values organizational commitment Performance Appraisal. Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): Inter-Personal Process, Helping Process –communication and Feedback and interpersonal styles; Capacity Building –Managerial skills and Managerial roles; Decision Making: Decision Making models, Types of Decisions, Heuristics in decision making – organizing for HRD – emerging trends and Prospective.

Subject: AGRONOMY

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of cereals, pulses, oilseeds, sugar crops fibre and fodder crops.

Agro-climatic and agro-ecological zones of India, quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit, effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield, scientific principles of crop production; concept of soil plant relations; yield and environmental stress.

Criteria of essentiality of nutrients; essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients and crop responses; Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions, time and methods of manures and fertilizers application; foliar application and its concept; integrated nutrient management.

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers, organic insect pest management, biological agents and pheromones, biopesticides, socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Weed biology and ecology, crop-weed competition including allelopathy, principles and methods of weed control and classification; weed indices, herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides, herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide

mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation, weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control and Integrated weed management.

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India, soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition, scheduling, depth and methods of irrigation; micro-irrigation system; fertigation; water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use, concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mixed-cropping, mechanism of yield advantage in intercropping systems, crop diversification for sustainability and crop rotation.

Definition, concept and characteristics of dry land farming; significance and dimensions of dry land farming in Indian agriculture, constraints limiting crop production in dry land areas; types of drought, crop planning for erratic and aberrant weather conditions, resistance to drought, adaptation of crop plants to drought, drought management strategies; mid contingent plan for aberrant weather conditions, tillage, concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use, concept of watershed resource management, problems, approach and components.

Subject: ENTOMOLOGY

Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites. Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications. Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors).

Scope and importance of insect anatomy and physiology. Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous,

sensory, reproductive, musculature, endocrine and exocrine glands. Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause. Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained. Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apteriygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera. Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

History and Definition. Basic Concepts. Organization of the Biological world. Plato's Natural Balance vs. Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalized action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology. Basic concepts of abundance- Model vs. Real world. Population growth basic models – Exponential vs. Logistic models. Discrete vs. Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation. Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of nicheecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies. Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's d/w , Relation between the two and their association with Dyar's Law and Przibram's

law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology.

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India. Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc. Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence. Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

History and origin, definition and evolution of various related terminologies. Concept and philosophy, ecological principles, economic threshold concept, and economic consideration. Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

Subject: FOOD SCIENCE & TECHNOLOGY

Definition and importance; major food constituents and their physicochemical properties; role of water in food. Carbohydrates, proteins and lipids: classification, physical, chemical, Nutritional, and functional properties and their structural correlations; auto-oxidation of lipids and rancidity. Properties of minerals, vitamins, pigments, anti-oxidants, flavour components, and anti-nutritional factors in foods; Changes during storage and processing; Browning reactions in foods. Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances; digestion, absorption, transport and metabolism of nutrients in human system; protein quality evaluation.

Scope of food processing; historical developments; principles of food processing and preservation. Processing and preservation by heat – blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying. Processing and preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro-freezing. Processing and preservation by drying, concentration and evaporation-types of dryers and their suitability for different food products; ultra- filtration, reverse osmosis. Processing and preservation by non-thermal methods,

irradiation, high pressure, pulsed electric field, hurdle technology. Use and application of enzymes and microorganisms in processing and preservation of foods; food fermentations, pickling, smoking; Food additives: definition, types and functions, permissible limits and safety aspects.

Definitions, objectives and functions of packaging and packaging materials; Packaging requirements and selection of packaging materials; Types of packaging materials: Paper: pulping, fibrillation and beating, types of papers and their testing methods; Glass: composition, properties, types of closures, methods of bottle making; Metals: Tinplate containers, tinning process, types of cans, aluminum containers, lacquers; Plastics: types of plastic films, laminated plastic materials, edible films, biodegradable plastics. Properties of materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, their methods of testing and evaluation; Barrier properties of packaging materials. Food packaging systems. Packaging equipment and machinery: Vacuum, CA and MA packaging machine; gas packaging machine; seal and shrink packaging machine; form and fill sealing machine; aseptic packaging systems; bottling machines; carton making machines.

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory *vis-à-vis* instrumental methods for testing quality. Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standards. Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits; Indian & International quality systems and standards like ISO and Food Codex.

Sampling techniques; Water activity, its measurements and significance in food quality; Calibration and standardization of different instruments. Spectroscopic techniques using UV/Vis, fluorescence, IR, FTIR, NIR, NMR, atomic absorption, ICP, polarimetry, refractometry. Chromatographic techniques: Adsorption, column, partition, affinity, ion exchange, size exclusion, GC, GLC, HPLC, HPTLC, GCMS. Separation techniques: Gel filtration, dialysis, electrophoresis, sedimentation, ultrafiltration and ultracentrifugation.

Subject: AGRO-FORESTRY

Silvicultural Principle; locality Factors; forest regeneration; propagation techniques; nursery including containerized seedling production in forestry; silvicultural systems; plantation forestry including site and species selection. Silviculture of economically important species in India.

Agroforestry - scope and necessity. Agro forestry systems under different agro-ecological zones; ideotype concept; multipurpose trees and NFTs; social/urban Forestry; JFM. Constraints in agroforestry; evaluation of agroforestry systems.

Forests soils, classification, factors affecting soil formation; soil conservation - definition, causes and types of erosion; techniques of conservation; wind breaks, shelter belts and sand dunes stabilization; reclamation of degraded and problematic soils. Soil organic matter; N and C cycles, VAM. Watershed Management –concepts, hydrology, watershed in rehabilitation of degraded areas; hilly and mountain areas; environmental functions of forests.

Environment; components and importance, principles of conservation, impact of deforestation, fires and human activities on environment. Pollution- types, global warming, green house effect, ozone layer depletion, acid rain, impact and control measures. Role of trees and forests in environmental conservation; control and prevention of pollution. Environmental policy and legislation in India. Environmental Impact Assessment.

Concepts of tree improvement, methods and techniques, variation, provenance, seed source, exotics; quantitative aspects of forest tree improvement, seed orchards, progeny tests, genetic base, forest genetic resources and gene conservation *in-situ* and *ex-situ*.

Methods of measuring- diameter, girth, height and volume of trees; form-factor; volume estimation, CAI and MAI. Sampling methods and sample plots. Yield calculation; yield and stand tables, forest cover monitoring through remote sensing; geographic information systems for management and modelling.

Forest eco-systems- components, forest community concepts; vegetation concepts, ecological succession and climax, primary productivity, nutrient cycling and water relations. Forest types in India, identification of species, dendrology, taxonomic classifications. Conservation of forest ecosystems. Clonal banks, Role of ethnobotany in Indian Systems of Medicine; agro-techniques of important medicinal and aromatic plants.

Forest harvesting practices; logging and extraction techniques. Non-Timber Forest Products (NTFPs)- gums, resins, oleoresins, fibres, oil seeds nuts, rubber, canes, bamboos, medicinal plants, charcoal, lac and shellac, katha and tendu leaves. Wood seasoning and preservation; Composite wood, plywood, fibre and particle boards-manufacture, properties and uses. Present status of composite wood industry in India. Pulp-paper and rayon. Anatomical structure of wood, defects and abnormalities of wood, timber identification - general principles.

Injuries to forest - abiotic and biotic, destructive agencies, insect-pests and disease, effects of air pollution on forests and forest die back. Protection against fire, equipment and methods, controlled use of fire. Rotational and controlled grazing, effect of wild animals on forest regeneration, human impacts; encroachment, poaching, grazing, lives fencing, theft, shifting cultivation and control.

Subject: FRUIT SCIENCE

Importance and management of tropical sub tropical temperate and dry land fruits grown in India. Commercial varieties of regional, national and international importance. Recent trends in propagation, rootstock Influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio-regulators. Physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential. Agri. Export Zones (AEZ) and industrial supports.

Crops Mango, Banana, Citrus, Papaya, Guava, Sapota, Jackfruit, Aonla, Pomegranate, Ber, Apple, Pear, Grapes, Plums, Peach, Nuts- walnut, Almond Minor fruits- Bael, Fig and Jamun. Sexual propagation, apomixis, polyembryony, chimeras. Asexual propagation- rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings In hotbeds. Rejuvenation through top working—Progeny orchard and scion bank. Micropropagation- principles and concepts, commercial exploitation in horticultural crops.

Nursery—types, structures, components, planning and layout. Nursery management practices tor healthy propagule production.

Principles of biodiversity in germplasm conservation of fruit crops. Present status of gene centers; exploration and collection of germplasm in situ and ex situ; Intellectual property rights. Crops Mango, citrus, guava, banana, papaya, coconut.

Principles and practices of breeding of fruit crops. Breeding systems, breeding objectives, approaches for crop improvement-introduction, selection, hybridization. mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses in the following selected fruit crops. Crops Mango, banana, citrus, grapes, guava, papaya.

Principles and practices in canopy management of fruit crops. Canopy management importance and advantages; factors affecting canopy development. Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Canopy management through plant growth inhibitors, training and pruning and management practices in temperate fruits, grapes, mango, guava, citrus and ber. Role of hormones in different horticultural crops- fruit thinning, fruit drop, ripening, dormancy breaking and propagation.

Subject: GENETICS & PLANT BREEDING

BREEDING:

Historical aspect of genetics; Cell structure and cell division; Mendel's laws; Multiple alleles, Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-

limited traits; Somatic cell genetics, Extra chromosomal inheritance. Population - Mendelian population – Random mating population -Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis. Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters. Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion sequences (IS) and transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing.

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs). Genomics and proteomics; Functional and pharmacogenomics; Metagenomics. Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

CYTOGENETICS:

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes. Chromosomal theory of inheritance. Structural and numerical changes in chromosomes; Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis,

Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications. Structural and Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids – Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.

Reversion of autopolyploids to diploids; Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same

chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species.

Fertilization barriers in crop plants at pre-and post-fertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization; case studies–Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

PLANT BREEDING:

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

Self-incompatibility and male sterility in crop plants and their commercial exploitation.

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.

Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding. Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses. Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of self incompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis-maintenance breeding of parental lines in hybrids. Organellar heterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis. Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Mutagenic agents: physical -- Radiation types and sources: Ionizing and non-ionizing radiations *viz.*, X rays, γ rays, α and β particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects –RBE and LET relationships.

QUANTITATIVE GENETICS:

Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

Principles of Analysis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – microsatellite, cluster and D2 analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis– principles and interpretation.

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

BIOTECHNOLOGY FOR CROP IMPROVEMENT:

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F₂s, back crosses, RILs, NILs and DH).

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding. Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

Biotechnology applications in male sterility/hybrid breeding, molecular farming. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights. Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

VARIETY DEVELOPMENT AND MAINTENANCE:

Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid and population; Variety testing, release and

notification systems in India and abroad. DUS testing- Genetic purity concept and maintenance breeding. genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties; Principles & methods of seed production; Generation system of seed multiplication -nucleus, breeders, foundation, certified, -

Quality seed production technology; of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearl millet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems

Subject: PLANT PATHOLOGY

Study the nomenclature, classification and characters of fungi. Introduction, definition of different terms, basic concepts. Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology. Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi. The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens types and importance, fungal genetics and variability in fungi.

Acquaint with the structure, virus-vector relationship, biology and management of plant viruses. History of plant viruses, composition and structure of viruses. Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship. Virus nomenclature and classification, genome organization, replication and movement of viruses. Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics. Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

Plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination. History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria. Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them. Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya. General biology of bacteriophages, L-form bacteria, plasmids and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria. Survival and dissemination of phytopathogenic bacteria.

Plant Pathology, its concepts and principles. Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens. Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies. Economic importance, symptoms, causes and management of Major diseases of field and horticultural crops.

Study of methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides and bactericides.

Subject: SERICULTURE

Important popular varieties of mulberry. Role of agro climatic conditions especially in rain fed and irrigated conditions for mulberry. Planting techniques and establishment of mulberry garden. Mulberry propagation: Sexual and Vegetative. Seedling production: Cutting, grafting, budding, layering. Management of chawki garden. Training and pruning. Types of training and pruning and its objectives, Requirement of manures, fertilizers and bio-fertilizers (a) Manuring: Organic and green manures, (b) Fertilizers: Composition and application, (c) Importance of composting: Vermi-composting and bio-fertilizers. Foliar nutrition. Merits and limitation, Weeds and their control measures. Irrigation: Methods of irrigation and its management. Nursery management:- Preparation of bed, sowing of seed, care of seedling.

Characteristics of silkworm for its placement in class, order and family level. Life history of *Bombyx mori*-Morphological features of egg, larva, pupa and adult. Morphological and Anatomical features of silkworm integument, colouration and moulting, Structure and function of digestive, respiratory, circulatory, reproductive, nervous and excretory system. Silk gland of silkworm.

Disinfection and hygiene: types of disinfectants and disinfection methods. Incubation and brushing: Effect of temperature, humidity and photoperiod on silkworm eggs. Chawki rearing requirements, methods and management. Late age rearing requirement and management of rearing in different seasons. Voltinism in silkworm. Factors influencing spinning. Influence of temperature and relative humidity on cocoon characters. Cocoon marketing and price fixation. Organization of seed production: breeder's stock, basic stock maintenance of pure

rices. Procedures for maintaining breed characteristics at multiplication level. Procedures of Pebrine and Bacterial flacherie examination in seed and commercial egg production. Seed preservation, hot and cold acid treatments. Short term chilling and different preservation schedules.

Breeding and genetics of silkworm, spermatogenesis, Oogenesis, Fertilization, Emryogenesis, germband formation. Diapause and its biochemical change. Parthenogenesis and its types and induction. Mutation and chemical mutagenesis. Silkworm breeding and its objectives. Pre-requisites for silkworm breeding programmes. Methods of breeding, fixation of commercial characters. Variability in silkworm breeds as a basis of selection, methods of selection, selection of qualitative and quantitative traits. Hybridization for the improvement of qualitative and quantitative traits in silkworm. Recurrent back crossing for evolution of new breeds. Heterosis and hybrid vigour. Biotechnology and its role / scope in improving silk production.

Subject: SOIL SCIENCE & AGRICULTURAL CHEMISTRY

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system. Soil texture, textural classes, mechanical analysis, specific surface. Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts. Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential. Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils. Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management. Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. Nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation - types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

Phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions. Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions. Sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium- factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers. Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions. Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management. Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Chemical (elemental) composition of the earth's crust and soils. Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics. Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange - inner-sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects. Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity. Chemistry of salt-affected soils and amendments; soil pH, E_{Ce}, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of submerged soils.

Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques;

amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils. Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

Concept of soil individual; soil classification systems - historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness. Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps. Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-eco system.

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI_{30} index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation. Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country. Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout. Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio-economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota. Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora. Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients.

Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil. Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost. Biofertilizers – definition, classification, specifications, method of production and role in crop production.

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation-reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling. Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

Principles of visible, ultraviolet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractometry; identification of minerals by X-ray by different methods.

Determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity. Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods. Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential. Analysis of soil extracts and irrigation waters.

Subject: VEGETABLE SCIENCES

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of cool season vegetables like Potato, Cole crops (cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels sprout), Root crops (carrot, radish, turnip and beetroot), Bulb crops (onion and garlic), Leguminous vegetables (peas and beans) and Solanaceous vegetables (tomato, eggplant, hot and sweet peppers), Leguminous vegetables (beans and cowpea), Okra, Cucurbitaceous vegetables, Tuber crops (tapioca and sweet potato) and green leafy vegetables.

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act for Solanaceous vegetables (potato, tomato Eggplant, hot pepper and sweet pepper), okra, Leguminous vegetables (peas and beans), leafy vegetables (amaranth, chenopods and lettuce), Cucurbitaceous vegetables (Gourds, melons, pumpkins and squashes), Cole crops (Cabbage and cauliflower), Root vegetables (carrot, beetroot and radish), Tuber crops (sweet potato and tapioca).

Cellular structures and their functions, Definition of growth and development, Growth analysis and its importance in vegetable production. Physiology of dormancy and germination

of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscisic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morph-actins, antitranspirants, anti-auxin, ripening retardants and plant stimulants in vegetable crop production.

Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance, Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; Parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

Plant growth regulators in relation to vegetable production; Morphogenesis and tissue culture techniques in vegetable crops.

Subject: BIOTECHNOLOGY

Structure of atoms, molecules and chemical bonds. Composition, structure and function of Carbohydrates, Proteins, Lipids and Nucleic acids. Principles of Biophysical chemistry: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Analytical Techniques: Spectroscopy, Chromatography, X-ray diffraction etc.,

Molecular Biology and Recombinant DNA methods: Isolation of Nucleic acids (RNA, Genomic and Plasmid DNA) and proteins, different separation methods. Analysis of Nucleic acids and proteins through different electrophoretic techniques. Principles of recombinant DNA technology (Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences, Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. *In vitro* mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms). Protein and DNA sequencing methods. Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD, AFLP, SSR, SNP genotyping techniques. Immunochemical and histochemical techniques. Microarray technology.

Biology Origin and evolution of cell; Cells as experimental model; Functional organization of a cell; Structure and composition of the plasma membrane, cell wall and extracellular matrix; Cytoskeleton and cellular interactions; Water relations and ion transport mechanisms; Endomembrane system-endoplasmic reticulum, Golgi apparatus and lysosomes; Bioenergetics and metabolism- mitochondria, chloroplast and peroxisomes; Cell cycle and cell signaling mechanisms; The nucleus- nuclear envelope, organization of nucleolus and chromatin, genomes, DNA and flow of genetic information; Mutations; Cell death and cell renewal.

Principles of Mendelian genetics: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles: Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes : Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non-homologous recombination including transposition.

Concepts and history. Various aspects of plant tissue culture. Somatic cell cultures. Somatic embryogenesis. Meristem culture. *In vitro* grafting. Micropropagation. Somaclonal variation. Anther and pollen culture. Embryo/ovule/ovary culture. Protoplast culture and somatic hybridization. Production of secondary metabolites through tissue culture. Cryopreservation of germplasm.

Introduction to Bioinformatics. Importance of Bioinformatics. Mapping and sequencing. Sequencing DNA, RNA and Proteins. PCR primer designing. Protein structure, classification and analysis. Informal retrieval- Sequence alignment and similarity searches- BLAST, FASTA, data submission. Bioinformatic resources- NCBI, EBI, ExPASy, EMBL, GENBANK, Entrez, DDBJ, PDB, SWISSPORT, TREMBL, PIR_PSD. Phylogenetics analysis. Genome projects. Computational Biology.

Microbial products: Acids, organic solvents, vitamins, enzymes and biodegradable plastics. Microbial technology: substrates, upstream and downstream processing, Biotransformation, Fermentors, BOD and COD treatments and disposal of effluents. Hybridization technology and production of vaccines. Production of plant secondary metabolites through cell and hairy root cultures. Concepts of industrial fermentation- batch and continuous, production of biopharmaceuticals, Immobilization techniques.

IPRs and agricultural technology- implications for India, WTO, WIPO, GATT, TRIPS. Plant Breeder's Rights, legal implications. Ethical issues associated with consumption of GM food, labelling of GM crops and foods. Biosafety regulations- guidelines for research in transgenic crops, public awareness of the processes of producing transgenic organisms.

BASIC SCIENCES

Subject: BIOCHEMISTRY

Scope and importance of biochemistry in agriculture, fundamental principles governing life, Fundamental principles governing life, structure of water, acid base concept and buffers, pH, hydrogen bonding, hydrophobic, electrostatic and van der Waals forces, General introduction to physical techniques for determination of structure of biopolymers. Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins and nucleic acids. Structure and biological function of vitamins, enzymes classification and mechanism of action, regulation, factors affecting enzymes action. Hormones- animals, plants and insects, fundamentals of thermodynamics principles applicable to biological processes, Bioenergetics. Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. DNA replication, transcription and translation, recombinant DNA technology.

Introduction to metabolism, methods of studying metabolism, transport mechanism, bioenergetics, biological oxidation, signal transduction, catabolic and anabolic pathways of carbohydrates, lipids, regulation and their metabolic disorders, energy transduction, oxidative phosphorylation, general reactions of amino acid metabolism, degradative and biosynthetic pathways of amino acids and their metabolic disorders, sulphur metabolism, metabolic engineering concepts, compartmentation of metabolic pathways, metabolic profiles of major organs and regulation of metabolic pathways.

Enzyme nomenclature and classification, enzyme compartmentalization in cell organelles, isolation and purification of enzymes, measurement of enzyme activity. Ribozymes, isozymes & abzymes. Enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis. Cofactors, coenzymes- their structure and role. Enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity. Isolation and purification of enzymes, Application of enzyme in chemical and food industry, enzymes immobilization, biosensors and clinical application of enzymes. Enzyme assay: alpha-amylase or acid phosphatase-isolation and purification, effect of enzyme and substrate concentrations and determination of K_m and V_{max} , determination of pH and temperature optima and effect of various inhibitors, determination of the pH and temperature stability of enzyme.

Chromatographic and electrophoretic methods of separation. Principles and applications of paper, Thin Layer & HPTLC, Gas, Gas – liquid, Liquid chromatography, HPLC and FPLC, Paper and gel electrophoresis, Different variants of polyacrylamide gel electrophoresis (PAGE) like native and SDS-PAGE, 2D-PAGE, capillary electrophoresis. Spectrophotometry: Principles and applications UV-Visible, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X- Ray spectroscopy. Hydrodynamic methods of separation of biomolecules such as viscosity and sedimentation – their principles, variants and applications. Tracer techniques in biology: Concept of radioactivity, radioactivity counting

methods, concept of α , β and γ emitters, autoradiography, applications of radioactive tracer in biology,

Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA. Genome origination in prokaryotes and eukaryotes, chromatin structure and function. DNA replication, DNA polymerases, topo-isomerases, DNA ligase, reverse transcriptase, repetitive and non repetitive DNA, satellite DNA, transcription process, RNA editing, RNA processing. Ribosome: structure and function, genetic code, aminoacyl-tRNA synthases, inhibitors of replication, transcription and translation, translation and post translational modification, nucleases and restriction enzymes, regulation of genes expression in prokaryotes and eukaryotes, molecular mechanism of mutation. DNA sequencing, recombinant DNA technology, vectors, isolation of genes, recombinant vectors, selection of recombinants, PCR, general features of replication, transcription, site directed mutagenesis and translation in eukaryotes.

Plant cell organelles and their separation, structure and function of cell organelle, photosynthetic pigments in relation to their functions, photosynthesis, C_3 , C_4 and CAM pathways, photorespiration. Sucrose- starch interconversion, biosynthesis of structural carbohydrates, storage proteins and lipids. Biochemistry of nitrogen fixation and nitrate assimilation, incorporation of sulphur into amino acids. Biochemistry of seed germination and development, fruit ripening, phytohormones and their mode of action, signal translation, significance of secondary metabolic: cyanogenic glycosides, glucosinlates, phenolic compounds, terpenoids, alkaloids, their role in plant defense system.

Fundamentals of human nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains (including cereals, pulses, oilseeds, fruits and vegetables, physicochemical, functional and nutritional characteristics of carbohydrates, proteins, and fats and their interactions (emulsions, gelation, browning etc.), biochemical and nutritional aspects of vitamins, minerals, nutraceuticals, antinutritional factors, biochemistry of post harvest technology, effect of cooking, processing and preservation of different food products on nutrients, biochemical aspects of food spoilage, role of lipase and lipoxygenase, oxidative rancidity and antioxidants, enzymes in food industry, food additives, (coloring agents, preservatives etc.), biogenesis of food flavours and aroma, nutritional quality of plant, dairy, poultry and marine products.

Subject: STATISTICS

Probability and its measure. Axiomatic approach to probability. Properties of probability based on axiomatic definition. Addition and multiplication theorems. Conditional probability and independence of events. Bayes theorem. Random variable. Probability mass function and Probability density function, Distribution function and its properties. Notion of bivariate random variables, bivariate distribution function and its properties. Joint, marginal and conditional distributions. Independence of random variables. Mathematical expectation, Raw and central moments and their relation. Addition and multiplication theorems of expectation.

Conditional expectation and conditional variance. Concepts of moment generating function and characteristic function and their properties.

Probability distributions: Discrete probability distributions - Bernoulli, Binomial, Poisson, Negative-binomial, Geometric and Hyper Geometric, uniform, multinomial distributions. Continuous probability distributions - rectangular, exponential, Cauchy, normal, gamma, beta of two kinds. Sampling distributions of sample mean and sample variance from normal population. Chi-Square, t and F distributions, their properties and inter relationships. Correlation, rank correlation, correlation ratio and intra-class correlation. Regression analysis, partial and multiple correlations and regression.

Concepts of point estimation: MSE, unbiasedness, consistency, efficiency and sufficiency. MVUE, Rao-Blackwell theorem, Cramer-Rao lower bound. Moments, least squares and maximum likelihood methods of estimation. Interval estimation. Fundamental notions of hypothesis testing, Neyman-Pearson fundamental lemma, UMP test. Non-parametric tests: Sign test, Wilcoxon signed rank test, Runs test for randomness, Kolmogorov – Smirnov test, Wilcoxon-Mann-Whitney U-test. Chi-square test for goodness of fit and test for independence of attributes.

Elements of linear estimation, Gauss Markoff Theorem. Orthogonality, contrasts, mutually orthogonal contrasts, Factorial experiments, confounding in symmetrical factorial experiments, partial and total confounding. Balanced incomplete block designs, Partially balanced incomplete block designs with two associate classes, Lattice designs. Missing plot technique, Split-plot and Strip-plot designs.

Basic concepts of sampling, Determination of sample size; Simple random sampling, Estimation of population proportion, Stratified random sampling, Number of strata and optimum points of stratification. Systematic sampling, Sampling with varying probabilities, Cumulative total and Lahiri's methods of selection, Horvitz Thompson estimator, sampling strategies due to Midzuno-Sen and Rao-Hartley-Cochran. Ratio and regression methods of estimation, Cluster sampling, Multistage sampling with equal probability, Double sampling.

Subject: PLANT PHYSIOLOGY

Cell structure and functions; structure and metabolic role of cell organelles; concept of water status, water potential and its components, water uptake, transpiration, stomatal physiology, antitranspirants, xylem and phloem transport, Atoms, molecules and ions; molarity, molality and normality; pH, buffers, solutions and colloids; permeability, diffusion and osmosis; structure and function of chloroplast; photosynthetic pigments, photosystems, electron transport, ATP synthesis, C_3 , C_4 and CAM pathways; redox potential; photorespiration, chemosynthesis, photosynthetic efficiency, effect of climate change on photosynthesis, glycolysis, HMP, TCA and glyoxylate cycles, fatty acid and lipid synthesis and degradation; macro-and micro- nutrient elements and their functions, deficiency symptoms, role in metabolism; foliar nutrition, concepts of ion uptake, concept of nutrient use efficiency, heavy

metal toxicity and concept of phytoremediation; nitrogen metabolism including nitrate reduction, ammonia assimilation, transamination, protein synthesis, nitrogen fixation; carbohydrate metabolism; sulphur metabolism; secondary metabolites; plant growth regulators, Brassinosteroids, triacontanol, polyamines, Jasmonates – biosynthesis and catabolism, signalling and role in plant growth and development including stress responses, hormone receptors and signal transduction, herbicides – classification and mode of action; photoperiodism, vernalization and flowering, florigen concept; light receptors – phytochrome, cryptochrome, phototropins; sex expression; abscission, senescence and PCD; seed physiology; dormancy; growth analysis, measurement of key growth functions such as NAR, LAI, RGR, growth response in relation to environmental factors; crop canopies and light utilization; source- sink relationship, dry matter partitioning, crop growth models describing yield; physiological basis of crop productivity – case histories of some crop plants *viz.*, cereals, grain, legumes and oil seeds; Abiotic stresses *viz.*, high and low temperature, light, water, salinity and alkalinity, their terminology and measurement techniques, Interaction between biotic and abiotic stresses, phenotyping methods, abiotic stress signalling, mechanism of stress responses in plants; environmental pollution, green house effects, global warming, global carbon deposits ; post harvest physiology, ripening mechanism, molecular biology of plant processes, physiological basis of cytoplasmic male sterility and fertility restoration.

Subject: MICROBIOLOGY

History and development of microbiology; classification of bacteria, fungi, virus, protozoa; microscopy; methods of isolation, pure cultures, enumeration, sterilization, preservation, molecular characterisation; morphology and reproduction in bacteria, fungi, actinomycetes, viruses. Microorganisms in food, fermented foods; spoilages of food; food - borne diseases; microbial pollution of air and water; metabolic pathways in microorganisms; fermentation and industrially useful microbial processes - citric acid, lactic acid, ethanol, vinegar, production of antibiotics, enzymes, vitamins, amino acids; mutations and genetic recombination, transformation, transduction and conjugation; soil microorganisms; rhizosphere and phyllosphere ; microbial association, biodegradation, composting and biogas; symbiotic and non-symbiotic nitrogen fixation; microbial transformation of phosphates; use of microorganisms ,biofertilizers biopesticides, biological control.

VETERINARY SCIENCES

Subject: ANIMAL GENETICS AND BREEDING

Development in animal cytogenetics and immunogenetics of farm animals. Immunoglobulins and their types: antigen-antibody interactions, Immune response, ELISA. Major histocompatibility complex; genetics of biochemical variants and their applications; Ir-genes and concepts of disease resistance including major genes; hybridoma and its significance; concept of immuno-fertility, BoLA, BuLA, TLRs, Interleukins. Chromatin structure of eukaryotes; chromosome number and morphology in farm animals banding and karyotyping; chromosomal and genetic syndromes, DNA packing in chromosomes, Z+B DNA, FISH

chromosome painting and PRINS. RH Panel Mapping. Mutation and assays of mutagenesis; sister chromatid exchanges; recombinant DNA technique and its application in animal improvement programme.

Basic concept: Genesis and importance of molecular techniques; Genome organization – physical and genetic map, current status of genome maps of livestock. Molecular markers and their application; RFLP, RAPD, Microsatellite/ Minisatellite markers, SNP marker, DNA fingerprinting. DNA sequencing, Genome sequencing, Genomic Library, Polymerase Chain Reaction (PCR), its types (PCR-RFLP, AS-PCR etc.) and applications; Transgenesis and methods of gene transfer. Statistical techniques for analyzing molecular genetic data, Quantitative Trait Loci (QTL) mapping and its application in animal breeding, Genome scan, Candidate gene approach, Genomic selection, Marker Assisted Selection- basic concept

Individual verses population. Genetic Structure of population. Factors affecting changes in gene and genotypic frequencies and their effect on genetic structure of animal populations. Approach to equilibrium under different situations: Viz: Single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci; Small population: random genetic drift, effective population size, pedigreed populations, regular and irregular inbreeding systems. Quantitative genetics- gene effects, population mean and variance and its partitioning, biometric relations between relatives.

Genetic and phenotypic parameters-their methods of estimation, uses, possible biases and precision. Scale effects and threshold traits.

Type of selection and their genetic consequences. Response to selection and its prediction and improvement of response to selection. Theoretical aspects of accuracy and efficiency of different base of selection. Prediction of breeding value using different criteria. Combined Selection. Correlated response to selection and efficiency of indirect selection.

Selection of several traits. Evaluation of short term and long term selection experiments viz: bidirectional selection and asymmetry of response, selection plateau and limit. Genetic aspects and consequences of various mating systems. Effects of mating systems on mean and variance. Application of various mating system in animal improvement. Selection for general and specific combining ability. Genetic polymorphism and its application in genetic improvement.

Review of basic concepts in statistical inference and balanced experimental designs. Nature of structure of animal breeding data and sources of variation. Introduction to matrix algebra, types of matrices and matrix operations. Determinants and their properties, methods of finding inverse of a matrix and their application. ANOVA, Regression and Correlations, Henderson's methods for estimation of variance components, Basic concepts of linear models, Least-squares analysis, maximum likelihood; Method of estimation; Generalized LS and weighted LS. Fisher's discriminant function and its application, D2 - Statistics in divergent analysis. Linear models in animal breeding, Methods of analysis of unbalanced animal breeding data. Adjustment of data. Data base management and use of software packages in animal breeding.

Domestic Animal Diversity in India, its origin, history and utilization. Present status and flow of Animal Genetic Resources and its contribution to livelihood security. Methodology for genotypic characterization of livestock and poultry breeds through systematic surveys. Fodder availability; management of breed; physical, biochemical and performance traits and uniqueness of animals of a breed; social, cultural and economic aspects of their owners/communities rearing the breed. Methodology for molecular genetic characterization, diversity analysis and relationship among the breeds. Concept of conservation, *In-situ* and *ex-situ* (*invivo* and *in-vitro*); models of conservation; prioritization of breeds for conservation. National and international strategies for conservation of Animal Genetic Resources. Status, opportunities and challenges in conservation of AnGR. IPR issues pertaining to animal genetic resources/animal products or by-products. Registration of livestock breeds and protection of livestock owner's rights in India.

History of dairy cattle and buffalo breeding. Breeds of cattle and buffalo and their Characterisation. Inheritance of important economic traits. Recording and handling of breeding data. Standardization of records. Computation of correction factors for the adjustment of the data. Estimation of breeding values of the cows and bulls. Sire evaluation methods using single trait and multiple traits: construction of Sire indices, Sire evaluation under animal model, sire mode; and maternal grand sire model. Open nucleus breeding systems with MOET. Methods of cross breeding. Breeding of type, milk quality and production efficiency. Plans for developing new breeds of dairy cattle. History of development of important breeds of dairy cattle. Considerations in the import of exotic germplasm for breeding cattle in the tropics. Appraisal of buffalo and cattle breeding programme. Role of breed associations in dairy improvement.

Breeds–Economic traits–Prolificacy–Breeding records and standardization. Genetic parameters – Selection of males and females – Breeding systems. Development of new breeds. Breeding policy – Breeding research – Conservation of breeds. Culling and replacement – EADR.

Origin and history of poultry species: Chicken, turkey, duck and quail –Important qualitative traits in poultry including lethals – Economic traits of egg-type chicken and their standardization – Selection criteria – Aids to selection: Index selection and Osborne index – Restricted selection index –Economic traits of meat – type chicken and their standardization. Selection criteria and selection indices – Response to selection – Genetic controls – Genotype and environment interaction – Inbreeding, and its effects on production traits in egg and meat-type chickens – Inbred lines – Strain development – Crossing : strain and line crosses – Introduction to diallel cross – Utilisation of heterosis and reciprocal effect – Reciprocal recurrent selection and recurrent selection. Industrial breeding – Artificial insemination in chicken – Autosexing –Random Sample Test. Biochemical variants and immunogenetics of poultry – Use of molecular genetics in poultry breeding – Quantitative trait loci and marker-assisted selection – Conservation of poultry genetic resources

Introduction to laboratory animal genetics – Breeding colonies of mice, rats, hamsters, guinea pigs and rabbits. Selection and Mating methods/systems – monogamous, polygamous and others. Development of genetically controlled laboratory animals – Rules for nomenclature, inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains, gene targeting and production of ‘gene knock-out’ animals. Genetic control and monitoring – Record keeping – Ethics of laboratory animal use.

Subject: ANIMAL NUTRITION

Digestion and metabolism of Carbohydrate, Fat and Protein in different species of animals. Measures of feed energy. Partitioning of feed energy. Determination of energy and protein requirements. Rumen degradable Protein, rumen undegradable protein and NPN- Concepts and application. Protein quality determination in monogastrics. Energy and protein requirement for maintenance, growth, pregnancy and lactation in ruminants, companion animals and poultry. Feeding standards- comparative appraisal and limitations. Cell Wall partitioning. In-vitro/in-sacco determination of digestibility and digestion kinetics. Tracer techniques in Animal Nutrition.

Essential minerals, general role of minerals, requirement of minerals, factors affecting requirements, metabolism, physiological functions, deficiencies and excesses, requirements and sources. Toxic minerals. Definition, history, classification, chemistry, functions, deficiencies and excesses, requirements and sources of water soluble and fat-soluble vitamins. Chelates and chelated minerals. Inter-relationship of minerals and vitamins and with other nutrients. Feed additives including probiotics Prebiotics, Symbiotics and feed enzymes.

Principles of feed and fodder processing and preservation techniques, their merits and demerits. Importance of feed technology. The integrated biological, chemical and physical basis for evaluating the inherent nutritional quality of feed ingredients and feeds. Feed storage and godown management. Role of moisture, temperature and relative humidity during storage of feedstuffs. Physical and chemical changes in feeds during storage; storage losses. Specifications of feed ingredients and finished feeds, BIS standard, Pesticide and insecticide residues in feeds. Familiarization of various feed mill equipments. Grinding, mixing, pelleting, crumbling, flaking, Popping, Extrusion. Codex alimentarius, HACCP. Use of non-traditional feeds – by-products of agricultural, industrial, food processing units and forest by-products. Classification of toxic principles in animal feedstuffs. Effect of toxins on biological system and nutrients utilization in different species of livestock.

Nutrients and their metabolism with special reference to milk, meat and wool production. Classification of feedstuffs. Nutrient requirements for calves, heifers, dry, pregnant and lactating cows, buffaloes, sheep and goat. Introduction to rumen micro-flora and fauna. Concept of complete feed. Concept of by-pass nutrients and their impact on production, reproduction and immune status. Feeding during natural calamities.

Nutrients, their metabolism and requirements for poultry and swine during different stages of growth and production. Feeding systems and feed additives, feed formulations for different purposes including least cost rations. Nutritional factors affecting quality of the products. Hind gut fermentation and its importance, Nutrient requirements of rabbits and equines. Feed Habits, food Patterns, digestive structure and functions companion, laboratory, wild and zoo animals. Feeding of sick and old animals. Post-Surgical nutrition. Nutraceuticals in companion / laboratory foods and animal foods. Characteristics of feeding schedules for orphan neonates of wild and zoo animals.

Subject: LIVESTOCK PRODUCTION AND MANAGEMENT

Development of Dairy and poultry Industry in India and world – Present status and future prospects of livestock development in India Important breeds of cattle, buffalo, horse sheep & goat, swine and poultry. Traits of economic importance and their inter-relationships - Selection of high quality animals - Role of management in improving the reproduction efficiency in farm animals. - Housing and rearing systems of animals. System of breeding Economic traits. Methods of Breeding - Prenatal and postnatal care and management of cattle, buffalo, horse sheep & goat and pig - Care of neonate and young ones. Management strategies for reducing mortality in calves, age at first calving and calving interval in cattle and buffaloes. Management of labour, Machine milking and hand milking, Different laws governing the livestock sectors to produce quality products on par with international standards - Technique of harvesting clean and hygienic livestock products, transportation of animals, health management. Management of draught animals and summer management. Feed and fodder resources used for feeding of cattle, buffaloes, horse sheep and goat– Scientific technique of feeding, watering – Advantages and disadvantages of sheep farming under different systems of management Breeding Management: Breeding seasons, methods of detection of heat - Natural Service and artificial insemination, Use of teaser – Culling. Feeding Management: Feeding methods - Principles to be followed in feeding and watering- feeder space, waterer space, Range management - Stocking rate and pasture improvement and utilization; management under stall fed conditions, Wool: Importance of wool - Fiber structure- Fleece characters, Characters of mohair and Pashmina, fur and Angora - Marketing of goat fibers wool.- Planning of sheep and goat farm of various sizes. Care of pregnant sows, piglets and growers - Management of specific pathogen free and gnotobiotic animals, concepts to related to welfare of laboratory animals General principles in planning animal houses- farmstead and animal houses - Selection of site and planning; layouts for livestock farm of different sizes in different climatic zones in India - Farm structures - General principles of construction of enclosures, floor and road. Manure - Quantity of manure voided by domestic animals - Animal excreta a factor in spread of disease - Hygienic and economic disposal of farm waste - Modern techniques used in automation / semi-automation in disposal of farm waste. Effect of environmental pollution on livestock and its products directly and indirectly -Controlling environmental pollution - Different factors affecting the quality of livestock and its products meant for human consumption Poultry housing systems Cage Vs floor system, litter management and lights for poultry, rearing turkey, duck and quails.

Management of chicks, growing, laying and breeding flocks, broiler production, selection and culling of laying flocks. Procuring, care and pre-incubation storage of hatching eggs - Method of incubation, sanitation disinfection and management of hatchery. Introduction to Animal behaviour - Importance of animal behaviour studies - Patterns of behaviour - Daily and seasonal cycles of behaviour – Physiological basis of behaviour. Scope and limitation of integrated farming systems - Sustainability of integrated Livestock Farming Systems and their economic importance. Zoo and captive wild animals - Principles and concepts – Ecology of wild life sanctuaries and National parks- wild life legislation in India - Status of forest in India - Biological and ecological basis of management of wild life. Management principles - Planning - Techniques, strategic planning, organization structure, co-ordination and controlling techniques – Approaches to management. SWOT analysis, financial accounting - Accounting records - Balance sheet, fund flow statement - Cost and analysis for managerial decisions – Budgeting and control.

Subject: LIVESTOCK PRODUCTS TECHNOLOGY

History and development of meat science and meat industry, current trends and prospects of meat industry-Structure and chemistry of animal tissues, muscle functions and postmortem changes- Rigor mortis – Effect of transport on meat quality – its veterinary and clinical importance – PSE and DFD in meat quality– Conversion of muscle to meat. Composition, nutritional content and general quality characterization and evaluation of meat and its products- meat microbiology –Factors affecting quality of meat – Essential nutrients in meat and poultry meat – Tenderization. Factors affecting fresh meat quality, ageing, basic principles of preservation, chilling, freezing, thermal processing, dehydration, irradiation and use of chemicals and antibiotics; meat curing and smoking.

Comminuted meat; preparation of various kinds of fresh and cooked meat products-Canning - Heat processing – Sausages – Ham, Bacon, Tandoori - Barbecueing of poultry. Senses of taste and olfaction-factors influencing sensory measurements, physical and chemical properties related to sensory evaluation, types of sensory panels, discriminate and descriptive testing.

Pre-slaughter care, transportation, resting, fasting, ante-mortem examination, methods of slaughter and slaughtering procedure-postmortem inspection reasons for condemnation of carcass-yield and grading of dressed chicken, cut up parts and de boned meat.

Structure, nutritive value, compositional chemistry, microbiology and functional properties of eggs. Preservation and maintenance of quality of eggs - spoilage of egg and its prevention.- Preparation of fast foods. Egg breaking plant lay out and organization- freezing-pasteurization, desugarization - dehydration – quality estimation. Principles involved in preparation of egg powder-Development of convenient egg based products- packaging of egg and egg products.

Layout, designing – operation and maintenance of slaughter houses and processing plants- disposal of slaughter house effluents and different designs of effluent treatment plants -

equipments, organization and Slaughter house, maintenance, record keeping and operation-sanitation of slaughterhouse-Sanitary practices in meat plant and its benefits; quality control. Pre-slaughter judging, inspection, grading, pre-slaughter care, slaughter of meat animals; Humane slaughter – Principles and methods of stunning – Ritual slaughter of food animals and poultry – Machineries for slaughter and dressing- processing of different kinds of meat animals- Ante-mortem inspection and Post-mortem examination of animals. Disposal and condemnation of unfit materials. Carcass quality appraisal, meat cutting. Slaughter house byproducts industry in India and abroad – Importance of utilizing slaughterhouse offals – Rendering- Planning a by-product plant - Utilization of blood, bones, hooves, glands, intestines, feathers, glandular byproducts and other minor by-products for industrial exploitation.

Flaying - Classification and factors affecting quality of hides and skin-Physical and chemical characteristics of hide and skin- Processing of hide and skin for manufacture of leather-Preparation and quality control of gelatin and glue. Preservation and packaging practices of various kinds of hides and skin. Collection of inedible and edible by-products for industrial uses – Disposal of slaughterhouse effluents – Effluent treatment plant.

Status and prospects of wool-Grading of wool. Wool types and their uses, Growth and structure of wool fibre; physical and chemical properties of wool. Characteristics of hair fibres and their use, factors influencing quality of wool and hair fibres. Composition of milk, major and minor constituents of milk, physico-chemical, microbial and nutritional properties of milk and preservation of raw milk. Layout Designing and organization of dairy plant, Milk procurement, handling and transportation. Chilling, centrifugation, separation, clarification, bacto-fugation and homogenization. Thermal processing- pasteurization, UHT processing, sterilization and packaging, Storage and distribution of processed milk. Fortified, reconstituted and mild floured milks. Cleaning and sanitization of dairy equipment, HACCP, Physico-chemical and microbial changes during procurement, processing and storage of milk and milk products.

Fundamental rules for sensory evaluation, Hedonic scale, score cards and their use, Hurdle technology and its application in development of dairy products. Manufacture of milk products; butter, evaporated milk, condensed milk, milk powders, ice cream and other frozen desserts. Manufacture of yoghurt, acidophilus milk, bulgaricus milk, kumiss-kefir. Manufacture of cheddar, cottage and processed cheese. Manufacturing of indigenous milk products- paneer- channa- khoa- ghee- dahi and shrikhand. Evaluation of functional properties. Packing, storage and marketing of milk products. Defects in milk products, their preventions and remedies.

Meat adulteration and substitution– Different techniques for meat speciation. Principles of packaging- Product characteristics affecting packaging requirements; packaging material and their characteristics - different methods of packaging meat – Vacuum packaging – MAP – Retort pouch processing.

Role of Biotechnology in productivity of livestock, Meat speciation and quality control. Use of biotechnology in production of food additive. Use of biotechnological tools for the processing and preservation and foods of animal origin.

Subject: VETERINARY ANATOMY

Technical terms, structure and chemical composition of bones, bones of the appendicular and axial skeleton of ox and its comparison with horse, pig, dog and poultry. Classification and detailed study of the joints of the animal body, basics of biomechanics of the locomotor system.

Descriptive gross anatomy of the various body systems of ox and their comparison with the same of horse, pig, dog and fowl, body cavities, surgical sites for various operations and clinically significant areas for performing auscultation, percussion and for carrying out various procedures such as laparotomy, cystotomy, oesophagotomy, ruminotomy, caesarian section, thoracocentesis etc.

Topographic anatomy of the vascular system, nervous system and organs of special senses of ox, origin & insertion of different muscles of the body of ox, study of different nerve blocks.

Embalming fluids, embalming of animals, maceration and preparation of skeletons, plastination. Preparation of animal tissues for light microscopy using various fixatives, staining methods for routine light microscopy, various histochemicals and histoenzymic techniques for demonstrations of histochemicals in the animal tissues, staining for nervous tissue. Light and ultrastructural details of the animal cell, light and ultrastructural details of the basic tissues. Light and ultrastructural details of the various body systems with the important differential features among the domestic animals. Gametogenesis, fertilization, cleavage and gastrulation. Development of the foetal membranes and placenta in domestic animals, organogenesis of various body systems.

Subject: VETERINARY AND ANIMAL HUSBANDRY EXTENSION EDUCATION

Concept, philosophy, principles, genesis, growth and scope of extension education, Earlier extension efforts. Emerging issues, problems and challenges of animal husbandry extension education. Communication- meaning, concept, purpose and process, Models of communication. Types of communication intrapersonal, interpersonal, verbal and non-verbal. Criteria of effective communication, Determinants of communication. Concept of diffusion. Elements in diffusion process, Decision-making, Stages in diffusion-adoption process. Concepts and stages of adoption. Adopter categories and their characteristics. Factors influencing adoption. Attributes of innovations, rate of adoption and sources of information.

Teaching learning process and its principles. Steps in extension teaching process, cone of experience. Learning situation. Criteria for effective teaching and learning. Extension approaches in livestock development– individual, group and mass approach (electronic and

non electronic). Relative merits and demerits of different teaching methods in animal husbandry extension. Audio-visual aids– classification, use and evaluation. Importance of programme planning in veterinary and animal husbandry extension. Objectives, principles and steps in programme planning process. Role of animal husbandry extension agencies, local leaders, livestock owners and institutions in planning and implementation of need-based veterinary extension programmes. Concept, principles, types and methods of evaluation. Concept of FSR, Participatory Approaches- Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA).

Concept, nature and scope of research in social sciences. Types of research- fundamental, applied and action research, experimental and non experimental research. Variables, types and their measurement. Selection and formulation of research problem. Hypothesis– importance, selection criteria (quality of workable hypothesis), formulation and testing of hypothesis. Concept of development, social and economic development; Historical overview on Rural Development in India. Transfer of Technology (TOT) programmes of ICAR. Recent trends in extension. Privatisation of extension. Public Private Partnership. Contract farming. Organic animal husbandry. Animal welfare programmes.

Concept, importance and functions of human resource management. Process of management- planning, organizing, staffing, directing, coordination, reporting and budgeting. Principles, levels and types of organization. Training methods, identification of training needs, training evaluation and developing strategies for human resource development in animal husbandry sector. Role of livestock sector in Indian economy and poverty alleviation. Enterprise integration women in agriculture and livestock. Livestock and agrarian scenario. ICT – concept, importance and types of tools; Development and application of ICT tools including information kiosks, E-learning.

Subject: VETERINARY BIOCHEMISTRY

Scope and importance of Biochemistry in animal science. Cell structure and functions. Techniques of cell fractionation, Ultra-centrifugation and electron microscopy. Chemistry and biological significance of carbohydrates, lipids, proteins, nucleic acids, vitamins, and hormones. Enzymes, chemistry, kinetics, mechanism of action and regulation. Metabolic inhibitors with special reference to antibiotics and insecticides. Sub-unit structure of macromolecular and supra-molecular systems. Chemistry of antigens and antibodies and molecular basis of immune reaction. Separation of macromolecules of biological significance, their isolation, purification, and characterization. Radioimmuno assay and other binding essays. Colorimetry, spectro-photometry, chromatography and electrophoresis, Isotopic methods. Bioenergetics and biological oxidation; Digestion of food, its absorption and energy metabolism in ruminants and nonruminants. Metabolism of carbohydrates, lipids, amino acids and nucleic acids. Bio Synthesis of Proteins and nucleic acids. Regulations of gene expression Chemistry of respiration and gas transport. Water and electrolyte metabolism. Significance of calorie, proteins and essential amino acids. Deficiency diseases, metabolic disorders and

clinical biochemistry. Endocrine glands, Biosynthesis of hormones and their mechanism of action. Environmental factors like heat, cold, radiation and environmental pollutants.

Subject: VETERINARY GYNAECOLOGY AND OBSTETRICS

Development of female genitalia, Functional anatomy of female reproductive system of farm animals, Puberty and sexual maturity, onset of postpartum ovarian activity, Oestrus cycle and Endocrine regulation of estrous cycle. Folliculogenesis, oogenesis and ovulation and associated endocrine pattern, manipulation of follicular waves, synchronization of estrus and ovulation and induction of ovarian activity. Gamete transport, fertilization, implantation and maternal recognition of pregnancy. Embryonic and fetal development, Placenta classification and functions. Pregnancy diagnosis in farm animals with different methods. Pseudo-pregnancy. Factors affecting reproduction. Lactation and artificial induction of lactation.

Introduction to infertility, classification, economic impact. Causes of infertility. Importance of body condition score. Out of season breeding. Ovarian dysfunction: anoestrus, cystic ovarian degeneration, anovulation, delayed ovulation and luteal insufficiency. Repeat breeding. Early embryonic death (EED). Abortion. Interactions in Immunological mechanisms and infertility.

Pelvis and Pelvimetry, Parturition, Induction of parturition, Principles of handling of dystocia, obstetrical procedures: mutations, fetotomy, caesarean section. Obstetrical anaesthesia. Dystocia: causes, diagnosis and management. Uterine torsion. Diseases and accidents during gestation and around parturition. Pseudocyesis, Ectopic pregnancy, Abnormalities of fertilization and fetal development, Superfecundation and Superfoetation, Abortion, Dropsy of fetal membrane and fetus, Maceration, mummification, pyometra, ante-partum and post-partum uterine and vaginal prolapse. Retention of placenta, metritis. Elective termination of pregnancy. Involution of uterus. Care of dam and the newborn.

Comparative anatomy of male reproductive system. Thermoregulation of testis and blood testis barrier, Growth, puberty and sexual maturity, Spermatogenesis, sperm morphology and ultra structure of spermatozoa, sperm transport, maturation and storage in male genital tract. Secretions of male reproductive tract including accessory glands and their role in reproduction. Sexual behavior. Examination of bulls for breeding soundness. Semen and its composition, Biochemistry of semen and sperm metabolism. Diseases transmitted through semen. Factors affecting semen quality, tests for assessment of sperm motility, sperm survival and fertilizing capacity of spermatozoa. Infertility. Pathological and functional disturbances of epididymis, vas deferens and accessory sex glands. Impotentia cocundi and impotentia generandi. Testicular hypoplasia and degeneration. Coital injuries and vices of male animals.

History of artificial insemination. Methods of semen collection. Semen evaluation, Computer assisted semen analysis (CASA). Semen preservation. Extenders for preservation of semen at different temperatures. Semen additives. Cryopreservation of semen. Thawing protocols of frozen semen. Factors affecting post-thaw semen quality. Transport and storage of semen.

Handling of frozen semen and liquid nitrogen containers. Ideal protocol for AI in different species of animals. Factors affecting success of AI. Planning and organization of semen bank.

Embryo transfer technology: selection of donors and recipients. Synchronization, super-ovulation, surgical and non-surgical collection of embryos and evaluation of embryos. Cryopreservation of embryos, transfer of embryos to donors. *In vitro* fertilization, *in vitro* maturation, micromanipulation of embryos. Sexing of sperm and embryos. Transgenic animals. Chimeras. Stem cell biotechnology. Immuno-neutralization of hormones. Immunomodulation of fertility.

Subject: VETERINARY MEDICINE

General systemic states like – bacteremia, septicemia, pyemia, toxemia, hyperthermia, hypoglycemia, allergy, anaphylaxis, shock, dehydration, stress, anasarca, anaemia, pica, etc. Veterinary fluid therapy with fluid, electrolyte, plasma expanders, packed cell transfusions, etc. Blood transfusion and oxygen therapy. Diagnosis and therapeutic management of various medical emergencies in farm and companion animals.

Definitions of diseases known as – infectious, contagious, sporadic, epizootic, enzootic, panzootic, exotic, zoonotic, etc. Meaning and purpose of segregation, isolation, quarantine, etc., role of occurrence, mode of transmission of diseases, economics. General principles of control of diseases. Role of OIE in disease control. Internationally recognized control methods of designated diseases. History taking. General clinical examination. Special clinical examination – electrocardiography, paracentesis, rumen fluid examination, haematology, blood biochemistry, urinalysis, ophthalmoscopy, otoscopy, endoscopy, ultrasonography etc. Serological and molecular tests used for disease diagnosis.

To study the internal and infectious (bacterial, viral, fungal, Chlamydia, rickettsial viral, parasitic, mycoplasma and prions) diseases of digestive, urinary, respiratory, nervous, cardiovascular, musculoskeletal system, blood and blood forming organs, skin, eye and ear among bovine, sheep, goat, equine, cat and dog. Diseases of endocrine organs. Metabolic profile test, milk fever, Downer's cow syndrome, ketosis, hypomagnesaemia, diabetic ketoacidosis, hypomagnesaemia, post-parturient haemoglobinuria, azoturia. Fat cow syndrome, rickets, osteomalacia, osteodystrophia fibrosa. Trace mineral and vitamin deficiency.

Diseases caused by physical agents and poisoning of organic and inorganic compounds in domestic and companion animals. Plant poisonings. Snake bite. Insect bites and stings. Environmental pollution hazards. Radiation hazards and injuries.

Etiology, epidemiology, pathogenesis, clinical manifestations, postmortem findings, diagnosis, treatment and control of the Bacterial, Viral, Parasitic, Protozoal, Chlamydial, Rickettsial and Fungal and Mycoplasmal diseases of livestock and companion animals.

Etiology, epidemiology, pathogenesis, clinical manifestations, postmortem findings,

diagnosis, treatment and control of the the internal and infectious diseases of poultry and pet birds.

Laws: Role of veterinarian. Legal enactment in IPC related to animals and veterinarians. Various aspects of veterinary jurisprudence and animal welfare. Legal provisions related to animals, animal diseases and drugs.

Subject: VETERINARY MICROBIOLOGY

Introduction to historical development of cellular organization, genetic & chemical characteristics of eukaryotic and prokaryotic cells. Classification. Bacterial cell structure, physiology and antigenic structure. Determinants of pathogenicity and its molecular basis. Bacteriophages: temperate and virulent phages; lysogeny and lysogenic conversion. Bacterial genetics: bacterial variation, genetic transfer mechanisms (transformation, transduction and conjugation); plasmids, transposons and drug resistance; recombinant DNA technology.

Systemic study of : Gram negative- aerobic rods and cocci, family *Pseudomonadaceae*, and genus *Brucella*. Facultative anaerobic Gram negative rods, family- *Pasteurellaceae*, *Enterobacteriaceae*. Gram positive cocci, streptococcus, staphylococcus, endospore forming Gram positive rods and cocci, family Bacillaceae genus Bacillus, and Clostridium. Spirochetes, Family Spirochetaceae and other families like Spirillaceae, coryneform bacteria, Dermatophilaceae. Mycobacteria and Nocardia, family Actinomycetaceae. Atypical prokaryotes such as Chlamydia, Rickettsiae, Mycoplasma. Regular non-sporing Gram positive rods such as Listeria and Erysipelas. Bacteroidaceae and genus Bacteroides and Fusobacterium.

Morphology, physiology, reproduction, cultural characters, classification of fungi. Systematic study of animal mycoses such as aspergillosis, candidiasis, cryptococcosis, epizootic lymphangitis, histoplasmosis, rhinosporidiosis, mycotic abortion, mycotic mastitis, mycotic dermatitis, dermatophytoses, mycotoxicosis etc.

History of virology; origin and nature of viruses; biochemical and morphological structure of viruses; nomenclature and classification of viruses. Replication of DNA and RNA viruses, viral genetics and evolution. Genetic and non-genetic interactions between viruses, virus-cell interactions, viral pathogenesis, viral persistence, oncogenic viruses, epidemiology of viral infections. Immune response to viruses, viral vaccines, viral chemotherapy.

Studies on animal viruses belonging to various families, and prion agents. Capripoxvirus, avipoxvirus, cowpoxvirus; bovine herpes viruses, equine herpes viruses, infectious laryngotracheitis virus, Marek's disease virus, pseudorabies virus, malignant catarrh fever virus; infectious canine hepatitis virus, egg drop syndrome virus, inclusion body hepatitis hydropericardium virus, papillomatosis, canine parvoviruses, feline panleucopenia virus. New castle disease virus, canine distemper virus, rinderpest virus, PPR virus; infectious bursal disease virus; rotavirus, blue tongue virus, African horse sickness virus; rabies virus,

ephemeral fever virus. Infectious bronchitis virus, transmissible gastroenteritis virus; equine arteritis virus; swine fever virus, BVDV mucosal disease virus; foot and mouth disease virus; visna/maedi virus, equine infectious anemia virus, avian leucosis complex virus, chicken anemia virus; prions: scrapie, bovine spongiform encephalopathy.

Highlights of Veterinary Immunology, Basics of immunology & definitions in immunology, General structures and properties of immunoglobulin. MHC, T cell receptors and T cell activation, B Cell activation. Antibodies: Isotypes, Allotypes, Chemical and physical properties and Effector functions. Phagocytes and Phagocytosis, Basophils, Eosinophils, NK cells etc. Complement system: Properties and function, Classical and alternative complement pathways. Organs associated with immune system. Antigen: definition, properties, and types. CMI and its role for protection against diseases. Hypersensitivity: Type I, II & III. Hypersensitivity: Type IV, V & VI. Autoimmunity and autoimmune diseases. Immunodeficiency and Immunoproliferation. Hybridoma technology. Serology: Precipitation reactions, Agglutination reaction. Complement fixation test and Immunofluorescent test. Enzyme Linked Immunosorbent Assay. Immunization, Adjuvant-their functions. Biologicals in immunoprophylaxis.

Subject: VETY. PARASITOLOGY

Introduction, history, classification, general account and economic importance of platyhelminths. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Dicrocoeliidae, Opisthorchiidae, Strigeidae and Fasciolidae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Echinostomatidae, Heterophyidae, Plagiorchiidae, Troglotrematidae, Prosthogonimidae, Nanophyetidae and Paragonimidae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of trematodes belonging to families: Notocotylidae, Brachylemidae, Cyclocoelidae, Paramphistomatidae and Schistosomatidae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families: Mesocestoididae, Anoplocephalidae, Thysanosomidae, Dipylidiidae and Dilepididae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of cestodes belonging to families: Davaineidae, Hymenolepididae, Taeniidae and Diphylobothriidae. Introduction, history, classification, general account and economic importance of nematodes and thorny-headed worms Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Ascarididae, Anisakidae, Oxyuridae, Heterakidae and Subuluridae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Rhabditidae, Strongyloidiidae and Strongylidae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Trichonematidae, Amidostomidae, Stephanuridae, Syngamidae and Ancylostomatidae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Metastrongylidae, Protostrongylidae, Filaroididae, Trichostrongylidae, Ollulanidae,

Crenosomatidae and Dictyocaulidae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Spiruridae, Thelaziidae, Acuariidae, Tetrameridae, Physalopteridae, Gnathostomatidae, Filariidae, Setariidae, Onchocercidae and Dracunculidae. Morphology, epidemiology, life cycle, pathogenesis, clinical signs, diagnosis and control measures of nematodes belonging to families: Trichinellidae, Trichuridae, Capillariidae, Dioctophymatidae, Polymorphidae, Oligacanthorhynchidae and Gnathobdellidae.

Introduction, history, classification and economic importance. Distribution, life cycle, seasonal pattern, pathogenesis, economic significance and control of arthropods belonging to the families: Culicidae, Ceratopogonidae, Simuliidae and Psychodidae. Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families: Tabanidae, Gasterophilidae, Muscidae, and Glossinidae. Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families: Oestridae, Sarcophagidae, Calliphoridae and Hippoboscidae. Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families: Pediculidae, Haematopinidae, Linognathidae, Menoponidae, Philopteridae and Trichodectidae. Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families: Siphonapteridae, Cimicidae and Reduviidae. Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families: Dermanyssidae, Argasidae and Ixodidae

Distribution, life cycle, seasonal pattern, pathogenesis, diagnosis, economic significance and control of arthropods belonging to the families: Sarcoptidae, Psoroptidae, Demodicidae, Trombiculidae, Cytoditidae and Linguatulidae. Strategic control measures of arthropods with special emphasis on improved versions of chemical, biological and immunological control and integrated pest management.

Introduction, history, classification, general account, economic importance of protozoan parasites. Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the families: Trypanosomatidae, Monocercomonadidae, Trichomonadidae, Hexamitidae and Endamoebidae. Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the families: Eimeriidae, Cryptosporidiidae and Sarcocystidae. Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of protozoan parasites belonging to the families: Plasmodiidae, Babesiidae, Theileriidae, Haemogregarinidae and Balantidiidae.

Morphology, epidemiology, pathogenesis, clinical signs, diagnosis and control measures of Rickettsiales like *Anaplasma*, *Ehrlichia* and *Haemobartonella*. History, clinical signs, gross and microscopic examination of secretions and excretions of clinical cases. Collection and dispatch of material to laboratory for diagnosis. Animal sub-inoculation tests; blood and biopsy smear examination; histopathology of affected organs.

Conventional and novel methods of control of helminth – anthelmintics, their mode of action, characteristic of an ideal anthelmintic, anthelmintic resistance, spectrum of activity, delivery devices, integrated control method and immunological control Formulation of deworming schedule. Snail and other intermediate host control. Conventional and novel methods of control of protozoan parasites – antiprotozoan drugs, their mode of action, integrated control method and immunological control. Conventional and novel methods of control of insects – Insecticides / acaricides - methods of application, their mode of action, insecticide resistance , integrated control method and immunological control.

Introduction, types of parasitic antigens and their characterization. Types of immunity in parasitic infections. Cellular and humoral immunity to parasites, hypersensitivity, regulation of the immune response. Evasion of immunity, immunomodulations and their uses. Immune responses in helminths, arthropods and protozoa of veterinary importance. Immunodiagnostic tests and their techniques; application of biotechnological tools in the diagnosis and control of parasitic diseases. Vaccines and vaccination against parasitic infections. Genetic control of parasites.

Introduction to the concept of zoonotic infections, definitions, various classifications of zoonoses, host-parasite relationships, modes of infections, factors influencing prevalence of zoonoses. A detailed study of transmission, epidemiology, diagnosis and control of major protozoa of zoonotic importance. A detailed study of transmission, epidemiology, diagnosis and control of major helminths of zoonotic importance. A detailed study of transmission, epidemiology, diagnosis and control of major arthropods of zoonotic importance.

A detailed study of major protozoa of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management. A detailed study of major arthropod parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management. A detailed study of major helminth parasites of zoo and wild animals with particular emphasis on morphological features, geographical distribution, epidemiology, diagnosis and management.

Characters and classification of Mollusca. Occurrence, distribution, ecology, life history, morphology and control of vector snails belonging to families, Planorbidae, Lymnaeiidae, Thiridae, Amnicolidae, Helicidae, Succineidae and Zonitidae. Examination of vector molluscs for parasitic infections. Haematology, internal defense mechanisms, parasite-induced pathology and molluscan tissue culture.

Subject: VETERINARY PATHOLOGY

Introduction, history and scope of pathology. Predisposing factors, intrinsic and extrinsic factors. Disturbances of circulation / haemodynamic derangements. Pigment metabolism, pathological calcification / ossification. Degenerative changes. Inflammation, healing.

Immunopathology, immune mediated tissue injury, hypersensitivity reactions. Genetic abnormalities. Disturbance in cell growth, neoplasms. Postmortem examination, histopathology, histochemistry. Histoenzymology, electron microscopy. Clinical laboratory examination of complete blood hemogram, serum enzymology, bone marrow examination, urine, skin scrapings stools, CSF and milk for pathological constituents and interpretation of results. Pathology of cardiovascular, haemopoietic, respiratory, digestive, urinary, genital, nervous and musculoskeletal systems, endocrine glands, organ of special senses i.e. eye, ear, skin, appendages. Pathology of bacterial, mycotic, viral, mycoplasmal, rickettsial, chlamydial and parasitic diseases. Diseases caused by prions. Pathology of nutritional deficiency disease. Etiopathology of common diseases of laboratory, wild and aquatic animals.

Subject: VETERINARY PHARMACOLOGY AND TOXICOLOGY

History and scope of pharmacology, Principles of drug absorption, distribution, metabolism and elimination. Drug bioavailability and routes of administration. Important pharmacokinetic parameters and their clinical significance. Pharmacodynamics: mechanism of action and the relationship between drug concentration and effect; signal transduction mechanism and drug receptors for physiological regulatory molecules. Quantitation of drug-receptor interactions and elicited effects. Competitive and non-competitive antagonism. Factors affecting drug response. Adverse drug reactions.

Anatomical and physiological considerations of autonomic nervous system (ANS). Neurohumoral transmission in ANS. Pharmacology of cholinergic agonists and antagonists. Pharmacology of adrenergic agonists and antagonists. Ganglionic stimulants and blockers. Autacoids: Histamine, serotonin, kinins, eicosanoids and platelet activating factor.

Anatomical and physiological considerations of central nervous system (CNS); neurohumoral transmission in CNS. Historical development, theories, principles and stages of general anaesthesia. Pharmacology of anaesthetics, sedatives, hypnotics, neuroleptics, antiepileptics. CNS stimulants, analeptics, opioid agonists and antagonists; non-steroidal anti-inflammatory agents, central and peripheral muscle relaxants, local anaesthetics, therapeutic gases. euthanizing agents. Doping. Pharmacology of drugs acting on gastrointestinal tract. Appetite stimulants, emetics and anti-emetics.

Anti-ulcer drugs, modulators of gastric and intestinal motility and secretions. Gastrointestinal protectants and adsorbents, laxatives and cathartics. Agents promoting digestive functions; bile acids and pancreatic enzymes, drugs affecting liver; rumen pharmacology. Pharmacology of drugs acting on respiratory system: pathogenesis of inflammatory respiratory diseases. Bronchodilators, antitussives, mucolytics, expectorants, decongestants. Drugs used in treatment of asthma.

Pharmacology of cardiac glycosides. Antiarrhythmic, antihypertensive and antihyperlipidaemic drugs. Drugs affecting vasomotor and cardiorespiratory reflex mechanisms and haemopoietic system. Coagulants and anticoagulants, thrombolytic agents. Pharmacology of drugs affecting renal functions and fluid-electrolyte balance. Fluid and electrolyte therapy, diuretics, antidiuretics, uricosuric drugs.

Pharmacology of drugs affecting endocrine functions of pituitary, thyroid, adrenals and pancreas. Hormonal regulation of calcium and phosphorus homeostasis. Pharmacology of drugs affecting male reproductive organs, spermatogenesis. Pharmacology of drugs affecting female reproductive organs, ovulation, oestrus, conception, gestation and lactation. Oxytocic and tocolytic drugs.

General consideration and principles of chemotherapy, classification of chemotherapeutic agents; development of microbial resistance to antimicrobials, combination therapy. Systemic and gut acting sulfonamides, diaminopyrimidines, quinolones sulfones, nitrofurans. Penicillins, cephalosporins, beta-lactam antibiotics. Chloramphenicol, tetracyclines, macrolides, polymyxins, polypeptides. Aminoglycosides and other antibiotics. Anti-protozoans, anthelmintics, ectoparasiticides. Antituberculosis, antifungal, antiviral and antineoplastic drugs.

Principles and scope of toxicology, sources of poisoning. General modes of action of poisons, detoxification, factors affecting toxicity, general principles of diagnosis and treatment of poisonings. Toxicology of metals, agrochemicals, solvents and vapors, feed additives. Toxic effects of radiations and radioactive chemicals, genetic and developmental toxicology; forensic and regulatory aspects of toxicology. Classification, identification and chemical constituents of poisonous plants. Plants containing cyanide, nitrate/nitrite, oxalate, lectins and cardiotoxic glycosides. Plants producing lathyrism, thiamine deficiency and photosensitization. Toxicology of mycotoxins: aflatoxins, rubratoxins, ochratoxins, trichothecenes, tremorgens and ergot. Animal bites and stings: snake venom, scorpion, spider and insect stings and toad poisoning. Bacterial toxins: botulism.

Principles of drug action and bioassay. Dose response curves and their analysis. Techniques for setting up isolated and intact preparations. Organization of screening programme of drugs; multidimensional screening procedures and gross observational methods. Animal models in toxicological studies. Animal toxicity tests for acute, sub-acute and chronic toxicity. Specific toxicity tests for neurotoxicity, immunotoxicity, developmental, behavioural, reproductive and inhalation toxicity, mutagenicity, carcinogenicity. Animal toxicological tests for the study of metabolism, synergism and antagonism.

Historical aspects: Traditional Indian remedies and regional folklore in disease cure. Classification, identification and chemical constituents of medicinal plants. Extraction, distillation, evaporation and other processes used in purification and preparation of active constituents from medicinal plants. Standardization and clinical validation of bioactive molecules from vegetable sources. Therapeutic and adverse effects of potential herbal drugs. Indigenous drugs used as carminatives, antiseptics, antimicrobials, analgesics, and anti-inflammatory agents. Alternate systems of medicine in animals.

Subject: VETERINARY PHYSIOLOGY

Digestion, control of motility and secretion of alimentary canal, gastric hormones and reflexes in the control of digestive functions, control of rumen motility, digestion in the ruminant and monogastric animals, absorption from rumen and the digestive tract, avian digestion, physiological basis of gastric disorders.

Blood and circulation, blood coagulation; haemoglobin and its polymorphism, anaemias, polycythemia, reticulo-endothelial system, body defense mechanism and immunogenesis, Electrophysiology of heart, ECG, principles and interpretation; haemodynamics and concerned biophysical principles; neural and humoral control of heart and blood vessels; cardiac output and vascular reflexes; autoregulation mechanisms in the heart, lungs, brain, muscle, kidneys and skin, blood-brain barrier, circulatory shock and hypertension.

Respiration-Mechanics of respiration; neural and chemical control of respiration, gaseous transport and exchange; hypoxia, anoxia, high altitude living; physiology of work and exercise. Excretion-Modern concepts of urine formation; control of renal circulation; secretion and absorption in the renal tubules; regulation of acid-base balance by the lungs and the kidneys, hormonal and renal regulation of body fluid and electrolytes balance, renal function in desert animals, physiology of micturation, uraemia and other renal disorders. Skin-general anatomy of epidermis, dermis, hypodermis, sweat and sebaceous glands. Immune properties of skin. Composition of body fluids and their regulation. Excretory system in birds.

Fat and water soluble vitamins, their functions and deficiency diseases, Physiological functions of trace elements, their role in metabolism, toxicity. Muscle contraction- Muscle types; their intracellular contractile mechanisms, electrophysiology of muscles; neuromuscular junction; excitation-contraction coupling, its biochemical and ionic mechanisms, Myopathies. Nervous System-Neurons, neurotransmission and neurotransmitters, Electrophysiology of nerves; synapses, neuronal circuit receptors, reflexes; cerebral cortex, control of motor & sensory functions; Physiology of plain sensory pathway, Hypothalamus, control of endocrine and viscera functions, autonomic nervous system; basal ganglia structures; Limbic system animal instincts and neurophysiology of behaviour, control of food intake, Special senses.

Methods of study bio-regulation including methods of endocrine analysis. Hormonal relationship in animal production and reproduction. Concepts in hormone function, classification and methods of study. Hormonal assay, mechanism of hormone synthesis, release and transport. Mechanisms of hormone action, target cell interactions, genetic and genomic approaches in endocrinology. Animal models and alternate uses of animal model. Regulation and metabolism of hypothalamic, hypophyseal, thyroid and adrenal hormones. Gonadal and placental hormones, their regulation and mechanism of action. Hormonal principles of pineal gland and its role in production. Endocrine control of carbohydrate and calcium homeostasis. Hormones and adaptation to environment. Hormonal regulation of

gastro-intestinal activity. Prostaglandins. Hormones in fertility regulation and production. Avian endocrinology.

Endocrine and neuro-endocrine relation in male and female reproductive function in different domestic animals. Sexual cycles and mating behaviours in females, oogenesis, folliculogenesis and ovulation. spermatogenesis, spermiogenesis, seminiferous epithelial cycles, fertilization, implantation, pregnancy and parturition, physiology of placenta; Zygote as an endocrine and immunogenic structure. Functions of PGs and oxytocin. Cardiovascular, respiratory, hepatic and renal evaluation of body functions in relation to clinical conditions. Carbohydrate, fat, protein and mineral metabolism in health and disease of various species. Functions and dysfunctions of liver, kidney and gastro-intestinal tract. Skeletal muscle fibers, membrane and action potential.

Subject: VETERINARY PUBLIC HEALTH AND EPIDEMIOLOGY

The scope of veterinary public health; principal functions and fields of activity of public health veterinarians. Veterinary Public Health agencies and institutions in India and abroad. Concept and classification of zoonoses; comprehensive description of etiology, host range, epidemiology, diagnosis and management of zoonotic diseases.

Importance of microbes in relation to veterinary public health; cultural, biochemical and other identification characters; ecology, transmission and survivability of microbes in nature. Bacteria: Description of Bacillus, Listeria, Mycobacterium, Clostridium, Staphylococcus, Enterococcus, Brucella and Leptospira Vibrio, Salmonella, Escherichia, Campylobacter, Yersinia, Lactobacillus, Pseudomonas and Micrococcus Description of Coxiella, Rickettsia and Chlamydia. Systematic study of viral agents of Japanese encephalitis, encephalomyelitis, rabies, influenza, KFD, Rift valley fever, and enteroviruses; their morphological and other characters, ecology, transmission and survivability in nature. Description of fungal agents of public health importance belonging to genera: Aspergillus, Penicillium, Fusarium, Mucor, Histoplasma, Microsporium, Trichophyton and Sporotrichum. Description of parasites of public health importance: Taenia, Echinococcus, Trichinella, Toxoplasma, Diphyllbothrium, Fasciola, and Cryptosporidium.

Principles of food hygiene with special reference to foods of animal origin, human health and economics, nature and problem of food supply in India. Meat hygiene and public health, abattoir hygiene.. Milk hygiene and public health, in place cleaning. Meat and Milk borne diseases. Meat and milk adulteration. Health problems due to food additives, biocides, bacterial toxins.

Hygienic handling, transportation and marketing of fish. Fish borne diseases in relation to human health. Hygienic disposal and utilization of byproducts of fish, environmental hygiene, environment and health, microbial aspects of pollution. Soil pollution, air pollution, water pollution, noise pollution and health. Natural and manmade disasters, impact analysis and classification of disaster scale, essential preparations to manage disaster, role and sequence of emergency medical services by veterinarians.

Components of epidemiology. Host-Agent-Environmental factors in causation of diseases and disease patterns. Epidemiological data: its nature, sources, collection, storage, retrieval and presentation. Surveys, sampling and collection of information, design questionnaires, disease monitoring and surveillance. Investigations of disease outbreak, modeling, disease forecasting, serological and molecular epidemiology. Economics of diseases. Molecular basis of a disease, application of nucleic acid based assays for characterization of field isolates vis-à-vis vaccine strains. Definitions and epidemiological approaches, measuring frequency of clinical events, incidence, prevalence, occurrence etc., principles of accuracy, precision, linearity, diagnostic sensitivity and specificity.

Subject: VETERINARY SURGERY AND RADIOLOGY

Asepsis-antisepsis, management of shock, haemorrhage. Symptoms, diagnosis and management of wound, abscess, tumors, cyst, haematoma, necrosis, gangrene. Introduction to anaesthesia, preanaesthetics, local analgesia, General anaesthesia & anaesthetic agents (barbiturates, dissociative agents). Anaesthetic emergencies and their management. Interpreting X-ray films, classification of radiographic lesions. Introduction to contrast radiography, radiation hazards and their prevention. Principles of ultrasonography. Sinusitis, pus in the sinus. Horn affections, irregular molars, shear mouth, sharp teeth, wave form mouth, step formed mouth dental tartar and dental caries, bishoping. Salivary cysts, salivary fistula. Ear haematoma, chronic otorrhoea. Entropion, ectropion, conjunctivitis, glaucoma, keratitis, corneal ulcer, cataract, worm in the eye. Choke. Hernia. Pyloric stenosis, gastric torsion, ruminal impaction, traumatic reticulitis, diaphragmatic hernia, abomasal displacement, omasal impaction, intestinal obstruction, intussusception, rectal prolapse, rectal tear, hyperadenitis, atresia ani et-recti et-coli. Urolithiasis. Surgical affections of udder and teat. Caesarian, spaying, castration. Lameness, definition, classification and diagnosis. Sweeny, bicipital bursitis, capped elbow, radial paralysis, hygroma of knee, contraction of digital flexors, splints, ringbone, quittor, side bone, navicular disease, pyramidal disease. Laminitis, sand crack. canker, thrush and corn, Upward luxation of patella, stringhalt, bog spavin, spavin. DJD, intervertebral disc protrusion, hip dysplasia, fracture and dislocation, principles of physiotherapy.

Common Paper (for all streams)

RESEARCH METHODOLOGY

Basic concepts of research: Rationale of research, research problem, research objectives, research design, types of research: fundamental, applied, action, quantitative/qualitative

Literature survey/review: Primary sources, secondary sources, searching e- resources: using search engines, searching databases, authenticity of e-resources, writing literature review

Research problem: Identification of research problem, defining research problem, components of research problem, and various steps in scientific research, selection and formulation of research problem

Research Methodology: Types of research methods, survey method (quantitative/qualitative), experimental method (variables, designs), historical methods, content analysis, Hypotheses: meaning, types of hypotheses, formulation of hypothesis

Sampling: Concepts of population, sample, sampling techniques, non-probability sampling techniques

Data collection methods, tools and techniques: Primary data collection, secondary data collection (questionnaire, interview schedule, focus group, library records and reports etc.)

Data analysis techniques: Use of databases, Statistical analysis techniques, qualitative analysis techniques. Common statistical tests, computer processing, interpretation and presentation of results

Report writing/documentation: Title, subtitle, formatting etc. citation, references, bibliography **Research ethics:** Ethics in conducting research, copyright, plagiarism, originality of research work.