AFRICA CENTRE OF EXCELLENCE FOR MYCOTOXINS AND FOOD SAFETY, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGERIA

STUDENT HANDBOOK

BACKGROUND

Food safety and insecurity, malnutrition and poverty are severe interdependent development challenges in Africa. Almost half of Africa's population is living below the poverty line (48.5%), suffers from chronic hunger (75%) and malnourishment (226.7 million-20.5%) and these figures are highest in Central and West African regions. Food production increases resulting from agricultural initiatives are compromised by food borne diseases; to this effect, much effort is already deployed to address the threat from mycotoxins, major biotic constraints to food security causing losses in crop yield, human productivity (40%) and in export, and lowered performance of animal husbandry in addition to the direct human health impacts of increased incidence of cancers, growth stunting in children, reduced life expectancy and death. Other threats, such as salmonellosis, entero-haemorrhagic, hepatitis A, acute and chronic aflatoxicosis, cholera, heavy metal poisoning, and the threat of antibiotic resistance arising from improper use of veterinary drugs, and chronic pesticide and industrial chemical residue exposure need urgent attention. These pervasive problems, which affect children at a disproportionately high rate, require transformative science, engineering and policy solutions brought about by a knowledgeable workforce. Thus the MTech and PhD programmes in Food Safety will help to create learning opportunities and come up with research results that will address Africa's shortage of expertise and applicable solutions to ensure a safe, controlled and sufficient food supply that will support economic growth and public health.

Likewise, this programme will balance the molecular biology, engineering, computing and modeling necessary for career in food safety and security. It connects research with application and integrates molecular genetics that explains the information in the gene expressed that give rise to abnormalities traits in an organism. Modern molecular biology depends on computational data analysis refers to as Bioinformatics. The emphasis will be placed on the genetic mechanisms underlying diseases, mapping and diagnosis such as salmonellosis, entero-haemorrhagic, hepatitis A, acute and chronic aflatoxicosis, cholera, heavy metal poisoning, and the threat of antibiotic resistance arising from improper use of veterinary drugs, and chronic pesticide and industrial chemical residue exposure. This programme combines concepts and techniques of molecular biology with hands on bioinformatics as a necessary skill gap career to address Africa's shortage of expertise and applicable solutions to ensure a safe, controlled and sufficient food supply that will support economic growth and public health. Also, the centre focus on training in innovation process, entrepreneurship and commercialization of biotechnology products. The knowledge and skills gain from this programme open doors to employment within many sectors in industry, academia and agencies concerned with patent and legal issues, education or research funding.

Toxicology is a scientific discipline, overlapping with biology, chemistry, pharmacology and medicine, that involves the study of the adverse effects of chemical substances on living

organisms and the practice of diagnosing and treating exposures to toxins and toxicants. The chemical toxicants include inorganic substances such as lead, mercury, cadmium, hydrofluoric acid, chlorine gas and organic compounds such as methyl alcohol, most medications and poisons from living things. The Africa Centre of Excellence for Mycotoxin and Food Safety intends to train toxicologist in the areas of analytical toxicology, applied toxicology, clinical toxicology, veterinary toxicology, forensic toxicology, environmental toxicology, and industrial toxicology. These toxicologists will have expertise to investigate, interpret, and communicate the nature and the adverse effects of the toxicants, thereby providing the necessary basis for protection measures. In doing these, toxic genomics that involves applying molecular profiling approaches to the study of toxicology would be employed. The toxicology course would help in the development of new effective and safe chemicals monitor the effect of chemicals on environment, ensures that food and water are free from chemical and microbial contamination and safe for consumption. It will also assist in the diagnosis and treatment of chemical poisoning in humans and animals, provides specialized expert opinion in legal cases where medicines, food borne pathogens/poisons, drugs of abuse may be implicated, provide guidance for the safe use of chemicals in farms/farm produce and the ecosystems.

GENERAL PHILOSOPHY, VISON AND MISSIONS

The Africa Centre of Excellence for Mycotoxin and Food Safety came into existence in 2019 through NUC/World bank support and it is one of the ten (10) different projects in various strategic areas of Science and Technology aimed at creating World Class research Centers in the country. The CoE established at the Federal University of Technology Minna to leverage the research infrastructure available in the National Centre for Genetic Engineering and Biotechnology (CGEB) and its strategic plan to train a skilled and innovative work-force that would transform Africa's natural resources into goods and services, driven by entrepreneurship and information and communication technology (ICT), to positively affect the economy and thus the quality of life of her people.

PHILOSOPHY

The ignorance of illiterate African farmers and extension workers, the public and policy makers on the existence and health impact of food borne toxicants, coupled with the deficits in funds, qualified personnel and laboratory infrastructure of national food control systems to generate occurrence data, formulate and effectively enforce standards; account for the deplorable food safety situation of the Continent. Postgraduate study (M.Tech) in Food safety is a full time programme designed by the Africa Centre of Excellence for Mycotoxin and Food Safety for the purpose of encouraging cross-border collaboration to provide relevant human and material resources for the effective training of high-level independent minded, self-reliant and competent researchers that are capable of providing critical skills in effective food system. Postgraduate programme in food safety will provide the skills that will adequately address the research and training needs to conduct regional survey of food borne pathogens and toxic chemical residues, assess their health and economic impacts and consequently set appropriate national and regional standards for effective prevention and control.

VISION

To produce skilled manpower with quality education and training in the use of modern functional equipment and innovative research for assessing impacts of food borne pathogens and toxic chemical residues on the health and economy of West and Central Africa Sub-region and consequently set appropriate national and regional standards for effective prevention and control of food poison that can guide policy formulation across the African region.

MISSION

To train a skilled and innovative work-force that would transform Africa's natural resources into goods and services, driven by entrepreneurship and Information and Communication Technology (ICT), to positively affect the economy and thus the quality of life of her people.

AIM: To train Food Safety, Molecular Biology and Bioinformatics, and Toxicology graduates that will impact better food and feed safety culture, and ensure safer foods for healthy living across Africa.

OBJECTIVES:

It will impart the knowledge required to create an interdisciplinary, experimental education model that will prepare them on the rapidly emerging need for innovations at the nexus of food security, food safety, agricultural productivity and economics from local to global scales.

(a) Acquire knowledge required to create an interdisciplinary and experience based educational model that will prepare them on the rapidly emerging need for innovations at the nexus of food security, food safety, agricultural productivity and economics from local to global scales.

(b) Acquire skilled and innovative ideas that would transform Africa's natural resources into goods and services, driven by entrepreneurship and Information and Communication Technology (ICT), to positively affect the economy and thus the quality of life of her people.

(c) Be able to foster impactful interdisciplinary research and implement solutions that will improve the quality of life of Africans through fit-for-purpose interventions fostering economic growth and access to sufficient safe food for all.

(d) Be able to address Africa's shortage of expertise and applicable solutions to ensure a safe, controlled and sufficient food supply that will support economic growth and public health.

Specific objectives for Food Safety are as follows:

- To gain better understanding of effective food safety principles
- To differentiate between traditional food safety management system versus a science-based food safety approach.

- To understand international food safety regulation and its subsidiary bodies
- To improve the effectiveness of training, education and communication efforts in creating smarter food safety goals
- To acquire practical food safety knowledge and real-world applications that will help them become more effective in their current role and better equip them as food safety Experts
- To increase knowledge on how to handle and prevent food-borne disease outbreaks
- To understand process of food production from farm to table.
- To award M.Tech and PhD degree in Food Safety

Specific objectives for Molecular Biology and Bioinformatics are as follows:

- To provide theoretical and practical knowledge in general and microbial biochemistry, molecular biology and bioinformatics related to food contaminant control and safer food among postgraduate students from West and Central African region.
- To position the postgraduate students for successful grant writing and becoming independent researchers in mycotoxin and food safety
- To provide linkages for industrial experience acquisition among the postgraduate students.
- To help the postgraduate students understand research ethics and use of intellectual property for innovative research products for wealth creation and addressing mycotoxin control needs in West and Central African region.
- To award M.Tech and PhD degree in Molecular Biology and Bioinformatics

Specific objectives for Toxicology are as follows:

- To explain the history and scope of toxicology such as; food, environmental, forensic and clinical toxicity.
- To have broad knowledge of classes of toxicants with the view to exposing students to advanced toxicological activities
- To describe various toxic actions and explain how they affect organs and systems
- To expose students to instrumentation techniques and analytical procedure in toxicology
- To acquire knowledge on risk assessment, prevention and control of toxins
- To expose the students to toxicological techniques for food, industrial and environmental applications.
- To receive M.Tech and PhD degree in Toxicology

ADMISSION REQUIREMENTS

Candidate for admission to the M.Tech programmes of the Africa Centre of Excellence for Mycotoxin and Food Safety shall have the following requirements:

(a) Candidates applying for M.Tech must have minimum of five 'O' level credit passes in NECO/WAEC/NABTEB or its equivalent for international students which must include English/French, Mathematics and any other (three) relevant science subjects (Chemistry, Biology and Physics) at no more than two sittings.

(b) National Youth Service Corps (NYSC) certificate or NYSC exemption certificate (Nigerians only)

(c) M.Tech candidates must ensure their Academic Transcripts are received on time to allow for consideration of the application.

(d) Candidates applying for master's degree must have at least a second class lower honour degree or its equivalent for foreign candidate.

(e) A third class (Hons) degree with at least three years of post-qualification experience in the relevant field may be considered.

(f) Candidates with recognized PGD with a minimum of lower credit (CGPA of 2.50) in relevant fields with, at least one year post-qualification experience may be considered.

(g) Candidates must provide three referees, one of whom must be his/her supervisor or an academic referee.

(h) A qualifying examination may be necessary.

Note:

1. First degree graduates from the following areas: Food Safety, Food Toxicology, Biochemistry, Molecular Biology and Bioinformatics, Microbiology, Veterinary Medicine, Bachelor of Medicine & Surgery, Pharmacy, Chemistry, Food Science, Animal Science, Crop Science, Plant Pathology are qualified to apply for the M.Tech programme in Food Safety.

2. Candidates from non-English speaking countries (Francophone Countries) are to undergo proficiency training in English Language (maximum of six months). The waiting period for the training is not counted as part of candidate's academic programme duration.

Admission into the PhD programme is TWICE a year (ie at the beginning of new academic session and commencement of second semester of every academic session).

Candidate for admission to the PhD programme of the Africa Centre of Excellence for Mycotoxin and Food Safety shall have the following requirements:

(i) Candidates applying for PhD must have minimum of five 'O' level credit passes in NECO/WAEC/NABTEB or its equivalent for international students which must include English/French, Mathematics and any other (three) relevant science subjects (Chemistry, Biology and Physics) at no more than two sittings.

(j) Nigerian applicants must have National Youth Service Corps (NYSC) certificate or NYSC exemption certificate.

(k) Candidates should ensure their Academic Transcripts are received on time to allow for consideration of the application.

(l) Applicants for admission to PhD shall be Master's Degree graduates and must have attained an average performance of 'B' grade or weighted average of 60% or a minimum CGPA of 3.50

(m) Applicants should ensure that their research proposals are received on time for consideration of the application.

(n) Candidates must provide three referees, one of whom must be his/her supervisor or an academic referee.

Note:

3. Graduates with Master degree from the following specialization/areas: Food Safety, Food Toxicology, Biochemistry, Molecular Biology and Bioinformatics, Microbiology, Veterinary Medicine, Medicine & Surgery, Pharmacy, Chemistry, Food Science, Animal Science, Crop Science, Plant Pathology are qualified to apply for the PhD programme in Food Safety.

4. Candidates without relevant background in food safety, molecular biology and bio-informatics, and toxicology (M.Sc/M.Tech Food Safety or Molecular Biology and Bio-informatics or Toxicology) will be required to audit core courses from our Masters programme on assessment of their academic transcript by Academic Board of the Centre.

5. Candidates from non-English speaking countries (Francophone Countries) are to undergo proficiency training in English Language (maximum of six months). The waiting period for the training is not counted as part of candidate's academic programme duration.

GRADUATION REQUIREMENTS

Master Programme

To be awarded a master degree in Food safety, Toxicology and Molecular biology and Bioinformatics, a candidate is expected to satisfy the following conditions before graduation;

(a) Pass all courses, including research project

(b) A minimum of three (3) semesters and maximum of six (6) semesters are required to be spent by the candidates while on the program. This includes the period spent on the course work and internship. To successfully complete the course, students are required to register and **PASS.** Total number of credits required for graduation is 47 credits for Food Safety:
Core credit units: **35**
Elective credit units: **4**
Internship: **2**
Thesis: **6**

Total number of credits required for graduation is 44 credits for Molecular Biology and Bioinformatics:

Core credit units: **32**
Elective credit units: **4**
Internship: **2**
Thesis: **6**

Total number of credits required for graduation is 43 credits for Toxicology:
Core credit units: **31**
Elective credit units: **4**
Internship: **2**
Thesis: **6**

(c) Publication of at least one paper in Impact Factor Journal and conference presentation
(d) Attain an overall minimum CGPA of 2.5

Registration and Duration

MTech candidates will be required to register as full time at the beginning of any session.

Full Time -Minimum Time – 3 Semesters- 18 months

Maximum Time – 6 Semesters- 36 months

Doctoral Programme

To be awarded a PhD degree in Food safety, Toxicology and Molecular Biology and Bioinformatics, a candidate is expected to satisfy the following conditions before graduation;

(a) Must have presented and passed seminar of 4 credit units
(b) A group of supervisors shall be nominated by the centre, presented and approved by the postgraduate board for the candidates.
(c) Present oral proposal, two progress report and final internal oral examination.
(d) At least TWO paper publications from the dissertation in impact factor journals and TWO conference presentations before final examination can take place.
(e) Final oral examination

(f) The final corrected version of the PhD dissertation must be re-submitted within three months from the date of final oral defense.

Registration and Duration

PhD candidates will be required to register as full time at the beginning of any semester.
Full-time- Minimum 6 Semesters or 36 months
Maximum 10 Semesters or 60 months

METHODS OF INSTRUCTION

Generally, pedagogical approaches will be adopted. These will include lectures, demonstration, tutorials, group presentation; Laboratory practicals will include wet and dry practical, field trips, report presentation at the end of internship, teleconferencing and mid-term papers. All instructions shall be in English language.

The PhD programme will be based purely on research, except for those candidates that were recommended to audit courses.

METHODS OF EVALUATION

Procedure for formative assessment (FA) including assignments and mid-term test: 40%
Procedure for summative assessment (SA): 60%
Internship/Industrial experience: 3 months
Practical- based classes shall be assessed thus:
Class experiments: 40 %
Advanced technique term paper: 10 %
Examination: 50 %

CAREER/JOB OPPORTUNITIES

Graduates of Africa Centre of Excellence for Mycotoxin and Food Safety shall be opportune to work as laboratory analysts, surveillance/senior inspectors, molecular toxicologists, forensic and clinical toxicologists, food and safety officers/food safety regulators in various companies and industries. They would also be relevant as biosafety officers, toxicological risk assessors, food toxicologists, and instructors/lead instructors/trainers/lecturers. In addition, their expertise will needed in agriculture, food industries and regulatory organizations ; Standards bureau/organizations, National drug administration and food control, Quarantine services, Veterinary Centres, Hospitals, Food and Chemical Industries and as Bioinformatician, Drug Discovery scientist, Molecular Mycologist, Data Scientist, Computational Scientist, Modeling expert, Food Nanotechnologist, Food borne infection control expert, Biochemistry Food industry, Animal feed Quarantine Institution, Universities, and Research Institute.

EXAMINATION MALPRACTICE AND PENALTIES

1. Except where specifically stated, materials relevant to the examination should not be brought into the examination Hall.

2. The Senate shall impose penalties for any examination malpractices after thorough investigation.

3. Proven cases of cheating shall be punished with dismissal from the University. Other cases will be treated on their individual merits.

4. Suspected examination malpractices shall be investigated by the School panel and its report and recommendations submitted to the Students' Disciplinary Committee through the Registrar for determination subject to approval by the Vice-Chancellor.

5. Graded punishments include the following:

S/N	OFFENCES	PENALTIES
1.	Writing Before an Exam was officially started	First offender: Warning. Second offender: Suspension for one semester
2.	Writing beyond the official termination of examination	Letter of warning and deduction of 5 marks. To be done at the spot by the invigilator.
3.	Talking to another candidate during examination	First offender; Warning. Second offender: Suspension
4.	Writing on question paper	Letter of warning and deduction of 5 marks.
5.	Being caught with extraneous material not relevant to the examination	Cancellation of paper of the affected student.
6.	Anyone caught using foreign materials inside the examination hall that are relevant to the Examination/course.	Expulsion
7.	Anyone who brought relevant materials into the hall but was not caught using it.	Suspension for two semesters

8.	Unruly behaviour e.g. changing position without permission	Suspension for one semester
9.	Smuggling in/out of the examination hall, Blank answer booklet or continuation Sheet.	First offender: Minimum of 2 Years suspension. Those with previous records, expulsion.
10.	Anyone who brought into the examination hall already written answer script or continuation sheet.	Expulsion
11.	Aiding and abetting 'grafting'	Suspension for one semester
12.	Giving false evidence	Suspension
13.	Refusal to give evidence on request	Suspension
14.	Previous involvement in two examination misconduct with penalties less severe than rustication	Explosion
15.	Assaulting/Fighting an invigilator or any officer of the University	Expulsion
16.	Being in possession of dangerous weapon in and around the examination hall.	Expulsion
17.	Involvement in examination leakage	Expulsion
18.	Impersonation (both the impersonator and collaborator	Expulsion
19.	Those who fail to submit answer scripts at the end of examination	Suspension for one session
20.	Students who failed to sign out after Examination	First offender: Warning, Second offender: Suspension for one semester
21.	Refusal to surrender incriminating evidence, chewing or destruction of materials.	Expulsion

22.	Refusal to write statement	Expulsion
23.	Forging any document relevant to the Examination	Expulsion
24.	Anyone who refused to be identified and/or searched at the entrance of an examination hall.	Suspension from the examination for that particular paper, through Examination Officer and Dean.
25.	Staff harassment or intimidation for leakage of examination questions	Expulsion
26.	Writing on question paper	Letter of warning and deduction of 5 marks.
27.	Anyone who takes GSM handset into the Examination hall.	Suspension for one semester
28.	Refusal to appear before the Students Disciplinary Committee within a session following examination misconduct.	Expulsion
29.	Those who exchange or transfer calculator in the examination hall.	Expulsion.
30.	Exchange of answer booklets	Expulsion
31.	Writing on any part of the body and clothes	Expulsion
32.	Discussion in the course of writing an examination.	Letter of warning
33.	Making some writings relevant to the course at the back of calculators including placing relevant material inside Mathematical-set.	Expulsion
34.	Exchanging answer script or question papers or any relevant writing materials during Examination.	Expulsion. Note. Relevant material: Suspension for one semester.

DRESS CODE

Students' dressing should reflect a high sense of morality and decency and show respect for the sensibilities of other members of the community. Therefore, the following types of dressing and physical appearances be prohibited on the University campus:

1. Short and skimpy dresses e.g. Body hugs, Show-me-your chest/back/stomach; Spaghetti wears and dresses exposing sensitive parts.
2. Tight shorts and skirts that are above the knees (except for sporting purposes).
3. Tattered jeans with holes and/or patches.
4. Transparent and see-through dresses.
5. Tight fittings e.g. Jeans, Shirts, Hip Star, Patra, Lactra, Cross-No Gutter, Mini-micro and others that reveal the contour of the body.
6. Under clothing, such as singlets worn publicly.
7. Unkempt and haggard appearance, including bushy hair and rough beards.
8. Dresses that make it impossible to wear laboratory coat during practical's or participate actively in practical.
9. Long and tight skirts, with long slits that reveal sensitive parts.
10. Wearing of T-shirts with offensive captions.
11. Shirts without buttons or not properly buttoned leaving the wearer hare chested.
12. Wearing of earrings by male students.
13. Plaiting or weaving of hair by male students.
14. Wearing of coloured eye glasses, except on medical grounds in the classrooms/lecture halls/library/offices.
15. Wearing bathroom slippers to class/library/offices (except on medical grounds).

DISCIPLINARY MEASURES

1. Cultism: any students guilty of participating in any occultism shall be expelled from the university after proven guilty by the Students' Disciplinary Committee (SDC).
2. Stealing: any act of stealing shall attract maximum penalty of expulsion from the university.
3. Drug abuse: any drug- related anti-social behaviours shall attract necessary disciplinary measures ranging from suspension to expulsion.

4. Any students' case involving police shall also be tried by the university Students' Disciplinary Committee (SDC).
5. In any case of co-habitation by the student(s), centre shall make available form of intent to be completed by the student(s) concerned, failure to do this shall attract penalty ranging from suspension to suspension as determined by the Students' Disciplinary Committee (SDC).
6. Any student that disobeys laboratory code of conducts shall be suspended from the lab for a period to be determined by the Students' Disciplinary Committee.
7. Physical assault shall attract punishment ranging from suspension to expulsion to be determined by the Students' Disciplinary Committee (SDC)

SEXUAL HARASSMENT

Federal University of Technology Minna will provide enabling conditions for the guarantee of academic freedom and fundamental human rights of staff, students, service providers, and all persons; regardless of gender, thereby supporting an environment that is free of sexual harassment in any form.

Vision of the Policy

To raise FUTMINNA to the status of an ideal, safe, and secure institution, where the dignity of everyone is ensured and guaranteed.

Mission of the Policy

- Provide information to staff, students, and other stakeholders on what constitutes sexual harassment
- Enlighten staff and students on their rights to seek redress in cases of sexual harassment and the consequences of such acts.
- Put in place machinery for investigating allegations and incidents of sexual harassment and /or attempted sexual harassment.
- Ensure that victims of sexual harassment do not suffer any setbacks/victimization/stigmatization/discrimination and are integrated back into University life as quickly as possible.
- Sensitize staff and students on the need to comply with decent dress code and appropriate behavior; and discourage inappropriate relationships between staff and students that may engender conflict of interest.

The Scope of the Policy

The Sexual Harassment Policy shall apply to:

- All academic and non-academic staff of the University

- All students
- All contractors of the University and other service providers
- All visitors to the University
- Other groups of persons in the University, including but not limited to children, wards, and other dependents of staff resident on both campuses

Objectives of the Policy

The objectives of the policy are to:

- Create for staff, students and service providers a safe and secured work and learning environment that is free from sexual harassment/assault.
- Guarantee respect for both sexes, and provide a transparent operating system in the university that is devoid of demands for sexual gratification.
- Eliminate all manners of gender-based violence.
- Ensure that no member of the university community or its customers suffer any form of service failure due to gender bias.
- Forbid discrimination on the basis of sex in all the University's service windows.
- Ensure firm commitment to transparency on the issues of sexual harassment and sexual violence
- Enforce the dress code as enshrined in the University's code of conduct for staff and students.
- Train students/staff to be alert to the possibility of sexual misconduct, to identify warning signs and to learn strategies for getting out of those kinds of situations before it reaches a crisis level.

WHAT IS SEXUAL HARASSMAENT?

Sexual harassment is defined as unwelcome sexual advances, request for sexual favors and other verbal or physical conduct of a sexual nature when either:

i. The conduct is made as a term or condition of an individual's employment, education, living environment or participation in a University community.

ii. The acceptance or refusal of such conduct is used as a basis or factor in decisions affecting an individual's employment, education, living environment, or participating in a University community.

iii. The conduct unreasonably impacts an individual's employment or academic performance or creates an intimidating, hostile or offensive environment for that

individual's employment, education, living environment, or participation in a University community.

The following behaviors shall be considered by the University as sexual harassment:

- Unwanted sexually motivated conduct, crude jokes, comments, unwanted touching and expressions capable of prejudicing or undermining a person's freedom, rights and privileges. Such acts could include but are not limited to outright demands for sex, ogling, indecent comments and unnecessary bodily contact which could lead to psychological or physical unsolicited sexual relationships;
- Unwanted suggestive looks, phone calls or use of any other electronic medium with the intent to lure a person into a sexual relationship.
- Spousal abuse where one or both partners are members of the university community
- Sexual harassment may be from a superior to a subordinate or vice versa or among peers.
- Sexual harassment can be direct or indirect (including procuring or attempting to offer a person to another for sexual activity); and may involve persons of the same or opposite sex.
- Sexual harassment may take place over a period of time, may be a single incident and may or may not involve elements of overt coercion.

BEHAVIOURS THAT ARE CONSIDERED 'CONDUCT OF A SEXUAL NATURE'

I. Unwanted sexual statement: Sexual or 'dirty' jokes, comment on physical attributes, spreading rumors about or rating others as to sexual activity or performance, talking about one's sexual activity in front of others and displaying or distributing sexually explicit drawings, pictures and/or written material. Unwanted sexual statement can be made in person, in writing, electronically (e-mail, instant messaging, blogs, web pages etc) and otherwise.

II. Unwanted personal attention: Letters, telephone calls, visits, pressure for sexual favors, pressure for unnecessary personal interaction and pressure for dates where a sexual/romantic intent appears evident but remains unwanted.

III. Unwanted physical or sexual advances: Touching, hugging, kissing, fondling, touching oneself sexually for others to view, sexual assault, intercourse or other sexual activity.

WHAT IS SEXUAL ASSAULT?

Sexual assault/ sexual violence is any sexual act, attempt to obtain a sexual act, or other act directed against a person's sexuality using coercion, by any person regardless of their relationship to the victim, in any setting. It includes rape, defined as the physically forced or otherwise coerced penetration of the vulva or anus with a penis, other body part, or object (WHO, 2011).

FORMS OF SEXUAL HARASSMENT

Based on the definition provided above, sexual harassment in Federal University of Technology, Minna shall include but not limited to:

Verbal Conduct

- Unfriendly remarks with sexual connotations
- Forcing of females or males by staff or students to have sexual interaction.
- Demanding for sexual favors in exchange for employment, promotion, admission, grades, or any other benefits in the course of performing official duties.
- Victimizing an individual through denial of his or her entitlement for refusal to succumb to sexual advances.
- Sexually motivated jests, comments and defamation of a person(s).
- Making sexually motivated comments about a person's clothing, body or shape.
- Turning academic and occupational discussions into sexual discussions without precluding or restricting appropriate teaching methods and research.
- Compelling persons to narrate sexual fantasies, preferences or history.
- Unsolicited, sexually explicit or suggestive electronic and mobile messages.
- Directly or indirectly procuring or attempting to offer a person to another for sexual activity

Visual and Audio Conduct

- Recording and sending unwholesome pictures (videos, CDs, camera phones etc) for the purpose of blackmail or any other purpose.
- Forcing or inducing to watch pornography or X-rated movies
- Seductive postures and indecent dressing and exposure by males or females that offend public morality. Any form of dressing that exposes vital parts of the human body constitutes indecent dressing. The University shall encourage a 'dress sense' culture among males and females.
- Indecent and inappropriate public display of sexual intimacy

Physical Conduct

- Physical sexual assault and battering
- Repeated, unwelcomed and unwarranted brushing against a person's body.
- Unwelcomed caressing or fondling

WHO IS THE VICTIM OF SEXUAL HARASSMENT/ASSAULT?

In the University community, the following may be victims:

i. Students (males and females)
ii. Staff (males and females)
iii. Staff children/wards
iv. Students' children/wards

Sexual harassment by University staff/student outside the University community. The victim could seek support from University services and duty bearers within the community the University operates in like the security, health services and Servicom.

Redress Mechanism for Complainants

All complaints on violation or infringement of the sexual harassment policy shall be made at the Gender Mainstreaming Office (GMO) or SERVICOM unit of the University. If the complainant is not satisfied, he/she can complain to the Vice Chancellor. All complaints shall be treated with confidentiality and the victim shall be properly secured while reporting the incidence and afterwards.

Complaints of violation or infringement of the policy may be formal or informal. ACEMFS has a guidance counselor desk officer whom the victim reports to as soon as it happens.

- Informal complaints (i.e. oral complaints) shall be treated administratively. The receiving officer shall however document such complaint and treat with dispatch.
- Formal complaint must be in writing, signed and submitted at the GMO or SERVICOM unit.

A report or complaint can be made by the victim (or anyone who advocates on his or her behalf), or a witness. However, the decision to make such complaint formal or informal lies with the victim (or anyone who advocates on his or her behalf) or a witness.

PENALTIES

Any person found culpable of perpetrating sexual harassment, falsely accusing any person or instigating the occurrence of false accusation shall be subject to penalty as stipulated in the Conditions of Service of the University. These may include, but will not be limited to any of the following:

- Counseling and/or therapy
- Oral admonition
- Written warning or oral reprimand
- Referral to Staff/Student Disciplinary Committee (SDC) as the case may be or

- Any other disciplinary action which the University may deem fit (including suspension, expulsion or dismissal from service with photograph pasted around the campus).

In cases of sexual harassment outside the University, there will be a need for the involvement of security agencies and hence the court. The University shall follow the case to the latter while the student/victim is fully protected.

M.TECH FOOD SAFETY (COURSE OUTLINE)

FIRST SEMESTER

S/N	Course Code	Course Title	Credit Unit	Core/Elective
1	TOX 711	Principles of Toxicology	2	Core
2	TOX 712	Advanced Toxicology	3	Core
3	BFS 711	Introduction to Food Safety	2	Core
5	BFS 712	Chemical Food Safety 1	3	Core
4	BFS 713	Risk Analysis	2	Core
5	BFS 714	Plant Pathology	2	Core
6	BFS 715	Detection and Management of Mycotoxin for Food and Feed Safety	3	Core
7	MFT 711	Introduction to Nanoscience and Nanotechnology	2	Core
		Sub Total	19	
		Electives		
8	MBB 712	Molecular Biology 1	2	Elective
5	MBB 715	Bioinformatics 1	3	Elective
	Total	**Maximum to be registered**	**22**	

SECOND SEMESTER

S/N	Course Code	Course Title	Credit Unit	Core/Elective
1	BFS 721	Pesticide and Toxic Metals	2	Core
2	BFS 722	Veterinary Chemical and Drug Residues	2	Core
3	BFS 723	Chemical Food Safety II	2	Core
4	BFS 724	Food Borne Diseases Epidemiology	3	Core
5	BFS 725	Food and Feed Additives and	2	Core

		Fortification		
6	BFS 726	Food Processing and Packaging	2	Core
7	BFS 727	Food Laws, Standards and Regulations	2	Core
8	BFS 728	Seminar 1	1	Core
		Sub Total	**16**	
		Electives		
9	TOX 724	Environmental Toxicology	2	Elective
10	TOX 725	Forensic and Clinical Toxicology	2	Elective
		Maximum to be registered	18	

THIRD SEMESTER

S/No	Course Code	Course Title	Credit Unit	Core/Elective
1	MFT 730	Internship/Industrial work experience	2	Core
2	BFS 730	Thesis	6	Core
		Total	**8**	

COURSE CONTENT

TOX 711: PRINCIPLES OF TOXICOLOGY: 2 CREDIT UNITS

Introduction toToxicology: Definitions and Scope, Relationship to Other Sciences. A Brief, History of Toxicology, Dose–Response Relationships, Sources of Toxic Compounds and Movement of Toxicants in the Environment.**Introduction to Biochemical and Molecular Methods in Toxicology :** Cell Culture Techniques including Suspension Cell Culture, Monolayer Cell Culture, Indicators of Toxicity in Cultured Cells, Use of Stem Cells and Cell Culture Models as "Alternative" Toxicity Tests. **Molecular Techniques on** Molecular Cloning, cDNA and Genomic Libraries, Northern and Southern Blot Analysis, PCR and Evaluation of Gene Expression, Regulation, and Function. **Immunochemical Techniques** including Proteomics, Metabolomics and Bioinformatics. **Exposure Classes, Toxicants in Air, Water, Soil, Domestic and Occupational Location:** Air Pollutants; Types, sources and examples of air pollutants. Types and examples of water and Soil Pollutants. Routes of exposure and regulation of occupational pollutants and examples of industrial toxicants.**Classes of Toxicants:** History and introduction. Metals**:** History, Common Toxic Mechanisms and Sites of Action with

reference to Lead, Mercury, Cadmium, Chromium, and Arsenic. Treatment of Metal Poisoning.**Agricultural Chemicals (Pesticides)**; Introduction, Definitions and Terms, Organochlorine Insecticides, Organophosphorus (OP), Insecticides (Carbamate Insecticides, Botanical Insecticides, Pyrethroid Insecticides.New Insecticide Classes.Herbicides; Fungicides, Rodenticides, Fumigants.**Food Additives and Contaminants**: Toxins; History, Microbial Toxins, Mycotoxins, Algal Toxins, Plant Toxins and Animal Toxins, **Solvents, Therapeutic Drugs, Drugs of Abuse. Combustion Products and Cosmetics**

TOX 712 : ADVANCED TOXICOLOGY 3 CREDIT UNITS

Absorption and Distribution of Toxicant: Introduction. Structure of Cell Membranes, Mechanisms of Transport of toxicants across membranes: Passive Diffusion, Carrier-Mediated Membrane Transport, Physicochemical Properties Relevant to Diffusion namely Ionization and Partition Coefficients. Routes of Absorption; Extent of Absorption, Gastrointestinal Absorption, Dermal Absorption, Respiratory Penetration, Toxicant Distribution, Physicochemical Properties and Protein Binding Toxicokinetics**Metabolism of Toxicants: Phase 1 Reactions,** The Endoplasmic Reticulum, Microsomes, and Monooxygenations. The CYP-Dependent Monooxygenase System, The FMO, Nonmicrosomal Oxidations, Co-oxidation by Cyclooxygenase (COX), Reduction Reactions, Hydrolysis, Epoxide Hydration and DDT Dehydrochlorinase. **Phase II Reactions**: Glucuronide Conjugation, Glucoside Conjugation, Sulfate Conjugation, Methyltransferases, GSTs and Mercapturic Acid Formation, Cysteine Conjugate β-Lyase, Acylation and Phosphate Conjugation**. Reactive Metabolites:** Introduction. Activation Enzymes.Nature and Stability of Reactive Metabolites, Fate of Reactive Metabolites, Binding to Cellular Macromolecules and Lipid Peroxidation. Trapping and Removal: Role of Glutathione. Trapping and Removal: Role of Epoxide Hydration, Factors Affecting Toxicity of Reactive Metabolites (Levels of Activating Enzymes, Levels of Conjugating Enzymes and Levels of Cofactors or Conjugating Chemicals). Reactive Oxygen Species. Examples of Activating Reactions (PiperonylButoxide, Chlorpyrifos, Vinyl Chloride, Methanol, Aflatoxin B1, Carbon Tetrachloride (Tetrachloromethane), Acetylaminofluorene, Benzo(a)pyrene, Acetaminophen and Cycasin**. Chemical and Physiological Factors Affecting Xenobiotics Metabolism:** Nutritional Effects (Protein, Carbohydrates, Lipids, Micronutrients, Starvation and Dehydration and Nutritional Requirements in Xenobiotic Metabolism. Physiological Effects (Development, Gender Differences, Hormones, Pregnancy, Disease and Diurnal Rhythms.Comparative and Genetic Effects (Variations among Taxonomic Groups, Selectivity and Genetic Differences.Chemical Effects and Inhibition. Induction and Biphasic Effects: Inhibition and Induction. Environmental Effects (Temperature, Ionizing Radiation, Light, Moisture, Altitude and Other Stress Factors)**. Elimination of Toxicants:** Introduction on factors involved in elimination of toxicants; Size, Surface Area to Body Mass Ratio, Compartmentalization, Lipid Content and Barriers to the Environment. Transport.Renal Elimination (Size, Water Solubility, Hepatic Elimination, Entero-Hepatic Circulation and Active Transporters of the Bile Canaliculus.Respiratory Elimination.

BFS 711 INTRODUCTION TO FOOD SAFETY 2 CREDIT UNITS

Basic definition: Food, Dietary constituents-water, carbohydrates, proteins and amino acids, dietary fats and fatty acids, minerals, vitamins, factors affecting nutrient requirement, and dietary deficiencies and excess consumption of nutrients-, feed, water quality. **Food wholesome and safety**- introduction to various types of food contaminants (food additives, antinutrients in plant foods, mycotoxins, food borne pathogens, toxic metals, pesticides and industrial contaminants and drug residues) keeping quality, Bio-terrorism in food safety. **Food** – a matter of life and death.

BFS 712 CHEMICAL FOOD SAFETY I 3 CREDIT UNITS

Toxico-kinetics and dynamics; **Organ Toxicity:** Manifestation of toxicity to liver, kidney, and nervous, reproductive, endocrine, respiratory and immune systems. **Irritation and sensibilisation** : Definitions and Prevalence of Hypersensitivity Reactions, Mechanisms, Reactions in the Skin, Reactions in the Airways, Other Reactions, Test for Hypersensitivity Reactions, Prediction of Allergy Risk, Development of Tolerance and Treatment of Hypersensitivity, Summary. **Genotoxicity, carcino- and teratogenicity;** DNA Damage and Mutagenesis. General Aspects of Cancer. Human Cancer; Causes, Incidence, and Mortality Rates of Human Cancer, Known Human Carcinogens, Classification of Human Carcinogens, Usefulness and Limitations of Mutagenicity Assays for the Identification of Carcinogens. Classes of Agents That Are Associated with Carcinogenesis; DNA Damaging Agents and Epigenetic Agents. General Aspects of Chemical Carcinogenesis; Initiation-Promotion Model and Metabolic Activation of Chemical Carcinogens and DNA Adduct Formation. Oncogenes; Ras Oncogene, Tumor Suppressor Genes, p53 Tumor Suppressor Gene. **Teratogenesis:** Overview of Embryonic Development; Fertilization, Cleavage Stages, Determination, Gastrulation, Differentiation, Organogenesis and Fetal Period. Principles of Teratogenesis; Wilson's Principles and Critical Period, Mechanisms of Teratogenesis; Genetic Factors and Teratogens. Future Considerations

In vivo toxicological investigations; acute, subchronic, chronic and special test**. In vitro toxicological investigations** Prokaryote Mutagenicity, Eukaryote Mutagenicity, DNA Damage and Repair, Chromosome Aberrations, Mammalian Cell Transformation, General Considerations and Testing Sequences. Ecological Effects; Laboratory Tests, Simulated Field Tests and field Tests.

BFS 713 RISK ANALYSIS 2 CREDIT UNITS

Introduction: Components of risks analysis; Conducting risk analysis; Risk management; Risk assessment; Risk Assessment Methods; Hazard Identification, Exposure Assessment and Dose Response and Risk Characterization. Monitoring and surveillance, epidemiological and clinical studies for human data, animal and in vitro and structure-activity relationship. Non cancer Risk

Assessment: Default Uncertainty and Modifying Factors, Derivation of Developmental Toxicant RfD, Determination of RfD and RfC of Naphthalene using the NOAEL Approach, Benchmark Dose Approach, Determination of BMD and BMDL for ETU and Quantifying Risk for Non carcinogenic Effects, Hazard Quotient and Chemical Mixtures. Cancer Risk Assessment and PBPK Modeling. **Emerging Risk Assessment methods**: Hazard and Exposure Assessment using Toxicogenomics, Proteomics, Metabolomics, Systems Biology Approach to Risk Assessment, Endocrine Disruptors, Genetically and Modified Plants (GMPs). Risk Management. Risk Communication. *In Vivo* Toxicity. *In Vitro* Toxicity. Molecular and Biochemical Toxicology and Development of Selective Toxicants**Risk communication; Principles and application of HACCP/preventive control (allergens) in food safety**.

BFS 714 PLANT PATHOLOGY 2 CREDIT UNITS

What is plant pathology; Definition of disease, Abiotic, biotic and decline diseases, Signs, symptoms and patterns; Mechanisms of disease action; The disease triangle, square and tetrahedron; Classification of organisms; Organisms causing biological diseases; Pathogen/insect relationships. Allergen, susceptible crops and control strategies; Good Agricultural Practices (GAPs)

BFS 715 DETECTION AND MANAGEMENT OF MYCOTOXIN FOR FOOD AND FEED SAFETY 3 CREDIT UNITS

Fungi and mycotoxin in food; significance of fungi and mycotoxins in foods; Factors affecting growth of fungi in foods; Prevention and control of fungal growth in foods and food processing environments; Methods for detecting, enumerating, and identifying fungi; Airborne fungi – with introduction to antifungal preservatives; Role of fungi in food processing. **General introduction** to mycotoxins-chemical and toxicological characteristics, occurrence in foods and regulation of major and emerging mycotoxins, **Introduction to mycotoxin analysis**; - the chemical properties of mycotoxins, explore detection methods like;; Chromatographic techniques (HPLC, LC-MS),Immunoanalytical techniques (ELISA, LFD) and Multi-toxin Analysis by LC-MS-**Identification of mycotoxigenic fungi**- conventional and molecular based techniques-, **epidemiology of mycotoxicosis**; Prevention and control of mycotoxins; Physical factors associated with mycotoxin prevention; **Application of predictive modelling in mycotoxin control;**Mycotoxins in grain in selected countries. **Africa mycotoxin challenges: valid options and opportunities.** This would be based on current literatures and interventions across Africa. It will appreciate the roles mycotoxin play in health in Africa, including reported incidences with mycotoxins and also review the challenges Africa faces in addressing mycotoxin problems, student would produce papers on the approaches needed to mitigate mycotoxin problems. Discovery of opportunities of regional networking will be an output of this course.

MFT 711 INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY
2 CREDITS

Emergence of Nanotechnology-Definition of nanotechnology, nano-system, nanomaterials and properties-Size dependent properties - Mechanical, Physical and Chemical properties.**Nano Ethics and Environment**- Environment related case studies on nanomaterials; Screening of nanomaterials for understanding potential effects to human health and the environment.

Environmental Pollution by Nanoparticles- Health impact, safety and toxicological effects transport of nanomaterials in soil/sediments.Study of physical and chemical properties of nanomaterials influencing their behavior in the environment and in biological systems.

Application of Nanotechnology- Nanoporous polymers and their applications in water purification, nanotoxicology, use of nanoparticles for environmental remediation and water treatment. case studies and regulatory needs.

Nanotechnology in Food Production- Food and new ways of food production - efficient fractionation of crops - efficient product structuring -optimizing nutritional values - applications of nanotechnology in foods : sensing, packaging, encapsulation, nano-feed binder, engineering food ingredients to improve bioavailability - nanocrystalline food ingredients - nano- emulsions - nano-engineered protein fibrils as ingredient building blocks - preparation of food matrices - concerns about using nanotechnology in food production. crop improvement - reasons to package food products - physical properties of packaging materials - strength - barrier properties light absorption – structuring of interior surfaces - antimicrobial functionality - visual indicators – quality assessment - food safety indication - product properties - information and communication technology - sensors - radiofrequency identification technology - risks - consumer and societal acceptance.

Nanoparticles in Agricultural and Food Diagnostics- Enzyme Biosensors and Diagnostics - DNA-Based Biosensors and Diagnostics - Radiofrequency Identification- Integrated Nanosensor Networks: Detection and Response- Lateral Flow (Immuno) assay - Nucleic Acid Lateral Flow (Immuno) assay - Flow-Through (Immuno)assays - Antibody Microarrays -Surface Plasmon Resonance Spectroscopy.

Toxicology of Nanomaterials in Food- Characterization of Engineered Nanomaterials: Unique Issues for Characterization of Engineered Nanomaterials for Food Applications - Safety Assessment of Oral- Exposure Engineered Nanomaterials for Food Application - Experimental Design Considerations for Toxicology Studies - Toxicokinetics – ADME - Toxicodynamics - In Vivo Toxicity - In Vitro Toxicity - Study Reliability.

MBB 712 MOLECULAR BIOLOGY I 2 CREDIT UNITS

Unit I: DNA: Chemical composition of DNA: DNA structure-single stranded DNA, detailed account of double stranded DNA-BDNA, Z.DNA, and other structural forms, triple stranded DNA and quadruplex DNAs, curved DNA, rod shaped DNA, and their importance. Super coiled

DNA: Changes from one form to the other, and the enzymes involved, concept of Linking numbers. Importance of super helical DNA and their structural forms. Types of Topoisomerases and their function in adding or removing super helical structures. Characteristic features of highly repetitive DNA; Tandemly repetitive DNA and Mini and microsatellite DNA and Insertional elements and their role and importance

Unit II: C value paradox- Genome size and content over members of different orders and of the same family; cDNA value paradox. Resolving the paradox by DNA-DNA and DNA-RNA hybridization kinetics. Kinetics of DNA-DNA hybridization, DNA-RNA hybridization, Cot curves, Rot curves, kinetic complexity, chemical complexity, Results of kinetics – determining the portion of genomic DNA which has highly repetitive DNA, moderately repetitive DNA and Non repetitive DNA. Rot curve analysis to find the number and the kind of gene expressed in general and tissue specific manner, the copy numbers of each species of mRNAs, by subtractive method, additive method and micro array method.

Unit III: DNA replication: Prokaryotic DNA replication; replication origin and site and structure and DNA Ter regions and structure. DNA polymerases, composition and features, replication factors and the mechanism of replication, leading strand and lagging strand synthesis, procesessivity and fidelity and regulation of replication. Replication of single stranded DNA, M13 viral DNA-use of themas cloning vectors. **Eukaryotic-replication** origins, replication initiation complexes and their assembly, licensing factors, DNA polymerases and their composition, telomerase and mode of action, replicationfactors, disassembly of chromatin components and reassembly during replication. Organelle genome and composition, replication origins, Enzymes and factors involved in the Replication of mitochondrial DNA and Chloroplast DNA and the mechanism involved.

Unit IV: DNA damage: types and there repair – Factors involved DNA damage: types and their repair mechanisms-mechanism of DNA repair and the regulation of it; direct repair-excision-repair transcriptional excision repair, glycosylase pathway, miss-match repair, UVr A, B & C mechanism, broken end repair, recombination repair and SOS repair system. **RNAs: types** rRNAs; Structural features of rRNAs- prokaryotic and eukaryotic. tRNAs: structural features, their anticodon feature. mRNAs- prokaryotic and eukaryotic mRNAs, structural features, Genomics RNAs, Replication of Picorna and Rabies Viral RNA and mechanism; Structure of retroviruses, classification, Replication of HIV viral RNA; Sn-RNAs, Sno RNAs, RNAi

MBB 715 BIOINFORMATICS 1 3 CREDIT UNITS

Unit I : Introduction to Bioinformatics concepts, principles and applications: Biological databases, exploration, Data retrieval, homology searches and interpretation (BLAST algorithm and result interpretation: coverage, percentage similarity, e-value). Sequence alignments: types tools and practical applications, **DNA Sequences**: Alignments and Analysis; Proteins: Alignment, Analysis and Structure; Sequence assembly methods for multiple sequence alignment; Multiple sequence alignment tools and applications (Use of Clustal Omega and

Molecular Evolution and Genomic analysis (MEGA) software package for model and approach-based phylogeny constructrion, Overview of Primers and Primer Designing; Primer Designing; Primer specificity, Primer validation, n-Silico restriction digest in SMC and webcutter. In-Silico PCR in UCSC and virtual PCR

Unit II Exploration of DNA, and proteomic tools in Expasy: Pattern analysis in sequences Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Units III : Structure-related problems Representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; Structure classification (SCOP, CATH); Visualization software (Pymol, Rasmol etc.); Experimental determination of structures (X-ray crystallography, NMR); Structure databases; Secondary structure prediction; RNA structure prediction; Mfold; Protein structure prediction by comparative modelling approaches(homology modelling, threading); Ab initio structure prediction: force fields, backbone conformer generation by Monte Carlo approaches, side-chain packing; Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.); CASP; Protein-ligand docking; Computer-aided drug design (pharmacophore identification); QSAR; Protein-Protein interactions and Bioinformatic tools (e.g. STRING) ;

Unit IV::System-wide analyses: Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry; Protein arrays; Metabolomics: 13C NMR based metabolic flux analysis; Exploring and Analysing microbial and eukaryotic genomic dataset; analysing and exploring metagenomics data; Bioinformatics for transcriptomics; Bioinformatics for Systems Biology. Diversity studies: Case study in Fungi diversity

BFS 721 PESTICIDES AND TOXIC METALS 2 CREDIT UNITS

Introduction to pesticides, History and Development of pesticides; Classification of pesticides, Movement of residues in the environment and Source of pesticides residues, Mechanisms of toxicity and toxicity to the liver, kidney, nervous system, behavioural effects, immunosuppression, allergenicity, pesticide interactions, estrogenicity, carcinogenity, mutagenicity, and teratogenicity etc Occurrence of pesticide residues in soil, water and food crops and acceptable daily intakes. Residues monitoring programmes; Estimation of pesticides residues in crop and animal products; Chemical analysis of specific family of pesticides; Prevention and Control of pesticides residues in food value chain.**Introduction to toxic heavy metals**; Sources and types; Route of exposure to toxic metal contamination; Occurrence and toxicity of heavy metals; Detection methods of heavy metals; Prevention and control of heavy metal in food crop and food animal products; **Introduction to Radionuclides** Sources of exposure, Physiological effects and Prevention and control. Other pollution and pollutants in the environment

BFS 722 VETERINARY CHEMICAL AND DRUG RESIDUES 2 CREDIT UNITS

Types of drugs; Causes of drug residues in animal products; Potential effect of veterinary drug residues on public health: Development of drug resistance by microorganisms, Drug hypersensitivity reaction, Carcinogenic effect, Mutagenic effect, Teratogenic effect, Disruption of normal flora; Risk factors for development of residues in food producing animal; Permissible levels of residue; Detection methods of drug residues: Microbiological method, Immunological (rapid test kits), Immunoassay (ELISA), Chemical method (Chromatography); Safety evaluation of veterinary drug residues: Acceptable daily intake (ADI), Maximum residue limit (MRL), Calculating withdrawal time; Residues avoidance program; Control and prevention measure of veterinary drug residues

BFS 723 CHEMICAL FOOD SAFETY II 2 CREDIT UNITS

Occurrence, toxicity, prevention and control of other chemical hazards in food and feed**Dioxins and dl-PCBs; Non-dioxin-like PCBs**; **Concept of Anti-microbial resistant both in animal and plant**; **Plant and algal toxins**; inhibitors of proteinase, amylases lipases, lectins, phytate, tannins, cyanogens, saponins, glycosides in flaxseed, alkaloids; swainsonine in Ipomoea carnea gossypol, oxalates etc**. Seafood toxins and poisoning,** Toxic marine organisms, Types, mode of toxicity, symptoms and treatment of phycotoxins, **Mushroom toxins,** Types of poisonous mushrooms and their toxic effects, Symptoms and mechanisms of action of various mushroom poisons;

BFS 724 FOOD BORNE DISEASES EPIDEMIOLOGY 3 CREDIT UNITS

Food Borne Pathogen-Food as a substrate; Environmental factors; Storage and processing factors; Major pathogens: bacteria, fungi, viral, parasitic and prion; Food pathogens management strategies; and Emergency management: natural, accidental, or intentional introduction; Emerging and re-emerging zoonotic food pathogens; Detection methods for food pathogen; Food pathogen prevention and Management techniques. Food hygiene

Food Borne Diseases Epidemiology-Introduction to the principles of Epidemiology; Food borne Disease outbreak investigation: Introduction to outbreak investigation, Food production chain, Size and extent of food borne outbreak, Team players in food borne outbreak response, Detecting a possible outbreak, Defining and finding cases, Generating hypothesis about likely sources, Testing Hypothesis; Finding the point of contamination and sources of food; Controlling and outbreak; Closure; Management; Preventing future outbreak; Application of predictive modelling in control of food borne diseases.

BFS 725 FOOD AND FEED ADDITIVES & FORTIFICATION 2 CREDIT UNITS

Introduction; General principle of use; Food Additives intake assessments; Types, Risks and benefits of food additives; Sweeteners; flavouring; colourants; Emulsifiers; anti-caking;

Antimicrobial Agents; Food forticants; anti-nutritional factors; Enzyme safety Evaluations; National/regional and international needs and Benefits Assessment; Food Vehicles, Safety & Toxicity, and Regulation.

BFS 726 FOOD PROCESSING AND PACKAGING 2 CREDIT UNITS

Part I. The course will start with a case study on an existing food product, studying all elements of the food label (ingredients, nutritional value, rules and regulations, etc.) and finding out the production process of this product.To obtain a good understanding of these production processes, theories on chemical, microbial, physical and process engineering aspects will be explained in the lectures. Exercises will be worked out to illustrate the theory. Processes that will be discussed are beer brewing, production of chocolate, dairy production, sugar refinery, production of ingredients, etc.

Part II. Definition of Packaging, Historical Development; Functions of Packaging: Containment, Protection, Convenience; Communication; Attributes of Packaging: Commercially Efficient, Minimal Environmental Impacts, Not Contaminate Food; Environments of Packaging: Physical, Atmospheric, Human, Functions/Environments Grid, Types of Packaging Materials and safety issues, Packaging requirements for fresh and processed foods, Structural qualities and performance of packaging materials, Innovations in food packaging, Labelling. **Packaging materialsand migration;** types, sources of contamination, migration and assessment of dietary exposure of packaging materials;Need to highlight more developing country issues e.g. lantadine etc.)

BFS 727 FOOD LAWS, STANDARDS AND REGULATIONS 2 CREDIT UNITS

The food safety policies, regulation of food safety; Food additives; Genetic modified foods; Civil and criminal liability for defective products; Inspections; Labeling; and Current issues of concern; Food Recalls and Destruction; WTO/SPS (Sanitary and Phytosanitary Rules); Codes of practices, International Standards Setting Bodies (ISSBs): Codex Alimentarius Commission (Codex); World Organisation for Animal Health (OIE - Office International des Épizooties), International Plant Protection Convention (IPPC) and International Standards Organisation (ISO); Private Standards; Types and Import of Self Regulations.Quality assurance, certification (ISO9001:2015; ISO17025) and accreditation by NiNAS and SON, Import Licensing, GMP Certification and Marketing Authorisation by NAFDAC

MFT 721 RESEARCH METHODS, BIOSTATISTICS AND ETHICS 2 CREDITS

An in-depth study in preparation for seminar and conference presentations using visual aids. Writing of research and review papers for publication, thesis preparation, writing award winning research proposals, bibliographic citations, use of citation/referencing tools such as One Note, analysis and processing of raw quantitative data, literature search, abstracting etc. The use of

appropriate tool in analyzing data, sample collecting and preparation according to the needs of each research. Any relevant information that may be applicable to research. **BIOMETRY:** Introduction, terms and concept, scale of measurement, population and sample, sampling technique, descriptive statistics, probability, discrete probability, normal distribution introduction to hypothesis, hypothesis test; Z-distribution, chi square, student t-test, ANOVA single factor analysis of variance, Post-Hoch analysis with Duncan multiple range, Pearson(simple) Linear correlation, partial and multiple correlation, regression, the regression equation, multiple regression, binary logistic regression, non-parametric methods rationale and methods, comparison with parametric methods , fisher's Exact test, Wilcoxon rank-sum test, Wilcoxon signed rank test, spearman rank order, correlation coefficient

TOX 724 ENVIRONMENTAL TOXICOLOGY 2 CREDITS

Environmental sample collection, analytical techniques; quantification approaches.

Basics of Environmental Toxicology: Environmental persistence: abiotic degradation, biotic degradation, and nondegradative elimination processes. Bioaccumulation; factors that influence bioaccumulation. Toxicity: acute toxicity, mechanisms of acute toxicity, chronic toxicity, species-specific chronic toxicity, abiotic and biotic interactions. **Transport and fate of toxicants in the environment;**Sources of toxicants to the environment. transport processes: diffusion, equilibrium partitioning, air–water partitioning, octanol–water partitioning, lipid–water partitioning, particle–water partitioning, transformation processes: reversible reactions, irreversible reactions. Environmental fate models. **Environmental Risk Assessment:** Formulating the problem. Selecting assessment end points, developing conceptual models and selecting measures. Analyzing exposure and effects information. Characterizing exposure and ecological effects. Characterizing and estimating risk. Describing and Managing risk.

TOX 725 FORENSIC AND CLINICAL TOXICOLOGY 2 CREDITS

Introduction to forensic toxicology; overview, evidentiary requirements, sample type and chemical classes analyzed in Forensic Toxicology. **Clinical toxicology**; overview, clinical toxicology and health care, training and certification, clinical management of toxicant exposure and analytical methods in Forensic and Clinical Toxicology.

BFS 721 SEMINAR I 2 CREDIT UNITS

Each candidate shall be required to deliver a Proposal Seminar on his/her research project.

Recommended Topics for seminar but not limited to the following:

1. Food Safety Research Methods
2. Preventive Control for Human Food
3. Current Issues in Food Safety
4. Food Control

5. Food Fraud and Mitigation
6. Food Quality Management
7. Food Safety Economics
8. Food authenticity and traceability
9. Food Supply Chain and Food Safety
10. Data Analysis for Food Safety

MFT 730 INTERNSHIP/INDUSTRIAL WORK EXPERIENCE 2 CREDIT UNITS

This is the period of the Student's Industrial Work Experience Scheme (SIWES) programme which is normally undertaken for four months during the second year of study. The SIWES programme is basically devoted to practical training in the industries that are relevant to the programme. Students are expected to put into practical use the knowledge they have learned in the classroom and laboratories

BFS 730 THESIS 6CREDIT UNITS

Each candidate shall be required to submit a Thesis at the end of his/her research project.They must address a research, theoretical or applied problem that will be applied to the resolution of a relevant food safety concern. Research area chosen must be approved by the instructor. A written report of the problem suitable for publication, and/or oral presentation, will be required and must be submitted prior to completion of the Master of Technology in Food Safety.

SESSIONAL PROGRESS REPORTS FOR PhD FOOD SAFETY (NOT TO BE SCORED)

COURSE CODE	COURSE TITLE	
BFS 801	Seminar I	**Core**
BFS 802	Seminar II	**Core**
BFS 803	Seminar III	**Core**
BFS 800	Dissertation	**Core**

MTECH MOLECULAR BIOLOGY AND BIOINFORMATICS (COURSE OUTLINE)

FIRST SEMESTER

COURSE CODE	COURSE TITLE	CREDIT UNIT	
MBB 711	Biochemistry I	3	**Core**
MBB 712	Molecular Biology I	2	**Core**
MBB 713	Microbial Biochemistry	3	**Core**

MBB 714	Seminar	2	**Core**
MBB 715	Bioinformatics 1	3	**Core**
MBB 716	Laboratory Techniques	2	**Core**
MFT 711	Introduction to Nanoscience And Nanotechnology	2	**Core**
MBB 717	Cell Physiology	2	**Elective**
MBB 718	Intellectual property rights and Research Ethics	2	**Elective**
	Sub-total for Core courses	**17**	
	Sub-Total for elective courses	**4**	
	Total	**21**	

SECOND SEMESTER

COURSE CODE	**COURSE TITLE**	**CREDIT UNIT**	
MBB 721	Biochemistry II	3	**Core**
MFT 721	Research Methods, Biostatistics and Ethics	2	**Core**
MBB 722	Molecular Biology II	2	**Core**
MBB 723	Immunology	2	**Core**
MBB 724	Biotechnology	3	**Core**
MMB 725	Bioinformatics II	3	**Core**
MBB 726	Nano Drug Modelling	2	**Elective**
MBB 727	Nano pharmaceuticals	2	**Elective**
	Sub-total for core courses	**15**	
	Sub-total for elective courses	**4**	
	Total	**19**	

THIRD SEMESTER

COURSE CODE	**COURSE TITLE**	**CREDIT UNIT**	
MFT 730	Internship	2	**Core**
MBB 730	Thesis	6	**Core**
	Sub-total	**8**	
	Total credit unit for core courses	**40**	
	Total credit unit for elective courses	**8**	
	Grand total credit unit	**48**	

COURSES DESCRIPTION

MBB 711: BIOCHEMISTRY I 3 CREDIT UNITS

UNIT-1: Chemistry of Biomolecules: Carbohydrates-Classification; Monosaccharide nomenclature; sugar ring structures, derivatives of monosaccharides – phosphate esters, acids and lactones; amino sugars; glycosides and glycosidic bonds; oligosaccharides; polysaccharides– storage and structural polysaccharides; Lipids.

UNIT II: Definition, classification, structure of fatty acids, triacylglycerols, phospholipids and sphingolipids, Fluid Mosaic Model. Steroid hormones – androgens and estrogens, prostaglandins, thromboxanes and leukotrienes; lipids as constituents of biological membranes Amino acids - structure, properties (acid-base properties), classification; non-protein aminoacids, essential and non-essential amino acids; modified amino acids and function.

UNIT III: Nucleic acids: Structures of bases, nucleosides and nucleotides; phosphate diester bondformation, general structure of nucleic acids in brief. Hypochromicity, hyperchromicity, Tm, Chargaf's rule, importance of nucleotides.

UNIT- IV Protein structure: Primary, secondary, tertiary and quaternary structure Peptide bond – structure, stability and formation; steric interference ; Ramachandran plots and their importance; regular ways to fold the polypeptide chain; alpha helices and beta sheets; helixturn helix, helix loop helix and combination of them, fibrous proteins and globular proteins varieties of globular protein structure; Factors determining secondary and tertiary structure: information for protein folding, thermodynamics, disulfide bonds; prediction of secondary and tertiary protein structure; roles of chaperones and isomerases in protein folding; structures of collagen and DNA binding proteins (leucine zipper and zinc finger proteins); Quaternary structure of proteins - multisubunit proteins: homotropic and heterotropic protein-protein interactions.

UNIT-V: Enzymes: Classification and nomenclature; enzyme structure, monomeric, and multienzyme complex systems with examples; structural features such as substrate binding site, catalytic site, allosteric site; mechanism of enzyme activation, induced conformational changes. Cofactors and activators – characteristics, role of nicotinamide and flavin co-enzymes in redox reactions; concept of apozymes, prosthetic groups and holoenzyme.

Enyme kinetics: Rate of reaction, kinetic orders- first, second, third and zero and pseudo-order reactions; turn over, kcat; Derivation of Michaelis-Menton equation, Km value, Vmax, Lineweaver-Burk plot; effects of pH and temperature on reaction rates. Mechanism of enzyme catalysis- Activation energy, binding energy, transition states, acid-basecatalysis, covalent catalysis, metal catalysis; single substrate and multisubstrate reactions; Enzyme inhibition - reversible, competitive, noncompetitive, irreversible inhibition; Regulation of enzyme activity -

substrate-level control; feedback control; allosteric regulation – homoallostery; heteroallostery – examples; covalent modifications to regulate enzyme activity –role of proteases.

MBB 712 MOLECULAR BIOLOGY I 2 CREDIT UNITS

Unit I: DNA: Chemical composition of DNA: DNA structure-single stranded DNA, detailed account of double stranded DNA-BDNA, Z.DNA, and other structural forms, triple stranded DNA and quadruplex DNAs, curved DNA, rod shaped DNA, and their importance. Super coiled DNA: Changes from one form to the other, and the enzymes involved, concept of Linking numbers. Importance of super helical DNA and their structural forms. Types of Topoisomerases and their function in adding or removing super helical structures. Characteristic features of highly repetitive DNA; Tandemly repetitive DNA and Mini and microsatellite DNA and Insertional elements and their role and importance

Unit II: C value paradox- Genome size and content over members of different orders and of the same family; cDNA value paradox. Resolving the paradox by DNA-DNA and DNA-RNA hybridization kinetics. Kinetics of DNA-DNA hybridization, DNA-RNA hybridization, Cot curves, Rot curves, kinetic complexity, chemical complexity, Results of kinetics – determining the portion of genomic DNA which has highly repetitive DNA, moderately repetitive DNA and Non repetitive DNA. Rot curve analysis to find the number and the kind of gene expressed in general and tissue specific manner, the copy numbers of each species of mRNAs, by subtractive method, additive method and micro array method.

Unit III: DNA replication: Prokaryotic DNA replication; replication origin and site and structure and DNA Ter regions and structure. DNA polymerases, composition and features, replication factors and the mechanism of replication, leading strand and lagging strand synthesis, procesessivity and fidelity and regulation of replication. Replication of single stranded DNA, M13 viral DNA-use of them as cloning vectors. **Eukaryotic-replication** origins, replication initiation complexes and their assembly, licensing factors, DNA polymerases and their composition, telomerase and mode of action, replication factors, disassembly of chromatin components and reassembly during replication. Organelle genome and composition, replication origins, Enzymes and factors involved in the Replication of mitochondrial DNA and Chloroplast DNA and the mechanism involved.

Unit IV: DNA damage: types and there repair – Factors involved DNA damage: types and their repair mechanisms-mechanism of DNA repair and the regulation of it; direct repair-excision-repair transcriptional excision repair, glycosylase pathway, miss-match repair, UVr A, B & C mechanism, broken end repair, recombination repair and SOS repair system. **RNAs: types**

rRNAs; Structural features of rRNAs- prokaryotic and eukaryotic. tRNAs: structural features, their anticodon feature. mRNAs- prokaryotic and eukaryotic mRNAs, structural features, Genomics RNAs, Replication of Picorna and Rabies Viral RNA and mechanism; Structure of retroviruses, classification, Replication of HIV viral RNA; Sn-RNAs, Sno RNAs, RNAi

MBB 713 MICROBIAL BIOCHEMISTRY 3 CREDIT UNITS

Unit-I Viruses: Classification of viruses and the basis; Occurrence, structural organization of capsids (including geometrical pattern), DNA or RNA viruses, infection method, replication of the genomes, regulation of replication, assembly of the viral particles, M13 virus, T4 phages, Lambda phage (Lytic and lysogenic pathways), Orthomixovirus and Adenovirus, CaMV. **Bacteria:** Occurrence, structure of bacteria in general, classification- Ultra structure of E. coli, fagella, cilia, fimbriae, sex pili, Genome organization, cell division and its regulation. Recombination in Bacteria- E. coli as an example; sex determination, F+, HfR strains, conjugation mechanism, mapping and genetic recombination, transductions, sexduction.

Unit-II Bacterial plasmids: Features, plasmid with Sex factors, R-plasmids, pathogenic plasmids, ColE1 plasmids; transformation mechanism of bacteria; transposable elements IS type, Tn type, retrotranspons, structural features and their occurrence, mode of transposition, transposons mediated drug resistance, to locate genes using transposons and disrupt normal genes. **Cyanobacteria:** Occurrence, structural features; structural organization; mechanism of photosynthesis. Importance of Cyanobacteria. ***Agrobacterium***: Occurrence, structural features, Genome and its plasmid T-DNA and Ti and Ri plasmids, mechanism of infection and causing crown galls.

Unit-III: Fungi: General features, classification of fungi, detailed account of Yeast types, structure and reproduction, genetics of mating, cytoplasm inheritance, cell division mode, and the regulation of yeast cell cycle in brief. Microbial metabolism: Mechanism of bacterial photosynthesis, chemosynthesis, Light and dark reactions, - oxidative process. Bacterial carbohydrate metabolism, EMP pathway, Entner- Doudoroff pathway, Warburg Dickens pathway, pentose and hexose-ketolase pathways, electron transport chain, anaerobic pathways. Mechanism of Nitrogen fixation, regulation of Nod, Nif genes, hup genes. Mycotoxin Biosynthesis, genetic determinants and their expressions. Mycotoxins producing fungi, mechanisms of phytotoxicity, Significant of mycotoxins and mycotoxicosis, synergisms and /or association of mycotoxins.

Unit-IV: Microbial pathogenesis: Viral-pathogenesis (Influenza), Protozoan parasites (Plasmodium), mechanism of infection, effects on host cells, host response to infection; resistance to pathogenesis in plants, role of pathogen resistant genes R genes and the mechanism of resistance. Medically important bacteria: Mode of infection and pathogenesis of

Staphylococcus, Clostridium, Streptococcus, Enteropathogenic bacteria, Salmonella and Mycobacterium, Mycotoxins in Plant pathogenesis, pathways for aflatoxin, Biodegradation.

MBB 714 SEMINARS 2 CREDIT UNITS

Two seminars to be delivered following extensive literature review on two topics approved by the postgraduate committee of the department.

MBB 715 BIOINFORMATICS 1 3 CREDIT UNITS

Unit I : Introduction to Bioinformatics concepts, principles and applications: Biological databases, exploration, Data retrieval, homology searches and interpretation (BLAST algorithm and result interpretation: coverage, percentage similarity, e-value). Sequence alignments: types tools and practical applications,; DNA Sequences: Alignments and Analysis; Proteins: Alignment, Analysis and Structure; Sequence assembly methods for multiple sequence alignment; Multiple sequence alignment tools and applications (Use of Clustal Omega and Molecular Evolution and Genomic analysis (MEGA) software package for model and approach-based phylogeny construction, Overview of Primers and Primer Designing; Primer Designing; Primer specificity, Primer validation, n-Silico restriction digest in SMC and webcutter. In-Silico PCR in UCSC and virtual PCR

Unit II Exploration of DNA, and proteomic tools in Expasy: Pattern analysis in sequences Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Units III : Structure-related problems Representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; Structure classification (SCOP, CATH); Visualization software (Pymol, Rasmol etc.); Experimental determination of structures (X-ray crystallography, NMR); Structure databases; Secondary structure prediction; RNA structure prediction; Mfold; Protein structure prediction by comparative modelling approaches(homology modelling, threading); Ab initio structure prediction: force fields, backbone conformer generation by Monte Carlo approaches, side-chain packing; Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.); CASP; Protein-ligand docking; Computer-aided drug design (pharmacophore identification); QSAR; Protein-Protein interactions and Bioinformatic tools (e.g. STRING) ;

Unit IV::System-wide analyses: Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry; Protein arrays; Metabolomics: 13C NMR based metabolic flux analysis; Exploring and Analysing microbial and eukaryotic genomic dataset ; analysing and exploring metagenomics data; Bioinformatics for

transcriptomics; Bioinformatics for Systems Biology. Diversity studies: Case study in Fungi diversity

MBB 716 LABORATORY TECHNIQUES 2 CREDIT UNITS

Practicals:

Molecular Cell Physiology

1. Extraction of lipids-Plant and animal sources.
2. Qualitative estimation of lipids-using standard curve, emulsion test, solubility and saponification test, acid value test.
3. Determination of Iodine Number of different lipids.
4. Salicylic acid chromatography of Lipids
5. TLC of lipids and identification of different lipids.
6. Separation of Sugars by TLC.
7. Separation of amino acids by TLC.
8. Preparation of proteins by acetone extraction method and also ammonium sulfate fractionation method and running the gel.

Molecular Cell Biology

1. Preparation of Meiotic chromosomes using Haemotoxylin/Feulgen stain-*Poecilocera Picta* X- linked chromosomes-Bar Bodies
2. Isolation of Nuclei and determination of its purity
3. Isolation of mitochondria and plastids and Examination under microscope
4. Isolation of mitochondria and chloroplast DNA – run a gel to check the quality of DNA
5. Preparation of salivary gland chromosome-*Drosophila melanogaster*
6. Vital Staining-Animal and plant, Dye exclusion technique to determine cell viability.

Microbiology

1. Laboratory Safety including Chemical, Biological and Radiations. Principles and Practices of Sterilization.
2. Preparation and Sterilization of Media, Buffers, Solutions and Reagents.
3. Enumeration of microbes (bacteria and fungi) from water and soil.
4. Growth curve of *E. coli*
5. Isolation and culture of *Rhizobium* from soil and root nodules of leguminous plant.
6. Isolation and growth of cyanobacteria (Study of preserved specimens)
7. Preparation of competent cells by calcium chloride genetic transformation using PUC 18
8. Isolation of bacterial plasmid by Alkali lysis method.
9. Restriction of plasmid DNA and agarose gel electrophoresis.

Lab on Biochemistry and Analytical Techniques

1. To prepare an Acetic-NaAcetate Buffer system and validate the Henderson-Hasselbach equation.

2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.

3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC. 4. An enzyme purification theme (such as *E. coli* Alkaline phosphatase or any enzyme of the institutions choice).

(a) Preparation of cell-free lysates

(b) Ammonium Sulfate precipitation

(c) Ion-exchange Chromatography

(d) Gel Filtration

(e) Affinity Chromatography

(f) Generating a Purification Table

(g) Assessing purity by SDS-PAGE Gel Electrophoresis

(h) Enzyme Kinetic Parameters: Km, Vmax and Kcat.

5. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry

Lab on Microbiology

1. Sterilization, disinfection, safety in microbiological laboratory.

2. Preparation of media for growth of various microorganisms.

3. Identification and culturing of various microorganisms.

4.Staining and enumeration of microorganisms.

5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.

6. Assay of antibiotics production and demonstration of antibiotic resistance.

7. Growth curve of *E. coli*

5. Isolation and culture of *Rhizobium* from soil and root nodules of leguminous plant.

6. Isolation and growth of cyanobacteria (Study of preserved specimens)

7. Preparation of competent cells by calcium chloride genetic transformation using PUC 18

8. Isolation of bacterial plasmid by Alkali lysis method.

9. Restriction of plasmid DNA and agarose gel electrophoresis.

Lab on Immunology

1. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage.

2. Antibody titre by ELISA method.

3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.

4. Complement fixation test.

5. Isolation and purification of IgG from serum or IgY from chicken egg.

6. SDS-PAGE, Immunoblotting, Dot blot assays
7. Blood smear identification of leucocytes by Giemsa stain
8. Separation of leucocytes by dextran method
9. Flowcytometry, identification of T cells and their subsets
10. Immunodiagnostics using commercial kits

MBB 717 CELL PHYSIOLOGY 2 CREDIT UNITS

Unit-I Water and Osmoregulation: Chemical and physical properties of water, its colligative properties; hydrodynamic and thermodynamic properties of water, diffusion, fluidity; surface tension, cohesive property, tensile strength and tensile properties. Osmosis, concepts like osmotic pressure, osmotic potential and pressure potential. Chemical free energy of water, Kinetics of movement, Water Potential, Ficks law of diffusion, turgour pressure, hydraulic conductivity, Regulation of cellular pH. **Cytoplasmic fluidity:** Cytoskeletal elements- their chemistry and structural organization and their dynamics, fluidity, cytoplasmic streaming, cell movement, and the mechanism. Energy based cellular dynamics; role of molecular motorskinesins, dyneins; structure and role of myosin, microfilaments, microtubules-actins and their role in cytoplasmic flux.

Unit II: Membrane Structure and Function: Membrane composition, structure models and turnover; Membrane associated transport systems: transport of water –Structure and mechanism of transport by Aquaporins. Structure and function of different types of transporters, ion gates, passive and active transport, Bulk Transport. Facilitated –Passive and Active-uniport, ATP powered pumps-P-class, V-class, F-class pumps, and ABC family transporters, Muscle Ca-ATPase pumps, Calmodulin mediated Ca ATPase pumps, Na/K ATPase pumps, H^+ ATPase pumps, Ion coupled transport, voltage gated, ligand gated channels, antiport and symport mechanisms. **Concept of membrane electrical potential:** Resting potential, and action potential and propagation of the same in neuronal cells; neurotransmitters and receptor and transport; mechanism of signal transmission at synapses. Synaptosomes.

Unit III: Cell Receptors: Structure and function of cell surface receptor; Intracellular receptors and nuclear receptors; signal mediated signal transduction for different types of signaling molecules G-protein and PI3 mediated signal transduction. INF and cytokine. Insulin dependent pathway, TGFB induced Receptor serine/Threonine receptor kinase, NFkB pathway and Wnt-b Catenin pathways and downstream cascade of signal transductions. LDL receptor and Chloesterol metabolism. Protease activated receptors.

Signal Transduction: Cell to cell communication- autocrine, paracrine, endocrine systems; Synaptic; role of Gap junction in signal sharing, cell potential to receive signals and competence, kinds of signals, external and internal; Effect of concentration of signals; short-term and long-term signal induction and sustenance; chemistry of signaling molecules. **13 hrs**

Unit IV: Intracellular Membrane and Protein flow

Intracellular compartments and their characteristic features; membranes and proteins involved in transport-structures involved in trafficking of proteins. Protein sorting- secretory pathway; receptor mediated endocytosis and sorting of internalized proteins; structure and role of variety proteins involved in vesiculation, transport and targeting; clathrin and its associated proteins, adaptor proteins, CopI and Cop II and its associated proteins, receptor proteins, docking proteins, proteins involved in fusion of membrane to membranes, endocytosis, exocytosis and transcytosis

Fluid flow circulation in Plants and Humans: Include fluid flow and circulation in plants and animals-human; plants-Transpiration and Guttation, Absorption of water and mineral salts and flow, Ascent of sap, structures involved and mechanism. Fluid flow in human body structures involved and mechanism-heart, Veins and arteries, Blood Circulation and Excretion-structure and function involved.

MBB 718 INTELLECTUAL PROPERTY RIGHTS AND RESEARCH ETHICS **2 CREDIT UNITS**

UNIT 1: Intellectual property rights (IPR), sovereignty rights, CBD, bioethics and patenting General agreement on trade and tariffs Indian sui-generis system for animal variety and farmer's rights protection act, PVFRA, WTO with reference to biotechnological affairs, TRIPs. General Introduction: Patent claims, the legal decision – making process, ownership of tangible and intellectual property, Patent litigation. Basic Requirements of Patentability: Patentable subject matter, novelty and the public domain, non obviousness. Special issues in Biotechnology Patents: Disclosure requirements, Collaborative research, Competitive research. Plant biotechnology Indian patents and Foreign patents, Plant variety protection act. The strategy of protecting plants. Recent Developments in Patent System and Patentability of biotechnological inventions. IPR issues in Indian Context Role of patent in pharmaceutical industry, computer related innovations. Case studies Rice, Turmeric, Margo, etc. and challenges ahead.

UNIT II: Entrepreneurship Concept, definition, structure and theories of entrepreneurship Types of start-ups Types of entrepreneurship, environment, process of entrepreneurial development, Entrepreneurial culture, entrepreneurial leadership,

Product planning and development Project management Search for business idea Concept of projects Project identification, formulation Design and network analysis Project report and project appraisal

UNIT III: Ethical Issues: Introduction – causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains Professional ethics – professional conduct Ethical decision making, ethical dilemmas**;** Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, laboratory Modulation Bioethics & Society (Indian context): Ethical issues on New Genetics – Human Genome Project

– Gene therapy – Genetic screening – Experimentation with human subjects -National Practice of health care – Public & Private medical practice –National resource allocations.

UNIT IV: Biosafety in the laboratory institution: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad Biotechnology and food safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton). Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc. International dimensions in biosafety: Catagena protocol on biosafety, bioterrorism and convention on biological weapons

MFT 711 INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY **2 CREDIT UNITS**

Emergence of Nanotechnology- Definition of nanotechnology, nano-system, nanomaterials and properties-Size dependent properties - Mechanical, Physical and Chemical properties. **Nano Ethics and Environment**- Environment related case studies on nanomaterials; Screening of nanomaterials for understanding potential effects to human health and the environment.

Environmental Pollution by Nanoparticles- Health impact, safety and toxicological effects transport of nanomaterials in soil/sediments. Study of physical and chemical properties of nanomaterials influencing their behavior in the environment and in biological systems.

Application of Nanotechnology- Nanoporous polymers and their applications in water purification, nanotoxicology, use of nanoparticles for environmental remediation and water treatment. case studies and regulatory needs.

Nanotechnology in Food Production- Food and new ways of food production - efficient fractionation of crops - efficient product structuring -optimizing nutritional values - applications of nanotechnology in foods : sensing, packaging, encapsulation, nano-feed binder, engineering food ingredients to improve bioavailability - nanocrystalline food ingredients - nano- emulsions - nano-engineered protein fibrils as ingredient building blocks - preparation of food matrices - concerns about using nanotechnology in food production. crop improvement - reasons to package food products - physical properties of packaging materials - strength - barrier properties light absorption – structuring of interior surfaces - antimicrobial functionality - visual indicators – quality assessment - food safety indication - product properties - information and communication technology - sensors - radiofrequency identification technology - risks - consumer and societal acceptance.

Nanoparticles in Agricultural and Food Diagnostics- Enzyme Biosensors and Diagnostics - DNA-Based Biosensors and Diagnostics - Radiofrequency Identification- Integrated Nanosensor Networks: Detection and Response- Lateral Flow (Immuno) assay - Nucleic Acid Lateral Flow (Immuno) assay - Flow-Through (Immuno)assays - Antibody Microarrays -Surface Plasmon Resonance Spectroscopy.

Toxicology of Nanomaterials in Food- Characterization of Engineered Nanomaterials: Unique Issues for Characterization of Engineered Nanomaterials for Food Applications - Safety Assessment of Oral- Exposure Engineered Nanomaterials for Food Application - Experimental Design Considerations for Toxicology Studies - Toxicokinetics – ADME - Toxicodynamics - In Vivo Toxicity - In Vitro Toxicity - Study Reliability.

SECOND SEMESTER

MBB 721 BIOCHEMISTRY –II 2 CREDIT UNITS

Unit I: Bioenergetics: Concepts of internal energy, enthalpy, entropy, interplay of enthalpy and entropy, free energy and work, free energy change and the equilibrium constant, chemical potential, coupled reactions, laws of thermodynamics in relation to biological systems, Gibbs free energy. **Biological oxidation and electron transport:** Oxidations and energy generation; standard reduction (redox) potential; free energy changes from oxidation/reduction; mitochondrial structure and function Electron transport system – topology, chemical nature and sequence of electron carriers; inhibitors and artificial electron acceptors; shuttling electron carriers into the mitochondrion; oxidative phosphorylation; P/O ratio; mechanism of oxidative phosphorylation – chemiosmotic coupling; structural insights into oxidative phosphorylation - the F0F1 complex; integrity of mitochondrial membranes; uncoupling ETS and oxidative phosphorylation; energy yields from oxidative phosphorylation; respiratory control of oxidative phosphorylation, mechanism and photophosphorylation. Oxygen as substrate for other metabolic reactions - oxidases and oxygenases, cytochrome p450, reactive oxygen.

Unit II: Carbohydrate metabolism – I: c*atabolic processes* Glycolysis – pathway and regulation; metabolic fates of pyruvate – anaerobic and aerobic; TCA cycle – pathway and regulation; alternate pathways – glucuronate, glyoxalate and pentose phosphate pathways; Catabolism of other monosaccharides and disaccharides Catabolism of polysaccharides – glycogen mobilization and regulation of breakdown; starch and glycogen digestion, metabolic disorders. **Carbohydrate metabolism – II: Anabolic processes** Gluconeogenesis – pathway and regulation; glycogen biosynthesis – pathway and regulation; biosynthesis of other polysaccharides.

UNIT III: Photosynthesis: Basic processes of photosynthesis; structure and organization of photosynthetic apparatus; absorption of light – the light harvesting system - the energy of light; light absorbing pigments; light gathering structures; photochemistry in plants and algae - photosystems II and I; cyclic electron flow; bacterial photosynthesis; Calvin cycle; overall reaction and efficiency of photosynthesis; regulation of photosynthesis; RUBISCo structure and function photorespiration; C4cycle and CAM pathway. **Lipid metabolism:** Mobilization of stored fat - oxidation of saturated, unsaturated and odd numbered fatty acids, regulation, peroxisomal-oxidation of fatty acids Fatty acid biosynthesis - relationship of fatty acid synthesis to carbohydrate metabolism; elongation of fatty acid chains; fatty acid desaturation; control of

fatty acid biosynthesis; biosynthesis of triacyl glycerol and phosphatidlyl choline. Biosynthesis of cholesterol and its regulation metabolism of eicosanoids-prostaglandins, thromboxanes and leukotrienes Metabolic disorders.

UNIT IV: Nitrogen metabolism: The nitrogen cycle; protein turnover; amino acid degradation; urea cycle; ammonia transport in the body **Amino acid metabolism** : citric acid cycle intermediates in amino acid metabolism - glutamate as a precursor to other amino acids, metabolism of ornithine and arginine; metabolism of sulfur-containing amino acids – metabolism of glutathione, S-adenosylmethionine and biological methylations, polyamines; metabolism of aromatic amino acids in plants and animals and histidine – biosynthesis of aromatic rings, biosynthesis of histidine,; biosynthesis and metabolism of serine, glycine and threonine; metabolism of valine, leucine, isoleucine and lysine, metabolic disorders

Nucleic acid metabolism-I : Nucleotide metabolism - biosynthetic routes: *de novo* and salvage pathways; nucleic acid degradation and the importance of nucleotide salvage; *de novo* biosynthesis of purine nucleotides; Purine degradation and clinical disorders of purine metabolism;

Nucleic Acid Metabolism-II: pyrimidine nucleotide metabolism - de novo biosynthesis of the pyrimidine ring, control of pyrimidine biosynthesis, pyrimidine catabolism; Deoxyribonucleotide biosynthesis and metabolism; thymidylate synthase: a target enzyme for chemotherapy.

MFT 721: RESEARCH METHODS, BIOSTATISTICS AND ETHICS 2 CREDIT UNITS

An in-depth study in preparation for Seminar/Abstract, Conference presentation, Visual aids, writing papers for publication, thesis preparation, writing research proposals, Bibliographic citations, use of citation/referencing tools such as One Note, analysis and processing of raw quantitative data, literature search etc.

MBB 722 MOLECULAR BIOLOGY- II 2 CREDIT UNITS

Unit I: Post transcriptional Processing of RNA: Processing of rRNA: Precursor rRNAs of prokaryotic and eukaryotic types. Structural and functional features of U3 RNA-RNPs, sno-RNAs and sno-RNPs, sca RNAs and their role in modification and splicing of rRNAs and some Sn RNAs. Brief structural and functional features of Cajal bodies. **Processing of pre-tRNAs:** size of pre-tRNAs, number, size and position of tRNA introns; types of splicing and the mechanism of splicing. Enzymes involved in rRNA and tRNA processing-RNase P, RNase E (exosomes), RNase D, RNase III, kinases, diesterases, Polynucleotide phosphorylases. **Pre-mRNA processing:** Characteristic features of pre heterogenous nuclear RNAs (hnRNAs), structure and sizes of hn RNAs; hnRNP proteins, mRNP proteins; structural features of introns and exons; Processing of pre mRNAs **Capping and polyadenylation:** Time of capping, mechanism of capping. Factors, site, enzymes and the mechanism involved in Poly (A) addition,

importance of poly (A) tail; poly (A) binding proteins, polyA-polymerases and their role. Importance of polyA-signals, cytoplasmic poly-A additional signals (CPE), CPEB and Maskins, RNA transport sequences and their importance. Splicing: Concept of splicing, types of splicing, types of proteins involved. **Cis Splicing:** Characteristic features of introns splice junction site and intron's in and signal sites; Types of splicing. snRNAs and sn RNPs involved, their structural and functional features; Mechanism of splicing event, role of specific snRNA and snRNPs; role of SR proteins and Exon enhanceosomes (ESE), spliceosomal assembly and mechanism of splicing. Processing of Histone mRNA and the role of sn-U7 RNA and its RNPs.

Unit II: Alternative splicing: Concept of alternative splicing and its implications. Alternate splicing examples from Fibronectins, Collagens, Tropomyosins, Example from Dscam from *Drosophila*. Alternative splicing in sex determination of *Drosophila*. **Trans splicing**: Trans-splicing in *C.elegans*, Trypanosome, worms; splicing components- SLRNA and other snRNA-RNPs involved in transplicing. **Pre-mRNA Editing:** Editing Apo-lipoprotein mRNA and Glutamine receptor mRNA, features and mechanism. Special features of few mitochondrial faulty pre-mRNAs (called pre-edited mRNAs) in Trypanosomes and Leishmania; editosomes, and characters and their composition, genes for Guide RNA and the mechanism of editing. **Self-splicing introns:** Group-I introns, Group-II introns, Group III introns, Twin introns: their characters and functions, mechanism of self-splicing. **Informosomes:** Stored mRNAs in mature egg cells, normal cells and seeds, role of mRNPs, importance of poly (A) size, polyadenylation signal elements CPE), role of CPEB and Masking proteins, reactivation of mRNAs by Poly (A) addition and its regulation, role of RNA transportsignal elements; role and importance of 3' and 5' UTR sequence elements. **mRNA stability and turn over:** Sequence elements found in 5' leader sequences and 3' non-coding regions and their structural features, relationship between such sequences and sequence derived structures and stability; mechanism of protection and the mechanism of degradation and causes; eg. Casein mRNA, Transferrin mRNA, Ferretin mRNA.

Unit III: Genetic code: Genetic and biochemical basis of Genetic code, Salient features, Deviation from Universal codon dictionary in mitochondrial genomes, evolution of Genetic code. **Prokaryotic Translation:** Translation apparatus; ribosomal subunits, initiator-tRNAs, aminoacyl-tRNAs, initiating factors, elongation factors, termination factors; mechanism of chain initiation, elongation and termination; production of specific proteins on translation of apolycistronic mRNA. Post translational processing of polycistronic polypeptides, and targeting the protein to periplasmic space or to the membrane. Regulation of protein synthesis, autogenous regulation, stringent response type regulation. Polyribosomes: rate of synthesis and regulation of protein synthesis. **Eukaryotic translation Translational apparatus**- ribosomes, initiator-tRNAs, aa-tRNAs, initiation factors, elongation factors and termination factors; mechanism of translation; **Regulation of protein synthesis**: Regulation of translation at mRNA level, regulation at chain initiation factor level, ex. Heme regulated translated, regulation of Ferretin synthesis, and Transferrin receptor synthesis and interferon mediated regulation. Site of protein

synthesis, membrane free site, localized synthesis- example Actin protein synthesis, mode of transportation of mRNA to specific position in the cell.

Unit IV: Post translational processing: Cotranslational processing- transferring the translating system onto ER and transferring protein into the lumen of ER, role of SRP particles, docking proteins, Translocator proteins and signal sequences in targeting the protein (mitochondria, chloroplasts, peroxisome and glyoxysomes) and also in orienting N and C- terminal ends of proteins. Mechanism of transfer of proteins into ER lumen. Folding and modification of proteins while they are transported from SER to cis Golgi and trans-Golgi and protein sorting and vesciculation carrying the cargo. **Processing of Pre-pro-proteins:** Regulated cleavage of polyproteins and pre-pro proteins in stage specific and tissue specific manner. Splicing of proteins: Brief account of structural domains of proteins to be processed with Intiens and Exiens, splicing of intiens and joining ofexiens. **Protein stability and turnover:** Sequence based structural form, half-life of proteins, unstable proteins, protein degradation, and ubiquitination of condemned proteins and degradation by Proteosome; structure and features of Proteosome and the mechanism of degradation.

MBB 723 IMMUNOLOGY 2 CREDIT UNITS

Unit I: Types of immunity: Innate immunity, anatomic barriers, physiological barriers, native microbial flora. Inflammation, fever, interferon's, complement system; Acquired immunity- Active, passive and adaptive immunity. **Organs of immune system:** Primary lymphoid organs: Bone marrow, thymus; Secondary lymphoid organs: Spleen, lymph node, mucosal associated lymphoid tissues. **Cells of immune system:** Hematopoeisis, surface molecules, structure and function of stem cells, NK cells, dendritic cells, macrophages, T and B lymphocytes.

Unit II: Antigens and Antibodies: Antigens characteristics epitopes types. Valency, haptens, Activation and maturation of B lymphocytes, lymphocyte cell surface receptors/proteins; Immunoglobulin genes organization and expression, somatic gene recombination Ig diversity, factors affecting Ig diversity, types of Abs, class switching. antibody production and maturation; Structure and function of different Ig's; Activation of T lymphocytes- response, action and maturation of T lymphocytes and their surface protein and genes. Structure and types of Tlymphocytes and their function. T-cell and B-cell receptors. TI and To antigens.

Unit III: Antigen recognition: MHC molecules (Class I and ClassII), Humoral and cell mediated immune response. Grazymeperforins, clonal selection and immunological memory, recognition of endogenous antigens, recognition of exogenous antigens; T and B cell interaction. **Vaccines**-Principles of vaccination, primary and secondary responses, whole organism vaccines,

purify macromolecule as vaccines, multisubunit vaccines, DNA vaccines, edible vaccines, Monoclonal antibodies and its applications. Transplantation and rejection.

Unit IV: Disorders of immune system: Immunological tolerance, autoimmunity and autoimmune diseases. Deficiency of immune system-(congenital and acquired). Tumour Immunology. Immunological hypersensitivity: Gell and Coomb's classification, salient features of Type I, II, III and IV hypersensitive reactions. RIA, ELISA, agglutination. Immuno electrophoresis, precipitation test.

References:

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2. Abul Abbas, Saunders, (2006), Basic Immunology, Updated Edition 2006-2007 (Paperback) by Publishers; 2nd edition 336 pages
3. Ashi K Chakravarty, (2006), Immunology and Immunotechnology, Ist edition, Oxford Press.
4. Charles Janeway, Jr. and Paul Travers, (2004), Immunobiology - the immune system in health and disease, by. Garland Science; 6 edition, 800 pages
5. Gupta P K, (2004) Cell and Molecular Biology, Rastogi Publications, Meerut
6. Ivan Roitt, Jonathan Brostoff, and David Male. Mosby, (2006), Immunology, London. 7th
7. Lodish et al., (2001) Molecular Biology, W.H. Freeman G Co. 47
8. Thomas Kindt, Barbara Osborne and Richard Goldsby, (2006), Kuby Immunology. W. H. Freeman & Co., Sixth edition, 2006
9. William E Paul, Lippincott Williams & Wilkins;(2003) Fundamental Immunology (Hardcover) by 5th Bk&Cdr edition ,1502 pages

MBB 724 BIOTECHNOLOGY 2 CREDIT UNITS

Unit I: Basics Concepts: DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non- radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions- Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II Cloning Vectors : Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; EMBL; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies;

Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors,
Shuttle vectors

Unit III Cloning Methodologies: Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Farwestern cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV PCR and Its Applications: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Unit V Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Unit VI: Plant Biotechnology: Introduction: History, aim and scope of Plant Biotechnology, Biotechnology Scenario in India. Meristem culture, virus free plants. Large scale micropropogation, hardening and its application. Anther culture for haploid plant production, Doubled haploids, application of haploids in plant breeding and crop improvement. Somaclonal variations and their use in crop improvement.
Liquid culture: Suspension cultures, Batch cultures, continuous cultures. Bioreactors, immobilized bioreactors; Improving and enhancing yield of secondary plant products using bioreactors, Hairy root cultures for production of secondary metabolites.

Unit VII: Transgenic Plants: Vectors for plant transformation - Binary vectors and integration vectors; their characteristic features in detail. Construction of expression vectors, Use of selectable markers. Marker free technology for production of transgenics. Methods for gene

transfer: Gene gun and *Agrobacterium* methods. Details of *Agrobacterium*, Ti and T-DNA, mechanism of DNA transfer and integration Transgenic tissue regeneration and screening-of transgenics for gene integration using PCR and western or dot blotting techniques. Organelle Engineering: Targeting of genetically engineered DNA clones into chloroplasts of higher plants. **Disease Resistance:** Disease resistance to fungi by engineering chitinase (β-1, 3-glucanase gene) and osmotin. Disease resistance to bacteria by Lysozyme gene. Resistance to pests- Bt-toxin gene, protease inhibitor genes. Generation of herbicide tolerant plants, Development of transgenics to virus resistance, using of antisense and RNA interference technologies. Transgenic plants: Plantibodies, vaccines, Biopolymers and vitamins. Transgenics for delayed fruit ripening and increased shelf life-Tomato. Increase in the shelf life of cut flowers - (Carnation flowers).

Unit VII: Improvement of food crops: Increase in essential amino acids in cereal seed proteins (phaseolin protein and albumin gene (for increase in methionine content). Increase in lysine by using *E. coli* dihydropicolinate synthase (DHPS gene). Increase and change in the quality oils in Brassica species (increase in medium chain fatty acids and converting unsaturated fatty acid to saturated fatty acids). Increase in sweetness and flavor in fruits and vegetables (tomato). Increase in starch content (potato).

Unit VIII: Animal Biotechnology: Methods and protocols used for tissue and cell cultures. Maintenance of cell cultures. Animal tissue culture: skin cultures, Neuronal cell cultures, muscle cell cultures, cartilage culture, blastocysts cell culture, whole embryo culture and tissue engineering, Large scale production: Large scale animal cell culture for commercial production of the IGs, interferons, vaccines, Mabs, hybridoma cells and other downstream process and problems. Methods to induce stem cells to differentiate into specific tissues. **Animal cell Transformation and immortalization:** Methods employed for animal cell transformation, viral and oncogene methods. Characteristic features of transformed cells. **Transgenic animals:** Protocols used for developing transgenic animals; use of fertilized egg cells, use of bastocyst cells; success and failures, problems. Transgenic sheep, transgenic goat, transgenic fishes, transgenic cattle, transgenic mice, transgenic pigs for the production of recombinant proteins. Animal cloning: Techniques used in animal cloning- transfer of whole 2n nuclei to enucleated Cells (ex. Xenopus), cultured cell application and ethics.

MBB 725 BIOINFORMATICS II Credit Unit 3

Unit 1: Gene Expression and Functional Genomics using Array Express; Gene Expression data search and quick retrieval; gene Expression across species with Expression Atlas; Genomic features that regulate gene expression with Ensemble

Unit II: Chemical Data mining techniques and applications: Exploring bioactive drug-like molecules; Computational chemistry in drug discovery; Drug repurposing; mapping tool for

small molecule database and BioModels; Biosamples Databases: Data Identity and mapping, Data Cuation and annotation, Molecular modeling, Systems Biology

Unit III: Studying interaction of ligand-protein, protein-protein, protein-DNA using molecular simulation, Development of chemical library and screening of promising compounds using computer assisted drug design (CADD) techniques,

Unit IV: Gene Ontology, Gene Ontology Annotation, Phenotype Ontology, Ontology Lookup Service (OLS); Exploring data for toxigenomics studies using diXa data warehouse

MBB 726 NANO DRUG MODELLING Credit Unit 2

Unit I & II: Simulation of nanocomposite and analysis using molecular dynamic (MD) simulation, Encapsulation of nanoparticle and interaction studies using molecular simulation.

MBB 727 NANOPHARMACEUTICALS Credit Unit 2

Unit I : Introduction -Nanobiotechnology for Drug Discovery: Gold Nanoparticles for Drug Discovery -Use of Quantum Dots for Drug Discovery -Nanolasers for Drug Discovery -Cells Targeting by Nanoparticles with Attached Small Molecules -Role of AFM for Study of Biomolecular Interactions for Drug Discovery Nanoscale Devices for Drug Discovery - Nanotechnology Enables Drug Design at Cellular Level Nanobiotechnology-Based Drug Development - Dendrimers as Drugs- Fullerenes as Drug Candidates

Unit II: Nanobodies: Nanobiotechnology in Drug Delivery –Nanoscale Delivery of Therapeutics -Nanosuspension Formulations Viruses as Nanomaterials for Drug Delivery -Nanoparticle-Based Drug Delivery -Trojan Nanoparticles -Self-Assembling Nanoparticles for Intracellular Drug Delivery -Nanoparticle Combinations for Drug Delivery Liposomes -Liposome–Nanoparticle Hybrids-Nanospheres-Nanotubes -Nanocochleates.-Nanomolecular Valves for Controlled Drug Release -Nanomotors for Drug Delivery.Nanoparticle drug system for oral administration – Drug system for nasal administration – Drug system for ocular administration – Nanotechnology in diagnostic application. Preformulation

MFT 730 INTERNSHIP/INDUSTRIAL WORK EXPERIENCE 2 CREDIT UNITS

This is the period of the Student's Industrial Work Experience Scheme (SIWES) programme which is normally undertaken for four months during the second year of study. The SIWES programme is basically devoted to practical training in the industries that are relevant to the programme. Students are expected to put into practical use the knowledge they have learned in the classroom and laboratories

MBB 730 THESIS 6 CREDIT UNITS

Independent research in selected areas of Biochemistry and Molecular Biology under the guidance of academic supervisor(s). Students will be required to carry out literature survey on the topic, perform experiments and produce dissertations. The submitted project report shall be defended before a panel of internal external examiners.

SESSIONAL PROGRESS REPORTS FOR PhD MOLECULAR BIOLOGY AND BIOINFORMATICS (NOT TO SCORED)

COURSE CODE	COURSE TITLE	
MBB 801	Seminar I	**Core**
MBB 802	Seminar II	**Core**
MBB 803	Seminar III	**Core**
MBB 800	Research project	**Core**

MTECH TOXICOLOGY (COURSE OUTLINE)

FIRST SEMESTER

S/NO	Course Code	Course Title	Credit Unit	Course Status
1	TOX 711	Principles of Toxicology	2	Core
2	TOX 712	Advanced Toxicology	3	Core
3	TOX 713	Toxic Actions	2	Core
4	TOX 714	Organ Toxicity	3	Core
5	TOX 715	Analytical Toxicology	2	Core
6	TOX 716	Seminar	1	Core
7	TOX 717	Prevention of Toxicity	1	Core
8	MFT 711	Introduction to Nanoscience and Nanotechnology	2	Core
		Sub-total	**16**	
9	MBB 715	Bioinformatics I	3	Elective
10	BFS 713	Chemical Food Safety	2	Elective

SECOND SEMESTER

S/NO	Course Code	Course Title	Credit Unit	Course Status
1	TOX 721	System Toxicity	2	Core
2	TOX 722	Toxicological Risk Assessment and risk characterization	2	Core
3	TOX 723	Food Toxicology	2	Core
4	TOX 724	Environmental Toxicology	2	Core
5	TOX 725	Forensic and Clinical Toxicology	2	Core
6	TOX 726	Toxicological Methods	2	Core
7	MFT 721	Research Methods, Biostatistics and Ethics	3	Core
		Sub-total	**15**	
8	TOX 727	Plant and Animal Biotechnology	3	Elective
9	BFS 722	Veterinary Chemical and Drug Residues	2	Elective

THIRD SEMESTER

S/NO	Course Code	Course Title	Credit Unit	Course Status
1	MFT 730	Internship	2	Core
2	TOX 730	Research Project	6	Core

NOTE:

A minimum of forty three (43) credit units must be taken by students in the three semesters.

*Internship program for a minimum of three months will be in an accredited industry or research institute approved by the Department/Centre.

COURSE CONTENTS

TOX 711 PRINCIPLES OF TOXICOLOGY 2 CREDITS

Introduction to Toxicology

Definition and scope, relationship to other sciences and a brief, history of Toxicology. Dose–response relationships, sources of toxic compounds and movement of toxicants in the environment.

Introduction to Biochemical and Molecular Methods in Toxicology

Cell culture techniques, including suspension of cell culture, monolayer cell culture, indicators of toxicity in cultured cells, use of stem cells and cell culture models as "alternative" toxicity tests. **Molecular Techniques on** molecular cloning, DNA and Genomic Libraries, Northern and Southern Blot analysis, PCR and evaluation of Gene expression, regulation, and function. **Immunochemical Techniques** including proteomics, metabolomics and bioinformatics.

Exposure Classes, Toxicants in Air, Water, Soil, Domestic and Occupational Location.

Air pollutants; types, sources and examples of air pollutants. Types and examples of water and soil pollutants. Routes of exposure and regulation of occupational pollutants and examples of industrial toxicants.

Classes of Toxicants

History of common toxic metals, mechanisms and sites of action with reference to lead, mercury, cadmium, chromium, and arsenic. Treatment of metal poisoning**.**

Introduction to agricultural chemicals (pesticides). Definitions and terms, organochlorine insecticides, organophosphorus (OP),, insecticides (carbamate insecticides, botanical insecticides, pyrethroid insecticides. New classes of insecticide: herbicides, fungicides, rodenticides, and fumigants. Food additives and contaminants. Toxins of microbial origin, mycotoxins, algal toxins, plant and animal toxins and chemical toxins. Therapeutic and drugs of abuse. Combustion products and cosmetics

TOX 712 ADVANCED TOXICOLOGY 3 CREDITS

Metabolism of Toxicants

Phase 1 Reactions, The endoplasmic reticulum, microsomes, and monooxygenations. The CYP-dependent monooxygenase system. The FMO, nonmicrosomal oxidations, co-oxidation by cyclooxygenase (COX), reduction reactions, hydrolysis, epoxide hydration and DDT dehydrochlorinase. **Phase II Reactions**: Glucuronide conjugation, glucoside conjugation, Sulfate conjugation, methyltransferases, GSTs and mercapturic acid formation, cysteine conjugate β-lyase, acylation and phosphate conjugation.

Absorption and Distribution of Toxicant

Structure of cell membranes, mechanisms of transport of toxicants across membranes: passive diffusion, carrier-mediated membrane transport, physicochemical properties relevant to diffusion

namely ionization and partition coefficients. Routes of absorption; extent of absorption, gastrointestinal absorption, dermal absorption, respiratory penetration, toxicant distribution, physicochemical properties and protein binding toxicokinetics.

Reactive Metabolites

Activation of enzymes. Nature and stability of reactive metabolites, fate of reactive metabolites, binding to cellular macromolecules and lipid peroxidation. Trapping and removal role of glutathione. Trapping and removal role of epoxide hydration, factors affecting toxicity of reactive metabolites (Levels of activating enzymes, levels of conjugating enzymes and levels of cofactors or conjugating chemicals). Reactive oxygen species in activation reactions (piperonyl butoxide, chlorpyrifos, vinyl chloride, methanol, aflatoxin B1, carbon tetrachloride (tetrachloromethane), acetylaminofluorene, benzo(a)pyrene, acetaminophen and cycasin

Chemical and Physiological Factors Affecting Xenobiotic Metabolism

Nutritional effects (protein, carbohydrates, lipids, micronutrients, starvation, dehydration and nutritional requirements in xenobiotic metabolism. Physiological effects (development, gender differences, hormones, pregnancy, disease and diurnal rhythms. Comparative and genetic effects (variations among taxonomic groups, selectivity and genetic differences). Chemical effects and inhibition. Induction and biphasic Effects. Inhibition and induction. Environmental effects (temperature, ionizing radiation, light, moisture, altitude and other stress factors).

Elimination of Toxicants

Introduction on factors involved in elimination of toxicants; size, surface area to body mass ratio, compartmentalization, lipid content and barriers to the environment. Transport and renal elimination (size, water solubility, hepatic elimination, entero-hepatic circulation and active transporters of the bile canaliculus. Respiratory elimination.

TOX 713 TOXIC ACTIONS 2 CREDITS

Acute and chronic Toxicity

Introduction to acute exposure and effect, dose–response relationships and nonconventional dose–response relationships. Alternative methods including Up-Down method, fixed-dose method, and *In vitro* methods. Mechanisms of acute toxicity involving necrosis, acetylcholinesterase inhibition, ion channel modulators and inhibitors of cellular respiration.

Chemical Carcinogenesis and Mutagenesis

DNA damage and mutagenesis. General aspects of cancer. Human cancer; causes, incidence, and mortality rates. Known human carcinogens, classification of human carcinogens, usefulness and limitations of mutagenicity assays for the identification of carcinogens. Classes of agents that are associated with carcinogenesis; DNA damaging and epigenetic agents. General aspects of

chemical carcinogenesis; initiation-promotion model and metabolic activation of chemical carcinogens and DNA adduct formation. Oncogenes; Ras Oncogene, tumor suppressor genes.

Teratogenesis

Overview of embryonic development; fertilization, cleavage stages, determination, gastrulation, differentiation, organogenesis and fetal period. Principles of teratogenesis; Wilson's principles and critical period, mechanisms of teratogenesis; genetic factors and teratogens.

TOX 714 ORGAN TOXICITY 3 CREDITS

Hepatotoxicity

Liver structure, function and susceptibility of the liver. Types of liver injury (fatty liver, Cholestasis, Fibrosis and Cirrhosis, Necrosis, Apoptosis, Hepatitis, Carcinogenesis. Mechanisms hepatotoxicity; examples of hepatotoxicants, carbon tetrachloride, ethanol, bromobenzene, acetaminophen and troglitazone. Metabolic activation of hepatotoxicants.

Nephrotoxicity

Structural oganization of the kidney, function of the renal system and factors contributing to nephrotoxicity. Examples of nephrotoxicants will include metals, antimicrobial agents, agents that precipitate in renal tubules, halogenated hydrocarbon and analgesics.

Endocrine Toxicology

Introduction to endocrine system: Nuclear receptors and membrane-bound steroid hormone eeceptors. Endocrine disruption: hormone receptor agonists, hormone receptor antagonists and organizational versus activational effects of endocrine toxicants, inhibitors of hormone synthesis, inducers of hormone clearance and hormone displacement from binding proteins. Incidents of endocrine toxicity including organizational toxicity, Activational toxicity and hypothyroidism.

Respiratory Toxicology

The anatomy and function of the respiratory tract, upper and lower respiratory tracts as sites of toxicity. Airways of the lower respiratory tract, parenchyma of the lower respiratory tract, circulatory, lymphatic, and nervous system of the lung. Toxicant-induced lung injury, remodeling, repair and oxidative stress and lung injury, antioxidant mechanisms in the lungs. Respiratory tract injury from inhaled particles and fibers, particle and fiber deposition. Clearance and respiratory tract injury from gases and vapors. Occupational and environmental lung diseases: Pulmonary fibrosis, asthma, hypersensitivity, pneumonitis (HP), COPD 383 and lung cancer.

TOX 715 ANALYTICAL TOXICOLOGY 2 CREDITS

Measurement of Toxicants**:** biological techniques; bioassay procedures using vertebrates, invertebrates, algae and animal toxicity test, and cell cultures. Physical and chemical methods: Chromatography (paper, thin layer, adsorption chromatographic techniques, gas chromatography, High Performance Liquid Chromatography). Spectroscopic techniques (UV/Visible Spectrophotometry, IF Spectrophotometry, Atomic Absorption Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Mass Spectroscopy) and Binding Assay.

Toxicity Testing: Experimental administration of toxicants, routes of administration, chemical and physical properties, exposure and environmental fate. *In vivo* tests; acute toxicity, sub chronic tests, chronic tests, special Tests. *In vitro* and other short-term tests, prokaryote mutagenicity, eukaryote mutagenicity, DNA damage and repair, chromosome aberrations, mammalian cell transformation and general considerations and testing sequences. Ecological effects. Laboratory tests, simulated field tests. Risk analysis and the future of toxicity testing.

TOX 716 SEMINAR 1 CREDIT

New approaches in Toxicology: perspectives on informatics in toxicology**,** molecular and biochemical toxicology and development of selective toxicants and other emerging trends in toxicology of the various food contaminants.

TOX 717 PREVENTION OF TOXICITY 1 CREDIT

Overview of preventive methods. Legislation and regulation by Federal Government, State Governments, Legislation and regulation in other countries and international organizations. Prevention in different environments; home, workplace, pollution of air, water, and land.

MFT 711 INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY 2 CREDITS

Emergence of Nanotechnology- Definition of nanotechnology, nano-system, nanomaterials and properties-Size dependent properties - Mechanical, Physical and Chemical properties. **Nano Ethics and Environment**- Environment related case studies on nanomaterials; Screening of nanomaterials for understanding potential effects to human health and the environment.

Environmental Pollution by Nanoparticles- Health impact, safety and toxicological effects transport of nanomaterials in soil/sediments. Study of physical and chemical properties of nanomaterials influencing their behavior in the environment and in biological systems.

Application of Nanotechnology- Nanoporous polymers and their applications in water purification, nanotoxicology, use of nanoparticles for environmental remediation and water treatment. case studies and regulatory needs.

Nanotechnology in Food Production- Food and new ways of food production - efficient fractionation of crops - efficient product structuring -optimizing nutritional values - applications of nanotechnology in foods : sensing, packaging, encapsulation, nano-feed binder, engineering food ingredients to improve bioavailability - nanocrystalline food ingredients - nano- emulsions - nano-engineered protein fibrils as ingredient building blocks - preparation of food matrices - concerns about using nanotechnology in food production. crop improvement - reasons to package food products - physical properties of packaging materials - strength - barrier properties light absorption – structuring of interior surfaces - antimicrobial functionality - visual indicators – quality assessment - food safety indication - product properties - information and communication technology - sensors - radiofrequency identification technology - risks - consumer and societal acceptance.

Nanoparticles in Agricultural and Food Diagnostics- Enzyme Biosensors and Diagnostics - DNA-Based Biosensors and Diagnostics - Radiofrequency Identification- Integrated Nanosensor Networks: Detection and Response- Lateral Flow (Immuno) assay - Nucleic Acid Lateral Flow (Immuno) assay - Flow-Through (Immuno)assays - Antibody Microarrays -Surface Plasmon Resonance Spectroscopy.

Toxicology of Nanomaterials in Food- Characterization of Engineered Nanomaterials: Unique Issues for Characterization of Engineered Nanomaterials for Food Applications - Safety Assessment of Oral- Exposure Engineered Nanomaterials for Food Application - Experimental Design Considerations for Toxicology Studies - Toxicokinetics – ADME - Toxicodynamics - In Vivo Toxicity - In Vitro Toxicity - Study Reliability.

MBB 715 BIOINFORMATICS 1 3 CREDITS

Unit I : Introduction to Bioinformatics concepts, principles and applications: Biological databases, exploration, Data retrieval, homology searches and interpretation (BLAST algorithm and result interpretation: coverage, percentage similarity, e-value). Sequence alignments: types tools and practical applications,; DNA Sequences: Alignments and Analysis; Proteins: Alignment, Analysis and Structure; Sequence assembly methods for multiple sequence alignment; Multiple sequence alignment tools and applications (Use of Clustal Omega and Molecular Evolution and Genomic analysis (MEGA) software package for model and approach-based phylogeny constructrion, Overview of Primers and Primer Designing; Primer Designing; Primer specificity, Primer validation, n-Silico restriction digest in SMC and webcutter. In-Silico PCR in UCSC and virtual PCR

Unit II Exploration of DNA, and proteomic tools in Expasy: Pattern analysis in sequences Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Units III : Structure-related problems representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; structure classification (SCOP, CATH);

Visualization software (Pymol, Rasmol etc.); Experimental determination of structures (X-ray crystallography, NMR); Structure databases; secondary structure prediction; RNA structure prediction; Mfold; Protein structure prediction by comparative modelling approaches(homology modelling, threading); Ab initio structure prediction: force fields, backbone conformer generation by Monte Carlo approaches, side-chain packing; Energy minimization; Molecular dynamics; Rosetta; structure comparison (DALI, VAST etc.); CASP; Protein-ligand docking; Computer-aided drug design (pharmacophore identification); QSAR; Protein-Protein interactions and Bioinformatic tools (e.g. STRING) ;

Unit IV::System-wide analyses: Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry; Protein arrays; Metabolomics: 13C NMR based metabolic flux analysis; Exploring and Analysing microbial and eukaryotic genomic dataset ; analysing and exploring metagenomics data; Bioinformatics for transcriptomics; Bioinformatics for Systems Biology. Diversity studies: Case study in Fungi diversity

BFS 713 CHEMICAL FOOD SAFETY 2 CREDITS

Absorption, transport, metabolism and excretion; Toxico-kinetics and dynamics; irritation and sensibilisation. *In vivo* toxicological investigations; genotoxicity, carcino- and teratogenicity; plant and algal toxins; packing materials and migration. Food- a matter of life and death.

TOX 721 SYSTEM TOXICITY 2 CREDITS

Introduction to immune system. The immune system, immune Suppression, classification of immune-mediated injury (Hypersensitivity) and effects of chemicals on allergic disease (ACD). Respiratory allergens, adjuvants, systemic hypersensitivity and other issues: autoimmunity and the developing immune system.

Toxicity of the Nervous System

Introduction to the nervous system; the neuron, neurotransmitters and their receptors, Glial cells. The blood–brain barrier and the energy-dependent nervous system. Toxicant effects on the nervous system. Structural effects of toxicants on neurons and toxicant-mediated alterations in synaptic function. Neurotoxicity testing; *in vivo* tests of animal exposure, *in vivo* tests of human exposure and *in vitro* neurochemical and histopathological end points and skin toxicity.

Toxicity of the Reproductive System

Definition of reproductive toxicity, definition of endocrine disruption, the hypothalamic-pituitary-gonadal axis, male reproductive physiology, disruption of male reproduction by toxicants (pesticides, metals, plastics). Female reproductive physiology and the ovulatory cycle.

Disruption of female reproduction by toxicants such as cigarette smoke, diethylstilbestrol (DES), pesticides, plastics, phytoestrogens and others.

TOX 722 TOXICOLOGICAL RISK ASSESSMENT AND RISK CHARACTERIZATION 2 CREDIT UNITS

Introduction to risk assessment methods; hazard identification, exposure assessment and dose response and risk characterization. Non-cancer risk assessment: default uncertainty and modifying factors, derivation of developmental toxicant RfD, determination of RfD and RfC of naphthalene using the NOAEL approach, benchmark dose approach, determination of BMD and BMDL for ETU and risk for Non-carcinogenic effects, hazard quotient and chemical mixtures. Cancer risk assessment and PBPK Modeling.

Emerging Risk Assessment methods: hazard and exposure assessment using toxicogenomics, proteomics, metabolomics, systems biology approach to risk assessment, endocrine disruptors, genetically and modified plants (GMPs). Risk management. Risk communication. *In vivo* toxicity. Molecular and biochemical toxicology and development of selective toxicants.

TOX 723 FOOD TOXICOLOGY 2 CREDITS

Physiological functions and requirement of dietary constituents. General principles for use, safety assessment and types of **food additives** (food colours, sweeteners, acidulants and sequestrants, flavouring agents and antimicrobial agents. Types, occurrence, metabolism and toxicity of **toxicants resulting from food processing** (PAHs, premelanoidins, food irradiation, nitrates and nitrites) and effect of packaging materials. Classes, occurrence and effects of **Toxicants and antinutrients in plant foods** (proteinase, amylase and lipase inhibitors, phytates, tannins, cyanogenic glycosides, toxic amines and fatty acides, saponins, oxalates, alkaloids, phytoestrogens, antivitamins, phychoactive substances, etc.). Classification, occurrence, metabolism and toxicity of **fungal toxins**. Pathogenicity and toxicity of **Food Borne organisms and toxins**. Source of exposure and toxicity of toxic metals and radionuclides. Classification and mechanisms of toxicity of **pesticides, industrial contaminants (PCBs) and veterinary drug residues**. Prevention and controls of food borne toxicants (Nanotechnology, etc)

TOX 724 ENVIRONMENTAL TOXICOLOGY 2 CREDITS

Environmental sample collection, analytical techniques; quantification approaches.

Basics of Environmental Toxicology: Environmental persistence: abiotic degradation, biotic degradation, and nondegradative elimination processes. Bioaccumulation; factors that influence bioaccumulation. Toxicity: acute toxicity, mechanisms of acute toxicity, chronic toxicity, species-specific chronic toxicity, abiotic and biotic interactions.

Transport and fate of toxicants in the environment; Sources of toxicants to the environment. transport processes: diffusion, equilibrium partitioning, air–water partitioning, octanol–water

partitioning, lipid–water partitioning, particle–water partitioning, transformation processes: reversible reactions, irreversible reactions. Environmental fate models. **Environmental Risk Assessment:** Formulating the problem. Selecting assessment end points, developing conceptual models and selecting measures. Analyzing exposure and effects information. Characterizing exposure and ecological effects. Characterizing and estimating risk. Describing and Managing risk.

TOX 725 FORENSIC AND CLINICAL TOXICOLOGY 2 CREDITS

Introduction to forensic toxicology; overview, evidentiary requirements, sample type and chemical classes analyzed in Forensic Toxicology. Clinical toxicology; overview, clinical toxicology and health care, training and certification, clinical management of toxicant exposure and analytical methods in Forensic and Clinical Toxicology.

MFT 721 RESEARCH METHODS, BIOSTATISTICS AND ETHICS 2 CREDITS

An in-depth study in preparation for seminar and conference presentations using visual aids. Writing of research and review papers for publication, thesis preparation, writing award winning research proposals, bibliographic citations, use of citation/referencing tools such as One Note, analysis and processing of raw quantitative data, literature search, abstracting etc. The use of appropriate tool in analyzing data, sample collecting and preparation according to the needs of each research. Any relevant information that may be applicable to research.

TOX 726 TOXICOLOGICAL METHODS 2 CREDITS

Theory and practical familiarity with equipment used for investigations in toxicology.

BFS 722 VETERINARY CHEMICAL AND DRUG RESIDUES 2 CREDITS

Types of drugs; causes of drug residues in animal products; potential effect of veterinary drug residues on public health: developing of drug resistance, drug hypersensitivity reaction, carcinogenic effect, Mutagenic effect, teratogenic effect, disruption of normal flora; risk factors for development of residues in food producing animal; Permissible levels of residue; Detection methods of drug residues: microbiological method, immunological (rapid test kits), Immunoassay (ELISA), chemical method (Chromatography); safety evaluation of veterinary drug residues: acceptable daily intake (ADI), Maximum residue limit (MRL), calculating withdrawal time; residues avoidance program; control and prevention measure of veterinary drug residues.

TOX 727 PLANT AND ANIMAL BIOTECHNOLOGY 3 CREDITS

Unit I: Plant Biotechnology: Introduction: History, aim and scope of Plant Biotechnology, Biotechnology Scenario in India. Meristem culture, virus free plants. Large scale micropropogation, hardening and its application. Another culture for haploid plant production,

Doubled haploids, application of haploids in plant breeding and crop improvement. Somaclonal variations and their use in crop improvement.

Liquid culture: Suspension cultures, Batch cultures, continuous cultures. Bioreactors, immobilized bioreactors; Improving and enhancing yield of secondary plant products using bioreactors, Hairy root cultures for production of secondary metabolites.

Unit II: Transgenic Plants: Vectors for plant transformation - Binary vectors and integration vectors; their characteristic features in detail. Construction of expression vectors, Use of selectable markers. Marker free technology for production of transgenics. Methods for gene transfer: Gene gun and *Agrobacterium* methods. Details of *Agrobacterium*, Ti and T-DNA, mechanism of DNA transfer and integration Transgenic tissue regeneration and screening-of transgenics for gene integration using PCR and western or dot blotting techniques. Organelle Engineering: Targeting of genetically engineered DNA clones into chloroplasts of higher plants. **Disease Resistance:** Disease resistance to fungi by engineering chitinase (β-1, 3-glucanase gene) and osmotin. Disease resistance to bacteria by Lysozyme gene. Resistance to pests- Bt-toxin gene, protease inhibitor genes. Generation of herbicide tolerant plants, Development of transgenics to virus resistance, using of antisense and RNA interference technologies. Transgenic plants: Plantibodies, vaccines, Biopolymers and vitamins. Transgenics for delayed fruit ripening and increased shelf life-Tomato. Increase in the shelf life of cut flowers - (Carnation flowers).

Unit III: Improvement of food crops: Increase in essential amino acids in cereal seed proteins (phaseolin protein and albumin gene (for increase in methionine content). Increase in lysine by using *E. coli* dihydropicolinate synthase (DHPS gene). Increase and change in the quality oils in Brassica species (increase in medium chain fatty acids and converting unsaturated fatty acid to saturated fatty acids). Increase in sweetness and flavor in fruits and vegetables (tomato). Increase in starch content (potato).

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MFT 730 INTERNSHIP 2 CREDITS

This is the period of the Student's Industrial Work Experience Scheme (SIWES) programme which is normally undertaken for four months during the second year of study. The SIWES programme is basically devoted to practical training in the industries that are relevant to the programme. Students are expected to put into practical use the knowledge they have learned in the classroom and laboratories

TOX 730 RESEARCH PROJECT 6 CREDITS

Independent research in selected areas of Toxicology under the guidance of an academic supervisor(s). Students will be required to carry out literature survey on the topic, perform experiments and produce dissertations. The research outcome shall be defended before a panel of internal and external examiners.

SESSIONAL PROGRESS REPORTS PhD TOXICOLOGY (NOT TO SCORED)

COURSE CODE	COURSE TITLE	
TOX 801	Seminar I	**Core**
TOX 802	Seminar II	**Core**
TOX 803	Seminar III	**Core**
TOX 800	Research project	**Core**

The ACEMFS will also provide a platform to bring together experts with tremendous wealth of experience in the diverse areas of health, agricultural and environmental research which are major development challenges confronting Africa. The following tables indicate different roles and responsibilities of officers

TABLE 1: ADMINISTRATIVE OFFICERS

S/No	Name of Officer	Designation
1	Prof. Hussaini A. Makun	Centre Leader
2	Dr. (Mrs) Hadiza L. Muhammad	Deputy Centre Leader
3	Dr. (Mrs) Mercy T. Bankole	Monitoring and Evaluation Officer
4	Mr. Hafis Olawale Omoniyi	Project Accountant
5	Mrs. Funmilayo Okoinemen Imoleayo	Finance Officer
6	Mr. Silas Habila Bijim	Environmental Safeguard
7	Mr. Abubakar Haruna	Procurement Officer

8	Mr. Shafiu Ozovehe Sule	Auditor/Internal Auditor
9	Mrs. Dorothy Elaigu	Communication Officer
10	Mrs Ruth Lamai-Odepidan	Centre Secretary

TABLE 2: TECHNICAL OFFICERS

S/No	Name of Officer	Designation
1	Professor Emmanuel Ogbadoyi	ACEMFS Applied Research Coordinator
2	Dr Oluwatosin Kudirat Shittu	Molecular Biology and Bioinformatics Research Theme Leader
3	Dr Alexander Ikechukwu Ajai	Heavy Metals and Pesticides Residues Research Theme Leader
4	Dr John Adama	Veterinary Drug Residues Research Theme Leader
5	Professor Abdulkareem Ambali Saka	Nanotechnology Research Theme Leader/ ACEMFS Industrial/Sectoral Liaison Officer
6	Professor Chiemela Enyinnaya Chinma	ACEMFS Academic Program Coordinator

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Table 6: ACADEMIC FACULTY FOR MOLECULAR BIOLOGY AND BIOINFORMATICS

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Table 7: ACADEMIC FACULTY FOR TOXICOLOGY

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