

**CURRICULUM**  
**OF**  
**CROP PHYSIOLOGY**  
**BS & MS**

(Revised 2012)



**HIGHER EDUCATION COMMISSION**  
**ISLAMABAD**

# CURRICULUM DIVISION, HEC

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# PREFACE

The curriculum of subject is described as a throbbing pulse of a nation. By viewing curriculum one can judge the stage of development and its pace of socio-economic development of a nation. With the advent of new technology, the world has turned into a global village. In view of tremendous research taking place world over new ideas and information pours in like of a stream of fresh water, making it imperative to update the curricula after regular intervals, for introducing latest development and innovation in the relevant field of knowledge.

In exercise of the powers conferred under Section 3 Sub-Section 2 (ii) of Act of Parliament No. X of 1976 titled “**Supervision of Curricula and Textbooks and Maintenance of Standard of Education**” the erstwhile University Grants Commission was designated as competent authority to develop, review and revise curricula beyond Class-XII. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

In compliance with the above provisions, the HEC undertakes revamping and refurbishing of curricula after regular intervals in a democratic manner involving universities/DAIs, research and development institutions and local Chamber of Commerce and Industry. The intellectual inputs by expatriate Pakistanis working in universities and R&D institutions of technically advanced countries are also invited to contribute and their views are incorporated where considered appropriate by the National Curriculum Revision Committee (NCRC).

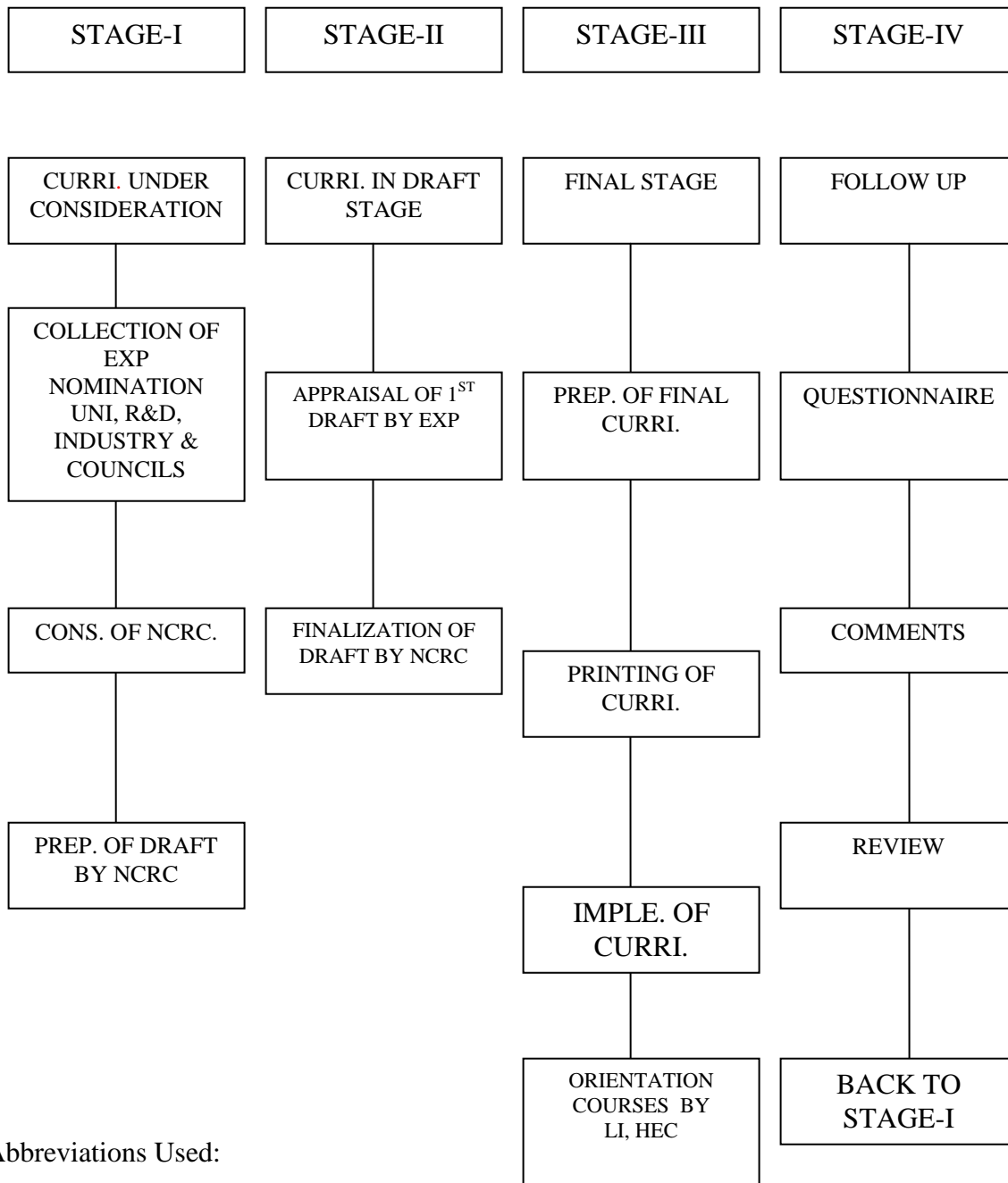
A committee of experts comprising of conveners from the National Curriculum Revision Committees of HEC in the disciplines of Basic, Applied, Social Sciences, Agriculture and Engineering met in 2007 & 2009 and developed the unified templates to standardize degree programmes in the country so as to bring the national curriculum at par with international standards, and to fulfill the national needs. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education.

Inline with above, NCRC comprising senior university faculty and experts from various stakeholders and the respective accreditation councils has finalized the curriculum for Crop Physiology. The same is being recommended for adoption by the universities/DAIs channelizing through relevant statutory bodies of the universities.

**MUHAMMAD JAVED KHAN**  
**Adviser (Academics)**

**April, 2012**

# CURRICULUM DEVELOPMENT



**Abbreviations Used:**

- NCRC. National Curriculum Revision Committee
- VCC. Vice-Chancellor's Committee
- EXP. Experts
- COL. Colleges
- UNI. Universities
- PREP. Preparation
- REC. Recommendations
- LI Learning Innovation
- R&D Research & Development Organization
- HEC Higher Education Commission

## INTRODUCTION

The final meeting of National Curriculum Revision Committee on Crop Physiology was held at HEC Regional Centre Lahore from March 12-14, 2012 to review the BS/BSc (4 years) and MS/MSc (2 years) Crop Physiology Curriculum. The following members attended the meeting:

Prof. Dr. Qamaruddin Chachar  
Chairman,  
Department of Crop Physiology,  
Faculty of Crop Production,  
Sindh Agriculture University,  
Tandojam. Convener

Dr. Jalal-ud-Din  
Principal Scientific Officer,  
Plant Physiology Programme,  
Crop Sciences Institute,  
National Agricultural Research Centre (NARC),  
Islamabad. Secretary/Member

Dr. Muhammad Ibrahim Keerio,  
Professor,  
Department of Crop Physiology,  
Sindh Agriculture University,  
Tandojam. Member

Prof. Dr. Fauzia Yusuf Hafeez,  
Professor / Chairperson,  
COMSATS Institute of Information Technology,  
Park Road,  
Islamabad. Member

Dr. Muzammal Hussain Siddiqui,  
Associate Professor,  
Department of Agronomy,  
Faculty of Agriculture, Rawlakot,  
University of Azad Jammu & Kashmir,  
Muzaffarabad. Member

Dr. Muhammad Rasheed,  
Assistant Professor,  
Department of Agronomy,  
PMAS, Arid Agriculture University,  
Rawalpindi. Member

Dr. Muhammad Naeem, Member  
Assistant Professor,  
University College of Agriculture & Environmental  
Sciences, Baghda-dul-Jadeed Campus,  
Islamia University,  
Bahawalpur.

Dr. Abdul Aziz Khakwani, Member  
Assistant Professor,  
Department of Agronomy,  
Gomal University,  
Dera Ismail Khan,  
Khyber Pakhtunkhwa.

Dr. Muhammad Naeem Shahwani, Member  
Assistant Professor,  
Faculty of Life Sciences and Informatics,  
Balochistan University of Information Technology,  
Engineering & Management Sciences,  
Quetta.

Dr. Muhammad Arif, Member  
Assistant Professor,  
Department of Agronomy,  
Khyber Pakhtunkhwa Agricultural University,  
Peshawar.

Dr. Hassan Munir, Member  
Lecturer,  
Department of Crop Physiology,  
University of Agriculture,  
Faisalabad.

The meeting started with recitation from the Holy Quran by Prof. Dr. Muzammal Hussain Siddiqui. Mr. Muhammad Raza Chohan, Director HEC, Regional Centre, Lahore welcomed all the participants. Malik Arshad Mahmood, Director (Curriculum) then requested the convener to conduct proceedings of all technical sessions of the meeting for three days.

On the request of the convener all members gave their detailed comments on the preliminary draft of the Crop Physiology Curriculum. The committee during its deliberation considered the following objectives:

1. To finalize the curriculum in the discipline of Crop Physiology and to bring it at par with international standards.

2. To incorporate latest reading & writing material against each course.
3. To bring uniformity and develop minimum baseline courses in each and every course of study.
4. To make recommendations for promotion/development of the discipline.

During the second day session, Prof. Dr. A. Q. Mughal, Vice Chancellor, Sindh Agriculture University, Tandojam paid a visit to the NCRC meeting. The participants from all over the country introduced themselves, while addressing the committee he highly appreciated the efforts of HEC for providing a forum to the experts for revision of curriculum in different disciplines. He emphasized for development/revision of curricula to bring it at par with the international standards.

After three days' long deliberations, the Committee unanimously approved final draft of the curriculum of the BS/BSc (4 years) and MS/MSc Crop Physiology degree programmes. Malik Arshad Mahmood, Director, Curriculum HEC Islamabad thanked the Convener, Secretary and all the members of the Committee for sparing their valuable time and for their quality contribution towards preparation of the preliminary draft curriculum of the BS/BSc (4 years) and MS/MSc Crop Physiology program. He acknowledged that their efforts will go long way in developing workable, useful and comprehensive degree programs in Crop Physiology.

The Committee highly admired the efforts made by the officials of HEC Regional Centre, Lahore, and Malik Arshad Mahmood, Director Curriculum for making excellent arrangements to facilitate the forming of the committee and their accommodation at Lahore.

The meeting ended with the vote of thanks to the HEC officials for providing an ideal environment to discuss the agenda. The convener of the NCRC also thanked the members for their inputs in re-engineering the teaching / learning landscape of the country to make it more practical, competitive and effective.



# FRAMEWORK FOR 4-Year BS in Crop Physiology

<b>Non-Agricultural Domain</b>							
Knowledge Area	Subject Area	Name of Course	Cr	Total Courses	Total Credit	% Area	% Overall
Humanities	English	English-I (Functional English)	3	2	6	19.35	4.44
		English-II (Communication Skills)	3				
	Culture	Pakistan Studies	2	2	4	12.9	2.96
		Islamic Studies/Ethics	2				
	Social Sciences	Marketing & Agri Business	3	2	6	19.35	4.44
		Rural Development	3				
Computing	IT	Introduction to Communication Technology	3	1	3	9.70	2.22
Natural Sciences	Mathematics/ Biology	Math-I/Botany	3	2	6	19.35	4.44
		Math-II/Zoology	3				
	Statistics	Statistic-I	3	2	6	19.35	4.44
		Statistic-II	3				
<b>Sub-Total:</b>				<b>11</b>	<b>31</b>	<b>100</b>	<b>23</b>

<b>Agricultural Domain</b>							
Interdiscip- linary	Agriculture Foundation	Crop Physiology	3	9	27	27.83	21.09
		Agronomy	3				
		Plant Breeding and Genetics	3				
		Entomology	3				
		Plant Pathology	3				
		Food Technology	3				
		Horticulture	3				
		Soil Science	3				
		Agricultural Economics	3				
Supporting Courses	Breadth Courses	Agricultural Extension	3	4-6	12-18	12.37	9.37
		Forestry & Range Management	3				
		Animal Sciences	3				
		Basic Bio- Chemistry	3				
		Agricultural Engineering	3				
		Any other Recommended by Universities	3				
Major Courses	Major Based Core (Depth)	Major	3	18-20	54-60	56.67	42.18
Project/ Internship		Project/ Internship	4		4		
<b>Total:</b>			-	<b>31-35</b>	97-109	100	77
<b>Grand- Total:-</b>			-	<b>42-46</b>	<b>128-140</b>	-	<b>100</b>

# SCHEME OF STUDIES BS IN CROP PHYSIOLOGY

<b>Subject/Title</b>	<b>Credit Hours</b>
1. Introductory Crop Physiology	3 (2-1)
2. Plant Cell Structures and Functions	3 (2-1)
3. Basic Physiological Processes of Crop Plants	3 (2-1)
4. Carbon Metabolism of Crop Plants	3 (2-1)
5. Environmental Physiology	3 (2-1)
6. Plant Growth and Development	3 (2-1)
7. Physiology of Crop Nutrition	3 (2-1)
8. Fundamentals of Nitrogen Fixation	3 (2-1)
9. Crop Ecology	3 (2-1)
10. Physiology of Cereals	3 (2-1)
11. Physiology of Non-Cereals	3 (2-1)
12. Basics of Seed Physiology	3 (2-1)
13. Plant Growth Substances	3 (2-1)
14. Stress Physiology	3 (2-1)
15. Plant Water Relations	3 (2-1)
16. Physiological Aspects of Tissue Culture	3 (2-1)
17. Introductory Molecular Biology	3 (2-1)
18. Internship	4 (0-4)
<b>Total Major Courses Credit Hours</b>	<b>55</b>

**Note:** Universities and Colleges may adopt their own system for course numbers for different degrees.

# DETAIL OF COURSES

**Title of the Course:     Introductory Crop Physiology**

**Credit Hours: 3 (2-1)**

**Prerequisites:**

## **Specific Objectives of Course:**

- To develop skills of the undergraduate students in the subject of crop physiology at introductory level

## **Theory:**

Concept, significance of crop physiology, basic terminology used in crop physiology, the cell, physico-chemical properties of solutions, suspensions and colloidal system of plant cells, buffers, absorption and transport of water in crop plants, plant nutrients, photosynthesis and respiration, seed germination and dormancy, growth and development, and growth substances and biotechnology.

## **Practical:**

- Introduction to equipment used in crop physiology
- Preparation of various solutions
- Measurement of soil and plant water contents
- Seed germination and seedling growth
- Demonstration of nutrient deficiency in crop plants

## **Recommended Books:**

1. Bajracharya, D. 1999. Experiments in Plant Physiology. A Laboratory Manual. Narosa Publication, New Delhi, India.
2. Hopkins, W. G. 2008. Introduction to Plant Physiology. 4<sup>th</sup> Ed. John Wiley and Sons. New York, USA.
3. Meidner, H. 1984. Class Experiments in Plant Physiology. Allen and Unwin. London, U. K.
4. Moore, T. C. 1981. Research Experiences in Plant Physiology. A Laboratory Manual. 2<sup>nd</sup> Ed. Springer-Verlag. Heidelberg, Germany.
5. Sadras, V. and D. Calderini. 2009. Crop Physiology. 1<sup>st</sup> Ed. Academic Press, UK.
6. Salisbury, F. B. and C. W. Ross. 2010. Plant Physiology. 5<sup>th</sup> Ed., Wordsworth Publishing Company. Belmont, California, USA.
7. Taiz, L. and E. Zeiger. 2010. Plant physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers, Sunderland, USA.

**Title of the Course: Plant Cell Structures and Functions**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- This course aims to develop basic understanding of the cell organelles and their functions.

**Theory:**

Prokaryotic, eukaryotic and mesokaryotic cells, apoplast, cell wall and vacuole, symplast: cytoplasm, plasmodesmata, plasma membrane, cytosomes, endoplasmic reticulum, golgi complex, micro-bodies, ribosomes, mitochondria, plastids, nucleus, nuclear membrane, microtubules, microfilaments and tonoplast, cell metabolism and its regulation.

**Practical:**

- Slide preparation of various types of cells
- Identification of cell organelles

**Recommended Books:**

1. Albert, B., D. Bray, J. Lewis, M. Raft, K. Roberts and J. D. Watson. 2002. Molecular Biology of the Cell. 4<sup>th</sup> Ed. Garland Science, New York, USA.
2. Campbell, J. and R. Mitchel. 2001. Biology. 6<sup>th</sup> Ed. Addison Wesley Longman Inc.
3. De-Roberties, E. D. P. and E. M. F. Jr. DeRoberties. 2006. Cell and Molecular Biology. 8<sup>th</sup> Ed. John Willey and Sons, USA.
4. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers, Sunderland, USA.

**Title of the Course: Basic Physiological Processes of Crop Plants**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To create awareness of basic physiological processes going on within a crop plant

**Theory:**

Seed germination, mechanism of absorption and translocation of water, transpiration, physiology and regulation of stomatal movement, source-sink relationship, partitioning and remobilization of assimilates, plant growth regulators and their functions and photoperiodism.

**Practical:**

- Measurement of water content of plants
- Demonstration of hydroponics
- Measurement of transpiration rate
- Demonstration of effects of various growth regulators on crop plant

**Recommended Books:**

1. Fageria, N. K., V. C. Baligar and R. B. Clark. 2005. Physiology of Crop Production. Academic Press, New York, USA.
2. Fitter, A. H. and R. K. M. Hay. 2005. Environmental Physiology of Plants. 3<sup>rd</sup> Ed. Amazon Press, USA.
3. Hans, M. and P. Schopfer. 2010. Plant Physiology. Springer-Verlag. Heidelberg, Germany.
4. Hopkins, W. G. 2008. Introduction to Plant Physiology. 4<sup>th</sup> Ed. John Wiley and Sons. New York, USA.
5. Ilahi, I. 1995. Plant Growth. UGC Press, Islamabad.
6. Meidner, H. 1984. Class Experiments in Plant Physiology. Allen and Unwin. London, UK.
7. Moore, T. C. 1981. Research Experiences in Plant Physiology. A Laboratory Manual. 2<sup>nd</sup> Ed. Springer-Verlag. Heidelberg, Germany.
8. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers, Sunderland, USA.

**Title of the Course: Carbon Metabolism of Crop Plants**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To create awareness of basic physiological processes of anabolism and catabolism of carbon cycle

**Theory:**

Photosynthesis: photophosphorylation, mechanism and biochemistry of CO<sub>2</sub> fixation in C<sub>3</sub>, C<sub>4</sub> and CAM plants, factors affecting photosynthesis, photorespiration, respiration; types and bioenergetics, carbohydrate metabolism, transformation of inorganic nitrogen into amino acids and proteins.

**Practical:**

- Determination of rate of photosynthesis and respiration
- Identification of C<sub>3</sub>, C<sub>4</sub> and CAM plants

### **Recommended Books:**

1. Hall, D. O. and K. Rao. 1999. Photosynthesis. 6<sup>th</sup> Ed. Cambridge University Press, UK.
2. Moore, T. C. 1981. Research Experiences in Plant Physiology. A Laboratory Manual. 2<sup>nd</sup> Ed. Springer-Verlag. Hiedelberg Germany.
3. Hans, M. and P. Schopfer 2010. Plant Physiology. Springer-Verlag. Heidelberg, Germany.
4. Hopkins, W. G. 2008. Introduction to Plant Physiology. 4<sup>th</sup> Ed. John Wiley and Sons. New York, USA.
5. Ilahi, I. 1995. Plant Growth. UGC Press, Islamabad.
6. Meidner, H. 1984. Class Experiments in Plant Physiology. Allen and Unwin. London, U.K.
7. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers, Sunderland, USA.

**Title of the Course: Environmental Physiology**

**Credit Hours: 3 (2-1)**

### **Specific Objectives of Course:**

- To correlate the environment and physiological processes of crop plants

### **Theory:**

Plant environment, effect of solar radiation, temperature, precipitation, relative humidity, CO<sub>2</sub> and pollutants on physiology of crop growth and development, environmental control of growth and development; genetic, atmospheric, edaphic, biological and cultural factors. Physiological strategies for increasing crop productivity, crop productivity in relation to greenhouse effects, global warming and climate changes.

### **Practical:**

- Demonstration of effects of light, temperature, water and injurious salts on crop plants
- To visit sub urban agricultural land for observation of pollutant effects on soil and plants

### **Recommended Books:**

1. Alastair, H. F. and R. K. M. Hay. 2001. Environmental physiology of plants. 3<sup>rd</sup> Ed. Academic Press, New York, USA.
2. Gupta, U. S. 1984. Environmental Physiology of Crop Plants. Academic Press, New York, USA.
3. Gurevitch, J., S. M. Scheiner and G. A. Fox. 2002. The Ecology of Plants. Sinauer Associates, Inc., Publishers Inc. USA.

4. Hall, A. E. 2000. Crop response to environment. Culinary and Hospitality Indus Publication Services.
5. Moore, T. C. 1981. Research Experiences in Plant Physiology. A Laboratory Manual. 2<sup>nd</sup> Ed. Springer-Verlag. Heidelberg, Germany.
6. Pritchard, S. G. and J. S. Amthor. 2005. Crops and environmental change. Haworth Press Inc.
7. Srivastava, L. M. 2002. Plant Growth and Development. Academic Press, Oxford. UK.

**Title of the Course: Plant Growth and Development**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the basic events of growth and development in crop plants

**Theory:**

Concept of growth and development, growth curve, growth regions, factors affecting plant growth and development, photoperiodism, thermoperiodism, vernalization and tropisms, role of phytohormones in crop growth and development, fruit set, seed development, ripening and techniques for production of seedless fruits, maturation, abscission and senescence.

**Practical:**

- Demonstration of various tropic responses
- Growth analysis of crop plants

**Recommended Books:**

1. Gardner, F. P., R. B. Pearce and R. L. Mitchell. 1988. The Physiology of Crop Plants. Iowa State University Press. Ames, Iowa, USA.
2. Ilahi, I. 1995. Plant Growth. UGC Press, Islamabad.
3. Ottline, L. and S. Day. 2002. Mechanism in plant development. Blackwell, UK.
4. Srivastava, L. M. 2002. Plant Growth and Development. Academic Press, Oxford.
5. Tesar, U. K., J. B. 1984. Physiological Aspects of Growth and Development. CSSA and ASA, Madison, WI, USA.
6. Taiz, L. and E. Zeiger. 2010. Plant Physiology, 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers, Sunderland, USA
7. Thomas, B. and D. Vince-Prue. 1997. Photoperiodism in Plants. 2<sup>nd</sup> Ed. Academic Press. New York, USA.
8. Willkins, M. B. 1981. Physiology of Growth and Development. McGraw Hill Book Company, New York, USA.



**Title of the Course:     Physiology of Crop Nutrition**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To give an insight to the physiological bases of nutrients and their importance, deficiencies and uptake mechanisms of plants

**Theory:**

Introduction and scope of crop nutrition, essential elements; physiological functions and deficiency symptoms, mechanisms of absorption, translocation, and metabolism of nutrients, effects of deficiencies and toxicities on physiological functions/processes, nutrient requirements and management for efficient plant growth and yield, mycorrhizae in nutrient absorption.

**Practical:**

- Techniques of growing plants for nutritional studies
- Identification of deficiency and toxicity symptoms of different nutrients

**Recommended Books:**

1. Epstein, E. and A. J. Bloom. 2005. Mineral Nutrition of Plants: Principles and Perspectives. 2<sup>nd</sup> Ed. Sinauer Associates Inc. USA.
2. Mangel, K. and E. A. Kirkby. 1999. Principles of Plant Nutrition. International Potash Institute, Switzerland.
3. Marschener, H. 1995. Mineral Nutrition of Higher Plants. Academic Press, London, UK.
4. Pessarakli, M. 2010. Handbook of Plant and Crop Stress. CRC Press, Taylor and Francis. New York, USA.
5. Rengel, Z. 2002. Mineral Nutrition of Crops: Fundamental Mechanisms and Implications. CBS Publication and Distributers, New Delhi, India.
6. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 6<sup>th</sup> Ed. Sinauer Associates Inc. MA, USA.

**Title of the Course: Fundamentals of Nitrogen Fixation****Credit Hours: 3 (2-1)****Specific Objectives of Course:**

- To create awareness about the physiological basis of nitrogen fixation in plants

**Theory:**

Nitrogen and plant growth, nitrogen cycle, classification of nitrogen fixing microorganisms, symbiotic and asymbiotic nitrogen fixation, mechanism of BNF, nodulation; process and mechanism, nitrogenase, ammonia assimilation, factors affecting nodulation and BNF, introduction to bio-fertilizers and their application in agriculture, plant growth promoting rhizobacteria.

**Practical:**

- Demonstration of inoculation methods
- Study of nodule formation under different environmental conditions
- Identification of effective and non-effective nodules
- Methods used to measure biologically fixed nitrogen

**Recommended Books:**

1. Cappuccino, J. G. and N. Sherman. 2010. Microbiology (A Lab manual). 7<sup>th</sup> ed. Benjamin Cumming, New York, USA.
2. Elmerich, C. and W. E. Newton. 2010. Associative and endophytic nitrogen-fixing bacteria and cyanobacterial associations. Springer-Verlag. Heidelberg, Germany.
3. James, E. K., J. I. Sprent, M. J. Dilworth and W. E. Newton. 2010. Nitrogen-fixing leguminous symbiosis. Springer-Verlag. Heidelberg, Germany.
4. Pawlowsai, K. and W. E. Newton. 2005. Nitrogen-fixing actinorhizal symbioses. Springer-Verlag. Heidelberg, Germany.
5. Stacy, G. 1997. Biological Nitrogen Fixation. Chapman and Hall Inc., New York, USA.
6. Stacy, G., R. H. Burris and H. J. Evans. 1992. Biological Nitrogen Fixation. Chapman and Hall. Inc. London, UK.
7. Werner, D. and W. E. Newton. 2005. Nitrogen fixation in agriculture, forestry, ecology and the environment. Springer-Verlag. Heidelberg, Germany.

**Title of the Course: Crop Ecology****Credit Hours: 3 (2-1)****Specific Objectives of Course:**

- To understand the characteristics of agro-ecosystems and their dynamics

**Theory:**

Ecosystem; concept, species and population dynamics, crop ecosystem; aerial and soil environment, environmental factors and crop productivity; responses of crop plants to atmospheric, edaphic, biotic, pyric and anthropogenic factors, crop yield variability in relation to ecological optima; interaction between organism, interference: competition, predation, parasitism, symbiosis and allelopathy, ecological strategies for crop productivity; allocation and management of resources, agro-ecological zones of Pakistan

**Practical:**

- Visits to study the soil types, vegetation and water resources of major agro-ecological zones of Pakistan.

**Recommended Books:**

1. Fitter, A. H. and R. K. M. Hay. 1991. Environmental Physiology of Plants. Academic Press. London, UK.
2. Hussain. F. 1995. Manual of Plant Ecology. National Book Foundation, Islamabad, Pakistan.
3. Kochar, P. L. and S. H. Chaudhary. 1998. Ecology, Genetics, Evolution and Crytology. Kitab Mahal, Urdu Bazar, Lahore.
4. Larcher, W. 1995. Physiological Plant Ecology. 3<sup>rd</sup> Ed. Springer-Verlag. Hiedeberg, Germany.
5. Loomis, R. S. and D. J. Connor. 1993. Crop Ecology, Productivity and Management in Agricultural Systems. Cambridge University Press. New York, USA.
6. Smith, R.L. 1986. Elements of Ecology. Harper and Row Publishers. New York, USA.
7. Tivy, J. 1990. Agricultural Ecology. Longman Group. Ltd. Essex UK.

**Title of the Course:     Physiology of Cereals****Credit Hours: 3 (2-1)****Specific Objectives of Course:**

- To understand the physiological processes involved in the yield of cereal crops

**Theory:**

Physiology of leaf growth and tillering, leaf number, size, orientation, leaf area index and space resource distribution in relation to light interception, photosynthetic efficiency and utilization, source-sink relationships; partitioning coefficient, grain growth and development, ripening and maturity indices of economic yield.

**Practical:**

- Identification of growth stages in cereals
- Leaf area measurement and calculation of leaf area index
- Measurements of plant biomass and photosynthetic efficiency

**Recommended Books:**

1. Acquach, G. 2001. Principles of crop production: Theory, Techniques and Technology, 1<sup>st</sup> Ed. Prentice Hall.
2. Ali. M. H. 2010. Fundamentals of Irrigation and On-farm Water Management. Vol. I. Springer-Verlag. Germany.
3. Coombs, J., D. O. Hall, S. P. Long and J. M. O. Scurlock. 1987. Techniques in Bioproductivity and Photosynthesis. 2<sup>nd</sup> Ed. Pergamon Press. Oxford, UK.
4. Evans, L. T. 1996. Crop Evolution, Adaptation and Yield. Cambridge University Press. New York, USA.
5. Fageria, N. K., V. C. Baligar and R. B. Clark. 2005. Physiology of Crop Production. Academic Press. New York, USA.
6. Gardner, F. P., R. B. Pearce and R. L. Mitchell. 1988. The Physiology of Crop Plants. Iowa State University Press. Ames, Iowa, USA.
7. Goldsworthy, R. P. and N. M. Fisher. 1984. The Physiology of Tropical Field Crops. John Wiley and Sons. New York, USA.
8. Gupta, A. K. and N. Kaur. 2000. Carbohydrate Reserves in Plants: synthesis and regulation. Vol. 26. Elsevier Science. Amsterdam, The Netherlands.
9. Hay, R. K. M. and A. J. Walker. 1989. An Introduction to the Physiology of Crop Yield. Longman, Scientific and Technical. New York, USA.

**Title of the Course:     Physiology of Non-Cereals**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the physiological processes of yield in non-cereal crops

**Theory:**

Physiology of crop yield; germination, propagation, seedling growth, branching and leaf expansion, carbon dioxide assimilation and photosynthetic efficiency, source-sink relationships of sugar, fiber, oil seed, legume and tuber crops, morphology and physiology, senescence, maturity and maturity indices, partitioning coefficient and economic yield.

**Practical:**

- Leaf area measurements and calculations of leaf area index
- Measurements of plant biomass and photosynthetic efficiency
- Identification of developmental growth stages in non-cereal crops

**Recommended Books:**

1. Coombs, J., D. O. Hall, S.P. Long and J. M. O. Scurlock. 1987. Techniques in Bio-productivity and Photosynthesis. 2nd Ed. Pergamon Press. Oxford, UK.
2. Draycott, A. P. 2006. Sugar Beet. Blackwell Publishing Ltd. Oxford, UK.
3. Fageria, N. K., V. C. Baligar and R. B. Clark. 2005. Physiology of Crop Production. Academic Press. New York, USA.
4. Gardner, F. P., R. B. Pearce and R. L. Mitchell. 1988. The Physiology of Crop Plants. Iowa State University Press. Ames, Iowa, USA.
5. Gupta, A. K. and N. Kaur. 2000. Carbohydrate reserves in plants: synthesis and regulation. Vol. 26. Elsevier Science. Amsterdam, The Netherlands.
6. Stewart J. M., D. Oosterhuis, J. J. Heitholt and J. R. Mauney. 2009. Physiology of Cotton. Springer. London, UK.

**Title of the Course:     Basics of Seed Physiology**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To focus on development in the area of seed physiology and its practical application

**Theory:**

Definition of seed, seed structure, physiology of seed formation and development. composition of seed, physiology and biochemistry of seed germination, factors affecting seed germination and emergence, seed viability

and seed vigor, seed dormancy and methods of breaking dormancy, seed longevity and storage.

**Practical:**

- Seed testing for moisture, viability and vigor
- Demonstration of methods of breaking seed dormancy
- Germination under different moisture, temperature and salt regimes
- Seed vigor enhancement techniques

**Recommended Books:**

1. Benech-Arnold, R. L. and R. A. Sanchez. 2004. Handbook of Seed Physiology: Application to agriculture. Haworth Press, New York, USA.
2. Bewley, J. D., and M. Black. 1994. Seed: Physiology of Development and Germination. 2<sup>nd</sup> Ed. Plenum Press. New York, USA.
3. Copeland, L. O. and M. B. McDonalad. 2002. Principles of Seed Science and Technology. 2<sup>nd</sup> Ed. Burgess Publishing Company. Minneapolis, Minnesota, USA.
4. Fala, F. 1987. Handbook of Vigour Test Methods. 2<sup>nd</sup> Ed. ISTA Secretariat, Wageningen, The Netherland.
5. International Seed Testing Association (ISTA). 2011. International Rules for Seed Testing. Zurichstr-50, CH-8303 Bassersdorf, Switzerland.
6. Joshi, A. K. and B. D. Singh. 2008. Seed Science and Technology. Kalyani Publishers. New Delhi, India

**Title of the Course: Plant Growth Substances**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the mechanism of biosynthesis, functions, transport and degradation of plant growth substances

**Theory:**

Growth substances; nature, classification, occurrence, biosynthesis, translocation, mode of action and degradation, steady state level of plant growth substances, physiological role of growth substances, application of growth substances in agriculture and plant adaptation to stressful conditions.

**Practical:**

- Preparation of stock and working solutions of various plant growth substances.
- Demonstration of the effects of different growth substances on seed germination and seedling growth
- Bioassay of selected growth substances

### **Recommended Books:**

1. Arteca, R. N. 1997. Plant growth substances: Principles and Applications. Chapman and Hall Inc., New York, USA.
2. Davies P. J. 2005. Plant Hormones: Biosynthesis, signal transduction and action. Kluwer Academic Publishers. Dordrecht, The Netherlands.
3. Frankenberger, W. T. and M. Arshad. 1995. Phytohormones in Soils. Marcel Dekker Inc., New York, USA.
4. Hooykass, P. J. J., M. A. Hall and K. R. Libbenga. 1999. Biochemistry and molecular biology of plant hormones. Elsevier Publishers. Amsterdam, The Netherlands.
5. Lalit, M. S. 2004. Plant growth and development, hormones and environment. Academic Press. New York, USA.
6. Ranjan, R., S. S. Purohit and V. Prasad. 2004. Plant hormones. Agrobios. Jodhpur, India.
7. Srivastava, L. M. 2002. Plant Growth and Development, Hormones and Environment. Academic Press. USA.
8. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers, Sunderland, USA.

**Title of the Course:      Stress Physiology**

**Credit Hours: 3 (2-1)**

### **Specific Objectives of Course:**

- To understand the types and mechanism of plant environmental stresses

### **Theory:**

Introduction to biotic and abiotic stresses, responses of plant to various stresses, physiological effects of edaphic, moisture, temperature, radiation, pollutant, chemical, mineral and salt stresses, mechanisms of plant injury; physiological and biochemical basis.

### **Practical:**

- Demonstration of effects of drought, nutrition, temperature and salinity stresses on plants

### **Recommended Books:**

1. Fitter, A. H., and R. K. M. Hay. 2001. Environmental Physiology of Plants. Academic Press. London.
2. Fowden, L., T. Mansfield, J. Stoddart. 1993. Plant Adaptations to Environmental Stresses. Springer-Verlag. Berlin, Germany.
3. Khan, N. A. and S. Singh. 2008. Abiotic Stress and Plant Responses. International Publishing House Pvt. Ltd., New Delhi, India.
4. Levitt, J. 1980. Responses of Plants to Environmental Stresses. 2<sup>nd</sup> Ed. Vol-I and II. Academic Press. London.

5. Moone, H. A., W.E. Winner, and E. J. Pell. 1991. Responses of Plants to Multiple Stresses. Academic Press. San Diego, USA.
6. Orcutt, D. M. and E. T. Nelson. 2000. Physiology of Plants under Stress. John Wiley and Sons. USA.
7. Pessarakli, M. 2010. Handbook of Plant and Crop Stress. 3<sup>rd</sup> Ed. CRC Press, Taylor and Francis. New York, USA.
8. Taiz, L. and E. Zeiger. 2010. Plant physiology, 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers. Sunderland, USA.
9. Turner, N. C., and J. B. Passioura. 1986. Plant Growth, Drought and Salinity. CSIRO, Australia.

**Title of the Course: Plant Water Relations**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the importance of water in plant life.

**Theory:**

Water; importance, physical and chemical properties, soil moisture, tensile strength, root pressure, ascent of sap, cohesion mechanism, capillary rise in xylem, free energy and chemical potential, water potential, hydrostatic pressure, water activity and osmotic potential, Van't Hoff relations and matric potential, water potential and plant cells, plasmolysis, plant air interface.

**Practical:**

- Techniques and experimental approaches for measurement of plant water status

**Recommended Books:**

1. Ehlers, W. and M. J. Goss. 2004. Water Dynamics in Plant Production. CABI Publishing.
2. Kirkham, M. B. 2005. Principles of soil and plant water relations. Elsevier Academic Press. Phoenix, USA.
3. Kramer, P. J. 1983. Water relations in plant. Academic Press. New York.
4. Nobel, P. S. 2009. Physio-chemical and Environmental Plant Physiology. Academic Press. New York, USA.
5. Taiz, L. and E. Zeiger. 2010. Plant physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers. Sunderland, USA.
6. Turner, N. C. 1981. Techniques and experimental approaches for measurement of plant water status. Plant and soil. Vol. 58. Dr. W. Junk Publishers. Hague, Netherland.



**Title of the Course: Physiological Aspects of Tissue Culture**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To enable students to understand plant tissue culture and its importance to crop physiology

**Theory:**

Historical background, composition of different culture media, sterilization techniques (glassware and media), culture conditions and environment, physiology of donor plant and explant, physiology of callus formation, differentiation and dedifferentiation, morphogenesis and factors affecting morphogenesis, organogenesis (root and shoot formation), protoplasts: isolation, culture and fusion haploid plants and their use in agriculture, embryogenesis and factors affecting embryogenesis, micro-propagation; application in agriculture, in vitro stress induction with special reference to salt, drought and temperature, problems and limitations of tissue culture techniques.

**Practical:**

- Glassware selection, cleaning and sterilization
- Study and preparation of various media
- In Vitro seed germination
- Explant: selection, preparation and inoculation techniques
- Callus induction and culture

**Recommended Books:**

1. Bhojwani, S. S. and M. K. Razdan. 1983. Plant Tissue Culture: Theory and Practice. Elsevier Publishers. Amsterdam. The Netherlands.
2. Dodds, J. H. and L. W. Roberts. 1999. Experiments in Plant Tissue Culture. 3<sup>rd</sup> Ed. Cambridge University Press. Cambridge, UK.
3. Skelsey, F. A. 1984. Biotechnology in Agriculture: New Tool for the Oldest Science.
4. Smith. J. E. 1996. Biotechnology, 3<sup>rd</sup> Ed. Cambridge University Press. Cambridge, UK.
5. Withers, L. A. and P. G. Alderson. 1986. Plant Tissue Culture and its Agricultural Applications. Butterworths Publishers. Cambridge, UK.

**Title of the Course:     Introductory Molecular Biology**  
**Credit Hours: 3 (3-0)**

**Specific Objectives of Course:**

- The course is designed to introduce students to basic concepts of molecular biology

**Theory:**

Nature of hereditary material, nucleic acid metabolism, relationship between DNA, chromosome and genome, DNA and RNA structure, replication, transcription, translation and DNA recombination, presentations on different mechanisms happening at molecular and crop level, introduction to bio-ethics and bio-informatics.

**Practical:**

- Demonstration of DNA extraction
- Visit to any bio-technological facility

**Recommended Books:**

1. Berg, J. M., J. L. Tymoczko, L. Stryer. 2006. Biochemistry. 6<sup>th</sup> Ed. WH Freeman and Company, New York.
2. Lodish, H., C. A. Kaiser, 2007. Molecular Cell biology. 6<sup>th</sup> Ed. WH Freeman and Company. New York, USA.
3. Nelson, D., M. M. Cox. 2009. Lehninger principles of biochemistry. 5<sup>th</sup> Ed. WH Freeman and Company. New York, USA.

# SCHEME OF STUDIES FOR MS IN CROP PHYSIOLOGY

<b>Subject Title</b>	<b>Cr. Hours</b>
1. Advanced Seed Physiology	3 (2-1)
2. Developmental Physiology of Crops	3 (2-1)
3. Physiological Aspects of Crop Yield	3 (2-1)
4. Plant Response to Stress	3 (2-1)
5. Physiological Aspects of Herbicides	3 (2-1)
6. Biological Nitrogen Fixation	3 (2-1)
7. Advanced Crop Physiology	3 (2-1)
8. Physiology of Drought	3 (2-1)
9. Recent Advances in Crop Physiology	3 (2-1)
10. Analytical Techniques in Crop Physiology	3 (0-3)
11. Plant Molecular Biology	3 (2-1)
12. Biophysics of Growth	3 (2-1)
13. Plant Metabolism and Bioenergetics	3 (2-1)
14. Modeling Crop Growth and Development	3 (2-1)
15. Crops for Changing Environments	3 (2-1)
16. Plant Microbes Interaction	3 (2-1)
<b>Thesis</b>	<b>6 (0-6)</b>

**Note:** Degree Awarding Institutions may select 24 Credits from above mentioned courses.

# DETAIL OF COURSES

## MS in Crop Physiology

**Title of the Course:     Advanced Seed Physiology**

**Credit Hours: 3 (2-1)**

### **Specific Objectives of Course:**

- To focus on the latest developments in the area of seed physiology and its practical applications

### **Theory:**

Physiology of seed development: reserve accumulation, source-sink relationship and the supply of nutrients affecting seed yield and quality, tolerance, seed storage, longevity and deterioration, germination; imbibition, activation and reserve mobilization, hormonal and environmental regulation, seed enhancement, recent advances in seed technology.

### **Practical:**

- Introduction to seed testing organizations
- Seed collection and identification
- Seed sampling methods
- Physical purity analysis
- Seed moisture determination
- Seed viability, Tetrazolium and Germination test
- Vigor testing:
  - Electrical conductivity test
  - Accelerated aging test
  - Cold test
  - Controlled deterioration test
- Methods for verification of species and cultivars
- Visit to public and private seed sectors
- Demonstration seed priming

### **Recommended Books:**

1. Benech-Arnold, R. L. and R. A. Sanchez. 2004. Handbook of Seed Physiology. Application to agriculture. Haworth Press. New York, USA.
2. Bewley, J. D., and M. Black. 1994. Seed: Physiology of Development and Germination. 2<sup>nd</sup> Ed. Plenum Press. New York.
3. Fala, F. 1987. Handbook of Vigor Test Methods. 2<sup>nd</sup> Ed. ISTA Secretariat, Wageningen, The Netherlands.
4. ISTA. 1985. International Rules for Seed Testing. Wageningen, The Netherlands.
5. Joshi, A. K. and B. D. Singh. 2008. Seed Science and Technology. Kalyani Publishers. New Delhi, India.

6. McDonald, M. B. and L. O. Copland. 2007. Principles of Seed Science and Technology. 2<sup>nd</sup> Ed. Burgess Publishing Company. Minneapolis, Minnesota, USA.

**Title of the Course:      Developmental Physiology of Crops**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the pattern of growth and development of major crops

**Theory:**

Structural organization of plants at subcellular, cellular, tissue and organ levels, basic events of growth; cell growth, cell division, cell enlargement and cell differentiation, meristem, physiology of root and shoot initiation and development, growth analysis, leaf growth and stomatal development, physiology of flowering, fruit set, ripening, maturity and senescence

**Practical:**

- Identification of developmental stages in various field crops
- Root and shoot growth patterns
- Identification of position, number and size of stomata

**Recommended Books:**

1. Garner, B. L. 1995. Plant Stem Physiology and Functional Morphology, Academic Press. USA.
2. Gardner, F. P., R. B. Pearce and R. L. Mitchell. 1988. The Physiology of Crop Plants. Iowa State University Press. Ames, USA.
3. Gregory, P. J., J. V. Lake, and D. A. Rose. 2010. Root Development and Function. Cambridge University Press. UK.
4. Hopkins, W. G. 2008. Introduction to Plant Physiology. 4<sup>th</sup> Ed. John Wiley and Sons. New York, USA.
5. Opik, H. and S. A. Rolfe. 2005. The Physiology of Flowering Plants. 4<sup>th</sup> Ed. Cambridge University Press. UK.
6. Ottline, L. and S. Day. 2002. Mechanism in plant development. Blackwell. UK.
7. Sadras and Calderini. 2009. Crop Physiology, Academic Press. UK.
8. Salisbury, F. B. and C. W. Ross. 2010. Plant Physiology. 5<sup>th</sup> Ed., Wordsworth Publishing Company. Belmont, California, USA.
9. Taiz, L. and E. Zeiger. 2010. Plant physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers. Sunderland, USA.

**Title of the Course:     Physiological Aspects of Crop Yield**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the role of physiological processes involved in crop yield

**Theory:**

Physiological basis of crop yield, leaf area development in relation to plant population, concept of critical and optimum leaf area index (LAI), leaf number, size, orientation and space distribution in relation to light interception, photosynthetic efficiency, effect of canopy architecture on crop yield, factors affecting pollination and fertilization, sink capacity, sink strength and source-sink relationship, grain growth and development, senescence and degradative processes affecting grain development.

**Practical:**

- Leaf area measurement
- Calculation of LAI and seed growth rate
- Calculation of effective seed filling duration from linear regression
- Calculation of economic and biological yields
- Partitioning coefficient
- Growth analysis

**Recommended Books:**

1. Boote, K. J., J.M. Bennett, T. R. S. Sinclair and G. M. Paulsen. 1994. Physiology and Determination of Crop Yield, ASA, CSSA, Madison, Wisconsin, USA.
2. Chetti, M. B., S.M. Hiremath and M. Kalpana. 2004. Physiological Approaches for Enhancing Productivity Potential Under Drought Condition. Studium Press.
3. Coombs J., D. O. Hall, S. P. Long, and J. M. O. Scutock. 1987. The Techniques in Bioproductivity and Photosynthesis. 2<sup>nd</sup> Ed. Pergamon Press Oxford. New York, USA.
4. Fageria, N. K., V. C. Baligar and R. B. Clark. 2005. Physiology of Crop Production. Academic Press. New York, USA.
5. Hay, R. K. M., and J. R. Porter. 2006. An Introduction to the Physiology of Crop Yield. Willey Blackwell. USA.
6. Taiz, L. and E. Zeiger. 2010. Plant physiology, 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers. Sunderland, USA.

**Title of the Course: Plant Response to Stress**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the types and mechanism of plant environmental stresses and their mitigation

**Theory:**

Biotic and abiotic stresses, responses of plants to various stresses, physiological effects of edaphic, moisture, temperature, radiation, pollutant, chemical, mineral, salt and pests stresses, mechanism of plant injury; physiological and biochemical basis, plant resistance mechanisms at the whole plant, organ, cellular and molecular levels, plant adjustments to stress conditions, mitigation of stresses through physiological enhancements.

**Practical:**

- Induction of different salinity, drought and temperature levels in pots and hydroponics
- Demonstration of effects of drought and salinity stresses on plants
- Mitigation of stresses by seed treatments, foliar and soil application

**Recommended Books:**

1. Fowden, L., T. Mansfield, J. Stoddart. 1993. Plant Adaptations to Environmental Stresses. Springer-Verlag. Berlin, Germany.
2. Fitter, A. H. and R. K. M. Hay. 2001. Environmental Physiology of Plants. Academic Press. London.
3. Khan, N. A. and S. Singh. 2008. Abiotic Stress and Plant Responses. International Publishing House Pvt. Ltd., New Delhi, India.
4. Harris, D. 2006. Advances in Agronomy. Development and Testing of "on-Farm" Seed Priming, University of Wales, Bangor, Gwynedd, UK.
5. Levitt, J. 1980. Responses of Plants to Environmental Stresses. 2<sup>nd</sup> Ed. Vol-I and II. Academic Press. London.
6. Moone, H. A., W. E. Winner and E. J. Pell. 1991. Responses of Plants to Multiple Stresses. Academic Press. San Diego, USA.
7. Orcutt, D. M. and E. T. Nelson. 2000. Physiology of Plants under Stress. John Wiley and Sons. USA.
8. Pessarikli, M. 2010. Handbook of Plant and Crop Stress. 3<sup>rd</sup> Ed. CRC Press, Taylor and Francis. New York, USA.
9. Taiz, L. and E. Zeiger. 2010. Plant physiology, 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers. Sunderland, USA.
10. Turner, N. C. and J. B. Passioura. 1986. Plant Growth, Drought and Salinity. CSIRO. Australia.

**Title of the Course: Physiological Aspects of Herbicides**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand mode of action and the role of herbicides in crop management

**Theory:**

Herbicides; classification, chemical and physical properties, surfactants and their significance, plant selectivity, resistance and tolerance to herbicides, mode of entry and action of herbicides, factors affecting uptake and translocation, metabolism of herbicides, response of plants to herbicides, herbicide effects on physiological processes; cell division, elongation, germination, early growth, solute transport, cell membrane, structure and function, water and CO<sub>2</sub> exchange, photosynthesis and respiration, residual effects of herbicides.

**Practical:**

- Calculation of herbicide doses
- Preparation of solutions with different concentrations
- Demonstration of different methods of herbicide application
- Demonstration of herbicide effects on weeds and crop plants
- Determination of effects of herbicides on plant metabolism

**Recommended Books:**

1. Anderson, W. P. 1993. Weed Science Principles. 2<sup>nd</sup> Ed. West Publishing Company. USA.
2. Ashton, F. M. and A. S. Crafts. 1981. Mode of Action of Herbicides. 2<sup>nd</sup> Ed. John Wiley and Sons. New York.
3. Asif, T. and A. Ali. 2003. Weeds and their control. Higher Education Commission, Pakistan.
4. Cobb, A. H. and J. P. H. Reade. 2010. Herbicides and Plant Physiology. 2<sup>nd</sup> ed. John Wiley and Sons. West Sussex, UK.
5. Leonard G. C. and H. G. Hewitt 1998. Chemistry and Mode of Action of Crop Protection Agents. Paston Press. Essex, UK.
6. Rao, V. S. 2000. Principles of Weed Science. Oxford and IBH Publishing Company. (Pvt). Ltd., New Delhi, India.
7. Sundus, L. J. 1976. Herbicides Physiology, Biochemistry and Ecology. 2<sup>nd</sup> Ed. Academic Press. New York, USA.



**Title of the Course: Biological Nitrogen Fixation**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the symbiotic and asymbiotic relationships between plants and microorganisms

**Theory:**

Biological nitrogen fixation (BNF), BNF in asymbiotic and symbiotic associations in legumes and non-legumes, mechanism of BN, nitrogenase; structure and function, genetics and regulation of BNF, molecular characterization of NIF gene, cross inoculation groups, estimation of BNF, physiological and ecological limitations of BNF, biological nitrogen fixation and plant productivity, BNF in agroforestry, biofertilizers; production and maintenance of legume inoculants

**Practical:**

- Morphology and anatomy of nodules
- Isolation of Rhizobium from nodules
- Grams staining, re-inoculation test
- Measurement of BNF
- Nitrogen estimation by Kjeldahl's method/acetylene reduction assay

**Recommended Books:**

1. Elmerich, C. and W. E. Newton. 2005. Associative and Endophytic Nitrogen Fixing Bacteria and Cyanobacterial Associations. Springer-Verlag. Berlin, Germany.
2. Hardarson, G. 2003. Maximizing the Use of Biological Nitrogen Fixation in Agriculture. Kluwer Academic Publishers. Amsterdam, The Netherlands.
3. James, E. K., J. I. Sprent, M. J. Dilworth and W. E. Newton. 2005. Nitrogen Fixing Leguminous Symbiosis. Springer-Verlag. Berlin, Germany.
4. Klipp, W., B. Masepohl, J. R. Gallon and W. E. Newton. 2005. Genetics and Regulation of Nitrogen Fixation in Free Living Bacteria. Springer-Verlag. Berlin, Germany.
5. Stacy, G., R. H. Burris and H. J. Evans. 1992. Biological Nitrogen Fixation. Chapman and Hall Inc. New York, USA.
6. Stacy, G. 1997. Biological Nitrogen Fixation. Chapman and Hall Inc. New York, USA.

**Title of the Course:     Advanced Crop Physiology**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To bestow upon the students with the advancements in the field of crop physiology

**Theory:**

Secondary plant metabolism; types, significance, role in agriculture, climate resilient crops, physiological enhancements to induce stress tolerance and enhancing economic yields, plant bioenergetics, recent research in crop physiology

**Practical:**

- Visits to different laboratories/centres of advanced research in the field of crop Physiology and report writing

**Recommended Books:**

1. Gupta, U. S. 1988. Progress in Crop Physiology. Oxford and IBH Publishing Company Pvt. Ltd. New Delhi, India.
2. Johnson, C. B. 1981. Physiological Process Limiting Plant Productivity, Productivity, Butterworths. London.
3. Marten, J. and D. E. Sadave. 1994. Plants, Genes and Agriculture. Jones and Bartlett Publishers International. USA.
4. Pessarakli, M. 2010. Handbook of Plant and Crop Stress. 3<sup>rd</sup> Ed. CRS Press, Taylor and Francis. USA
5. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 6<sup>th</sup> Ed. Sinauer Associates, Inc., Publishers. Sunderland, USA.
6. Wilkins, M. B. 1992. Advanced Plant Physiology. Longmans Singapore Publishers (pvt) Ltd. Singapore.
7. Review articles

**Title of the Course:     Physiology of Drought**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the mechanism and measurement of drought resistance in crop plants

**Theory:**

Global perspectives of drought, water deficit in plants, responses of plants to drought, mechanisms of drought tolerance in crop plants, morpho-anatomical consequences of drought, strategies for improving water use efficiency, water

stress and photosynthetic apparatus, photosynthetic adjustments to drought, relationships of drought with phytohormones, nitrogen fixation, nitrate reductase activity and protein synthesis, induction of drought tolerance in crop plants, crop research strategies for drought areas.

**Practical:**

- Measurement of water content of drought affected plants
- Crop growth analysis under drought

**Recommended Books:**

1. Close, T. J. and E. A. Bray. 1993. Plant Responses to Cellular Dehydration during Environmental Stress. Current Topics in Plant Physiology. Vol. 10. American Society of Plant Physiology. Rockville, USA.
2. Jones, H. G., T. J. Flowers and M. B. Jones. 1989. Plant Under Stress. Biochemistry, Physiology and Ecology and their Applications to Plant Improvement. Cambridge University Press. Cambridge, UK.
3. Khan, N. A. and S. Singh. 2008. Abiotic Stress and Plant Responses. International Publishing House Pvt. Ltd., New Delhi, India.
4. Paleg, L. G., and D. Aspinall. 1981. The Physiology and Biochemistry of Drought Resistance in Plants. Academic Press. Sydney, Australia.
5. Pessarakli, M. 2010. Handbook of Plant and Crop Stress. 3<sup>rd</sup> Ed. CRS Press, Taylor and Francis. USA.
6. Smith, J. A. C. and H. Griffiths. 1993. Water deficits: Plant Responses from Cell to Community. Bios Scientific Publishers.
7. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 6<sup>th</sup> ed. Sinauer Associates, Inc., Publishers. Sunderland, USA.

**Title of the Course:      Recent Advances in Crop Physiology**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To update the knowledge of learners with the current developments in the field of crop physiology

**Theory:**

Lectures on selected topics of recent advances in crop physiology, research review & data interpretation in the field of crop physiology, tutorials by the subject specialists, project development in crop physiology.

**Recommended Books:**

1. Agronomy Journal. American Society of Agronomy, USA.
2. Annual Review of Plant Physiology, USA.
3. Crop Science. Crop Science Society of America.
4. Current Science

5. Physiologia Plantarum
6. Plant Physiology. American Association of Plant Physiologists, USA.
7. Recent Advances in Agronomy.
8. Review articles

**Title of the Course: Analytical Techniques in Crop Physiology**  
**Credit Hours: 3 (0-3)**

**Specific Objectives of Course:**

- To equip students with recent analytical techniques in the field of crop physiology

**Practical:**

- Principles of analytical techniques
- Qualitative and quantitative analysis of seeds, seedlings and plants
- Centrifugation and use of tracers
- Chromatography
- Electrophoresis
- Spectroscopy
- Plant growth analysis

**Recommended Books:**

1. Coombs, J., D. O. Hall., S. P. Long. J. M. O. Scurlock. 1985. Techniques in Bioproductivity and Photosynthesis. Pergamon Press. Oxford, UK.
2. Dietmar, T. 1998. Nucleic Acid Electrophoresis: Lab Manual. Springer-Verlag. Berlin.
3. Hall, D. O., J. M. O. Scurlock, H. R. Balhar-Norden Kampf, R. C. Leegood and S. P. Long. 1993. Photosynthesis and Productivities in a Changing Environment: A field and laboratory manual. Chapman and Hall. London. UK.
4. Meidner, H. 1984. Class Experiments in Plant Physiology. Allen and Unwin. London, UK.
5. Moore, T. C. 1981. Research Experience in Plant Physiology: A Laboratory Manual. 2<sup>nd</sup> ed. Springer-Verlag. New York. USA.
6. Percy, R. W., J. R. Ehleringer, H. A. Mooney and P. W. Rundel. 1991. Plant Physiological Ecology: Field Methods and Instrumentation. Chapman and Hall Inc. New York. USA.
7. Robert, S. and G. Liam. 2003. Experimental Biochemistry: Theory and Exercises in Fundamental Methods.
8. Rodney, F.B. 2000. Modern Experimental Biochemistry. 3<sup>rd</sup> ed. Benjamin-Cummings Pub. Co.

**Title of the Course: Plant Molecular Biology**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To provide a vision of molecular biology to crop physiologists

**Theory:**

Introduction to molecular biology; macro molecules in plant; carbohydrates, proteins, lipids, nucleotides, nucleosides and their role; structure of DNA, RNA; genes and gene expression, protein synthesis, chromosomes, mitotic and meiotic behaviour of genes, DNA replication & repair mechanism, plant genome organization and fluidity, development of molecular markers for stress tolerance, gene regulation, signal transduction, chloroplast and mitochondrial genome, plant genetic engineering and its application in agriculture.

**Practical:**

- DNA & RNA extraction and amplification
- Isolation of Protein
- Visits to research labs with related facilities

**Recommended Books:**

1. Bruening, G., G. J. Harada, T. Kosuge and A. Hollaender. 1987. Tailoring Genes for Crop Improvement. Plenum Press. New York. USA.
2. Buchanan, B. B., W. Gruissem and R. L. Jones. 2002. Biochemistry and molecular biology of plants. John Wiley and Sons. USA.
3. Devies, P. 2005. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Student Edition, India.
4. Hafeez, F., Y. Zafar and A. M. Khalid. 2005. Modern Techniques in Biotechnology: a theoretical Manual. NIBGE, Faisalabad.
5. Keen, N. T., T. Kosuge and L. L. Walling. 1988. Physiology and Biochemistry of Plant Microbial Interaction. American Society of Plant Physiologists. Maryland, USA.
6. Mantell, S. H., J. A. Mathews and R. A. Mckee. 1985. Principles of Plant Biotechnology. Blackwell Scientific Publications. Oxford. UK.
7. Old, R. W. and S. B. Primrose. 1985. Principles of Gene Manipulation 3<sup>rd</sup> Ed. Blackwell Scientific Publications. Oxford, UK.
8. Pena, L. 2005. Transgenic Plants. Methods and Protocol. HUMANA, JN, USA.

**Title of the Course: Biophysics of Growth****Credit Hours: 3 (2-1)****Specific Objectives of Course:**

- To provide knowledge of biophysical aspects of plant growth.

**Theory:**

Long and short distance translocation, principles of cell wall growth, mechanisms of cell wall loosening and extension, changes in cellulose microfibril orientation during differential growth, relationship of cell wall extension with water and solute uptake, regulation of leaf growth, internodal growth and root growth, energy transduction and carbon relations during growth, effect of UV, IR & laser radiations on seed and growth, biomagnetism.

**Practical:**

- Measurement of cell membrane permeability and thermostability
- Demonstration of effect of magnetism on growth and development of plant growth

**Recommended Books:**

1. Baker, N. R., W. J. Davies, C. K. Ong. 1985. Control of Leaf Growth. Cambridge University Press. Cambridge, UK.
2. Baskin, T. I. 2005. Anisotropic Expansion of the Plant Cell Wall. Annual Review of Cell Development and Biology. 21: 203–222.
3. Cosgrove, D. J. and D. P. Knievel. 1987. Physiology of Cell Expansion During Plant Growth. American Society of Plant Physiologists. Rockville, USA.
4. Dale, J. E. 1982. The Growth of Leaves. Edward Arnold. London, UK.
5. Geitmann, A. and J.K. Ortega. 2009. Mechanics and Modeling of Plant Cell Growth. Trends in Plant Science. 14: 467–478.
6. Jarvis, M. C. and M. C. McCann. 2000. Macromolecular Biophysics of the Plant Cell Wall: Concepts and Methodology. Plant Physiology and Biochemistry. 38 (1/2): 1–13.
7. Tazawa, M., M. Katsumi, Y. Masuda and H. Okamoto. 1989. Plant Water Relations and Growth under Stress. Myu K. K., Tokyo, Japan.

**Title of the Course: Plant Metabolism and Bioenergetics**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the processes of plant metabolism and energy relationships

**Theory:**

Biological architecture; mitochondria and chloroplast, oxidation-reduction reactions, oxidizing and reducing agents, thermodynamics of energy in plant systems, bio-synthesis of protein, carbohydrates, fats and other compounds, respiration, its regulation and energetics and agriculture application of bioenergetics.

**Practical:**

- Demonstration of electron microscopy
- Gas exchange measurement using infrared gas analyzer, porometer, ceptometer and photosynthesis meter, leaf temperature measurement

**Recommended Books:**

1. Goodwin T. W. and E. I. Mercer. 1988. Introduction to Plant Biochemistry. Pergamon. Oxford, UK.
2. Hopkins, W. G. 2004. Introduction to Plant Physiology. 3<sup>rd</sup> Ed. John Wiley and Sons. New York, USA.
3. Ashihara, H., A. Crozier and A. Komamine. 2011. Plant Metabolism and Biotechnology. John Wiley and Sons. Sussex, UK.
4. Lehniger, A. L. 1981. The Molecular Basis of Biological Energy Transformation. 2<sup>nd</sup> Ed. Hopkins University Press, USA.
5. Taiz, L. and E. Zeiger. 2002. Plant Physiology. 3<sup>rd</sup> Ed. Sinauer Publishers. Sunderland, USA.

**Title of the Course: Modeling Crop Growth and Development**  
**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To understand the utilization of different crop models for the prediction of growth and development.

**Theory:**

Concept of crop modelling and agri-informatics, introduction to growth models for various crops, types of crop models, purpose and objectives of crop simulation models, limitations of crop models, development of crop growth models, requirements for simulating crop growth, meteorological information, components of a model: recent sub-models, phenological development, tiller

and leaf development, PAR interception and photosynthesis and dry matter partitioning, simulation of crop models.

**Practical:**

- Collection and maintenance of data files for development and simulation of crop models

**Recommended Books:**

1. Charles-Edwards, D. A., D. Doley and G. M. Rimmington. 1986. Modeling Plant Growth and Development. Sydney, Australia.
2. Charles-Edwards, D. A. 1982. Physiological Determinants of Crop Growth. Academic Press. London.
3. Hay, R. K. M and A. J. Walker. 1989. An Introduction to Physiology of Crop Yield. Longman Group UK Ltd.
4. Milthroe, F. L. and J. Moorby. 1979. An Introduction to Crop Physiology. Cambridge University Press. London.
5. Crostpher, T. 2006. Introduction to Mathematical Modeling of Crop Growth. Brown Walker Press. Florida, USA.
6. Thornley, J. H. M. and J. France. 2007. Mathematical Modeling in Agriculture. 2<sup>nd</sup> Ed. CABI. Oxford, UK.

**Title of the Course:      Crops for Changing Environments**

**Credit Hours: 3 (2-1)**

**Specific Objectives of Course:**

- To give impetus to learners for catering the need of climate resilient knowledge to address emerging challenges of climate change

**Theory:**

Environment, climate, agro-ecological zones of Pakistan, meteorological data and its relationship with respect to crop growth, environmental factors and their impact on crop productivity, climate change, crop water relations and gaseous exchange under varying climates, adaptability of conventional crops to changing environments, introduction and adaptability of new crops under indigenous conditions, climate resilience, climate proofing, introduction of climate resilient and climate proof crops, agro-biodiversity; limitations, options and scope; genotypic and phenotypic correlations of climate resilience; weedy behavior of introduced crops; morpho-physiological and phenological attributes of tolerance; resilient options on dry and saline environments.

**Practical:**

- Determination of Phenology of introduced and conventional climate proof and climate resilient crops
- Study and assessment of the weedy behavior of introduced crops
- Demonstration of morphological and physiological adaptation to biotic and abiotic stresses



### **Recommended Books:**

1. Pessarakli, M. 2011. Hand book of plant and crop stress. 3<sup>rd</sup> Ed. CRC press, Taylor & Francis group, N.Y., USA.
2. Popenoe, H., S. R. King, J. Leon, L. S. Kalinowski, N. D. Vietmeyer and M. Dafforn. 1989. The lost crops of Inca. National Academic Press. Washington D.C., USA.
3. R. Ortiz. 2011. Agro-biodiversity management for climate Change. In: Lenni, J. M. and D. Wood (Ed.). Agrobiodiversity management for food security: a critical review. CABI. Cambridge, USA.
4. Yadev, S. S., J. L. Hatfield, R. Redden, H. Lotze-Campen and A. Hall. 2011. Crop Adaptation to Climate Change. Iowa state university press. Ames, Iowa, USA.

**Title of the Course:      Plant Microbe Interaction**

**Credit Hours: 3 (2-1)**

### **Specific Objectives of Course:**

- Understanding the role of beneficial microorganisms to enhance the plant growth and their activities as bio-control agents against various diseases of plants.

### **Theory:**

Plant-soil-microbe interaction, biological nitrogen fixation, nutrients solubilization, phytohorm production, importance of microorganisms for soil fertility, microbiological control of bacterial and fungal plant pathogens, secondary metabolites with antifungal activities, antibiotic, hydraulic enzymes and siderophores, biofertilizers; production and maintenance of inoculants and application.

### **Recommended Books:**

1. Hafeez, F. Y., K. A. Malik and Y. Zafar. 2009. Microbial technologies for sustainable Agriculture. Crystal Press. Islamabad, Pakistan.
2. James, E. K., J. I. Sprent, M. J. Dilworth and W. E. Newton. 2005. Nitrogen Fixing Leguminous Symbiosis. Springer-Verlag. Berlin, Germany.
3. Klipp, W., B. Masepohl, J. R. Gallon and W. E. Newton. 2005. Genetics and Regulation of Nitrogen Fixation in Free Living Bacteria. Springer-Verlag. Berlin, Germany.
4. Saghir, M. D. A. Zaidi and J. Musarrat. 2009. Microbes in sustainable agriculture. Nova Science Publication. New York, USA.
5. Siddiqui Z. A. 2006. PGPR: Biocontrol and Biofertilization. Springer, the Netherlands.
6. Tilak, K. V. B. R., K. K. Pal and R. Dey. 2010. Microbes for Sustainable Agriculture. Int. Printing Publishing House Pvt. Ltd., New Dehli, India.

**ANNEXURE - A**

**DETAILS OF COMPULSORY COURSES**  
**COMPULSORY COURSES IN ENGLISH FOR**  
**Undergraduate Level**

**English I (Functional English)**

**Credit Hrs. 3**

**Objectives:** Enhance language skills and develop critical thinking.

**Course Contents**

Basics of Grammar  
Parts of speech and use of articles  
Sentence structure, active and passive voice  
Practice in unified sentence  
Analysis of phrase, clause and sentence structure  
Transitive and intransitive verbs  
Punctuation and spelling

**Comprehension**

Answers to questions on a given text

**Discussion**

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers

**Translation skills**

**Urdu to English**

**Paragraph writing**

Topics to be chosen at the discretion of the teacher

**Presentation skills**

Introduction

*Note: Extensive reading is required for vocabulary building*

**Recommended Books:**

1. **Functional English**

a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

- b) Writing
  1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
- c) Reading/Comprehension
  1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
- d) Speaking

## **English II (Communication Skills)**

**Credit Hrs. 3**

**Objectives:** Enable the students to meet their real life communication needs.

### **Course Contents**

#### **Paragraph writing**

Practice in writing a good, unified and coherent paragraph

#### **Essay writing**

Introduction

#### **CV and job application**

Translation skills

Urdu to English

#### **Study skills**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

#### **Academic skills**

Letter/memo writing, minutes of meetings, use of library and internet

#### **Presentation skills**

Personality development (emphasis on content, style and pronunciation)

*Note: documentaries to be shown for discussion and review*

### **Recommended Books:**

#### **Communication Skills**

- a) Grammar
  1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- b) Writing
  1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
  2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good



## ISLAMIC STUDIES (Compulsory)

### Objectives:

This course is aimed at:

- 1 To provide Basic information about Islamic Studies
- 2 To enhance understanding of the students regarding Islamic Civilization
- 3 To improve Students skill to perform prayers and other worships
- 4 To enhance the skill of the students for understanding of issues related to faith and religious life.

### Detail of Courses:

#### Introduction to Quranic Studies

- 1) Basic Concepts of Quran
- 2) History of Quran
- 3) Uloom-ul-Quran

#### Study of Selected Text of Holly Quran

- 1) Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
- 2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- 3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- 4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- 5) Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

#### Study of Selected Text of Holly Quran

- 1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- 3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

#### Seerat of Holy Prophet (S.A.W) I

- 1) Life of Muhammad Bin Abdullah ( Before Prophet Hood)
- 2) Life of Holy Prophet (S.A.W) in Makkah
- 3) Important Lessons Derived from the life of Holy Prophet in Makkah

#### Seerat of Holy Prophet (S.A.W) II

- 1) Life of Holy Prophet (S.A.W) in Madina
- 2) Important Events of Life of Holy Prophet in Madina
- 3) Important Lessons Derived from the life of Holy Prophet in Madina

#### Introduction To Sunnah

- 1) Basic Concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom –ul-Hadith

- 5) Sunnah & Hadith
- 6) Legal Position of Sunnah

## **Selected Study from Text of Hadith**

### **Introduction To Islamic Law & Jurisprudence**

- 1) Basic Concepts of Islamic Law & Jurisprudence
- 2) History & Importance of Islamic Law & Jurisprudence
- 3) Sources of Islamic Law & Jurisprudence
- 4) Nature of Differences in Islamic Law
- 5) Islam and Sectarianism

### **Islamic Culture & Civilization**

- 1) Basic Concepts of Islamic Culture & Civilization
- 2) Historical Development of Islamic Culture & Civilization
- 3) Characteristics of Islamic Culture & Civilization
- 4) Islamic Culture & Civilization and Contemporary Issues

### **Islam & Science**

- 1) Basic Concepts of Islam & Science
- 2) Contributions of Muslims in the Development of Science
- 3) Quran & Science

### **Islamic Economic System**

- 1) Basic Concepts of Islamic Economic System
- 2) Means of Distribution of wealth in Islamic Economics
- 3) Islamic Concept of Riba
- 4) Islamic Ways of Trade & Commerce

### **Political System of Islam**

- 1) Basic Concepts of Islamic Political System
- 2) Islamic Concept of Sovereignty
- 3) Basic Institutions of Govt. in Islam

### **Islamic History**

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids

### **Social System of Islam**

- 1) Basic Concepts of Social System of Islam
- 2) Elements of Family
- 3) Ethical Values of Islam

### **Reference Books:**

- 1) Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research

- Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, “Muslim Jurisprudence and the Quranic Law of Crimes” Islamic Book Service (1982)
  - 8) H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989)
  - 9) Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001)

## Pakistan Studies (Compulsory)

### Introduction/Objectives

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

### Course Outline

#### 1. Historical Perspective

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

#### 2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

#### 3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

### Books Recommended

1. Burki, Shahid Javed. *State & Society in Pakistan*, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.



7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

**COMPULSORY MATHEMATICS  
COURSES FOR BSc (Hons) AGRICULTURE**

**1. MATHEMATICS I (ALGEBRA)**

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

**Specific Objectives of the Course:**

To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

*Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression.

*Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices.

*Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

**Recommended Books:**

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

Boston (suggested text)

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

## 2. MATHEMATICS II (CALCULUS)

**Prerequisite(s):** Mathematics I (Algebra)

**Credit Hours:** 3 + 0

### **Specific Objectives of the Course:**

To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

### **Course Outline:**

*Preliminaries:* Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.

*Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

*Derivatives and their Applications:* Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

*Integration and Definite Integrals:* Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

### **Recommended Books:**

Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8<sup>th</sup> edition), 2005, John Wiley & Sons, New York.

Stewart J, *Calculus* (3<sup>rd</sup> edition), 1995, Brooks/Cole (suggested text)

Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston.

Thomas GB, Finney AR, *Calculus* (11<sup>th</sup> edition), 2005, Addison-Wesley, Reading, Ma, USA.

## 3. MATHEMATICS III (GEOMETRY)

**Prerequisite (s):** Mathematics II (Calculus)

**Credit Hours:** 3 + 0

### **Specific Objectives of the Course:**

To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

### **Course Outline:**

*Geometry in Two Dimensions:* Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation

of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

*Circle*: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

*Conic Sections*: Parabola, ellipse, hyperbola, the general-second-degree equation.

### **Recommended Books:**

Abraham S, *Analytic Geometry*, Scott, Freshman and Company, 1969

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston.

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston.

### **Note:**

- 1. Two courses will be selected from the following three courses of Mathematics.***
- 2. Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.***

**Statistics-I**

Credit 3 (2-1)

Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf digram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantiles and Mode in grouped and ungrouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

**Practicals**

- a. Frequency Distribution
- b. Stem-and-Leaf diagram
- c. Various types of Graphs
- d. Mean, Geometric mean Harmonic Mean,
- e. Median, Quartiles Deviation, mean Deviation.
- f. Standard Deviation, Variance, Coefficient of variation,
- g. Skewness and kenosis

**Book Recommended**

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crawshaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2<sup>nd</sup> Ed. (1986) Fran II. Dietrich-II and Thomes J. Keans

## Statistics-II

**Credit 3 (2-1)**

Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Interference Theory: Estimation and testing of hypothesis, Type—I and type-II error, Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test, Test of association of attributes using X<sup>2</sup> (chi-square) Testing hypothesis about variance.

### Practicals

- a. Sampling random sampling
- b. Stratified random sampling.
- c. Sampling distribution of mean
- d. Testing of hypotheses regarding population mean
- e. Testing of hypotheses about the difference between population means
- f. Chi-square test
- g. Testing of Correlation Coefficient
- h. Fitting of simple linear regression
- i. One-way ANOVA
- j. Two-way ANOVA

### Book Recommended

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. Principles and Procedures of Statistics A Bio-material approach, 2<sup>nd</sup> Edition, 1980 by R.G.D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2<sup>nd</sup> Edition (1980) by K. A. Gomez and A. A. Gomez.

***Note: Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.***

**Course Name: Introduction to Information and Communication Technologies****Course Structure:** Lectures: 2 Labs: 1**Credit Hours:** 3**Pre-requisite:** None**Semester:** 1**Course Description:**

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and world wide web, and ICT based applications.

After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

**Course Contents:**

- Basic Definitions & Concepts
- Hardware: Computer Systems & Components
- Storage Devices, Number Systems
- Software: Operating Systems, Programming and Application Software
- Introduction to Programming, Databases and Information Systems
- Networks
- Data Communication
- The Internet, Browsers and Search Engines
- The Internet: Email, Collaborative Computing and Social Networking
- The Internet: E-Commerce
- IT Security and other issues
- Project Week
- Review Week

**Text Books/Reference Books:**

Introduction to Computers by Peter Norton, 6<sup>th</sup> International Edition (McGraw-Hill)

Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6<sup>th</sup> Edition (McGraw-Hill)

Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer

# Functional Biology-I

***Credit Hours 3+0***

## **Biological Methods**

Principles of Cellular Life  
Chemical Basis  
Structure and Function  
Principles of Metabolism  
Energy Acquisition

## Principles of Inheritance

Mitosis and Meiosis  
Chromosomes  
Observable Inheritance Patterns  
DNA Structure and Function  
RNA and Proteins  
Genes  
Genetic Engineering and Biotechnology

## Biodiversity

Fundamental Concept of Biodiversity  
One or two examples of each of the following from commonly found organism  
Prions  
Viruses  
Bacteria  
Protistans  
Algae  
Fungi  
Plants  
Crops  
Animals  
Invertebrates  
Vertebrates

## ***Reading***

1. Roberts, M. M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N. A., J. B, Reece, L. G. Mitchell, M. R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.



# Functional Biology-II

## ***Credit Hours 3+0***

Myths and Realities of Evolution

Microevolution

Speciation

Macroevolution

Level of Organization

Plants

Tissues

Nutrition and Transport

Reproduction

Growth and Development

Animals

Tissue, Organ System and Homeostasis

Information Flow and Neuron

Nervous System

Circulation and Immunity

Nutrition and Respiration

Reproduction and Development

Ecology and Behavior

Ecosystems

Biosphere

Social Interactions

Community Interactions

Human Impact on Biosphere

Environment Conservation

## ***Reading***

1. Roberts, M. M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N. A., J. B, Reece, L. G. Mitchell, M. R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

**Note:** Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.

## General Recommendations

The committee recommended the following:

1. Department of Crop Physiology be established at PMAS Arid Agriculture University, Rawalpindi, Khyber Pakhtunkhwa Agriculture University, Peshawar, Gomal University, D.I. Khan, Balochistan University of Information Technology Engineering and Management Sciences, (BUIEMS) Quetta, Bahauddin Zakariya University, (BZU) Multan, The Islamia University of Bahawalpur, Lasbela, University of Agriculture, Water and Marine Sciences Uthal and The University of Azad Jamu and Kashmir, Rawlakot Campus like Sindh Agriculture University, Tandojam and University of Agriculture, Faisalabad where this department has already been established.
2. Crop physiology course may be added in agriculture domain and meetings of NCRC in Crop Physiology may be arranged in the series of agriculture domain subjects.
3. Teacher trainings be arranged to acquire new techniques in crop physiology.
4. Adequate number of posts of Crop Physiologists be created in agricultural departments/organizations of the country to strengthen the agricultural system by giving due recognition to this important field.
5. The committee further recommended that Crop Physiology be given an equivalent status as other major disciplines of agricultural specialization (e.g. Agronomy, Soil Science etc.) by the Federal and Provincial Governments to include this field of specialization in subject of preference.
6. National Book Foundation of Pakistan may be requested to print relevant text books in Crop Physiology in consultation with the experts.
7. Due recognition/incentive in the form of impact factor be given to the authors by Higher Education Commission for writing book/book chapter/manual.
8. The Society of Crop Physiologists needs to be established and later on a Journal of Crop Physiology may be published.
9. Internship:
  - a) Last six-months/final semester of the academic programme should preferably be reserved for internship. However, where internship opportunities are not available, optional courses should be offered as an alternative.
  - b) HEC should provide remuneration @ Rs.15000/month/internee for the internship.