CURRICULUM

OF

PLANT BREEDING AND GENETICS

BS/B.Sc (Hons)
MS/M.Sc (Hons)

(Revised 2010)

HIGHER EDUCATION COMMISSION
ISLAMABAD
## CONTENTS

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>Standardized Template for BS/B.Sc (Hons) in Agriculture</td>
<td>8</td>
</tr>
<tr>
<td>3.</td>
<td>Scheme of Studies for BS/B.Sc (Hons) in Plant Breeding and Genetics</td>
<td>9</td>
</tr>
<tr>
<td>4.</td>
<td>Details of Courses for BS/B.Sc (Hons) in Plant Breeding and Genetics</td>
<td>10</td>
</tr>
<tr>
<td>5.</td>
<td>Scheme of Studies for MS/M.Sc (Hons) in Plant Breeding and Genetics</td>
<td>28</td>
</tr>
<tr>
<td>6.</td>
<td>Details of Courses for MS/M.Sc (Hons) in Plant Breeding and Genetics</td>
<td>29</td>
</tr>
<tr>
<td>7.</td>
<td>Detail of Compulsory Courses</td>
<td>42</td>
</tr>
<tr>
<td>8.</td>
<td>Recommendations</td>
<td>60</td>
</tr>
</tbody>
</table>
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).

To bring international compatibility to qualifications held from Pakistani universities/DAIs for promotion of students mobility and job seekers around the globe, a Committee comprising of Conveners of the National Curriculum Revision Committee of HEC met in 2009 and developed a unified template for standardized 4-years/8-semesters BS degree programmes. This unified template was aimed to inculcate broader base of knowledge in the subjects like English, Sociology, Philosophy, Economics etc in addition to major discipline of study. The Bachelor (BS) degree course requires to be completed in 4-years/8-semesters, and shall require qualifying of 130-140 credit hours of which 77% of the curriculum will constitute discipline specific and remaining 23% will comprise compulsory and general courses.

In line with above, NCRC comprising senior university faculty and experts from various stakeholders and the respective accreditation councils has finalized the curriculum for BS and MS (Plant Breeding and Genetics). The same is being recommended for adoption by the universities/DAIs channelizing through relevant statutory bodies of the universities.

PROF. DR. ALTAF ALI G. SHAIKH
Member Academics

March 2010
CURRICULUM DEVELOPMENT
The final meeting of National Curriculum Revision Committee (NCRC) was held at HEC Regional Center Karachi from June 14-16, 2010 to review and finalize the revised draft curriculum. The following experts attended the meeting.

1. Prof. Dr. Hidayat-ur-Rahman Convener
   Conveners NCRC (PBG)
   NWFP Agriculture University
   Peshawar

2. Dr. Saif Ullah Ajmal Secretary/Member
   Professor
   Deptt of Plant Breeding and Genetics
   Arid Agriculture University
   Rawalpindi

3. Dr. Muhammad Jurial Rind, Member
   Associate Professor
   Deptt of Plant Breeding & Genetics
   Sindh Agriculture University
   Tandojam

4. Dr. Faqir Muhammad Azhar Member
   Professor
   Department of Plant Breeding & Genetics
   University of Agriculture
   Faisalabad

5. Prof. Dr. Farhatullah Member
   Professor,
   Department of Plant breeding & Genetics
   NWFP Agriculture University
   Peshawar

6. Dr. Muhammad Fareed Khan Member
   Department of Plant Breeding & Genetics
   University AJK Agriculture
   Rawlakot

7. Dr. Naeem Akhtar Member
   Assistant Professor
   Department of Plant Breeding & Genetics
   University of Sargodha,
   Sargodha
8. Mr. Ghulam Rasool Lashari  
   Member  
   Baluchistan Agriculture College  
   Chaman Road Beleli Quetta

9. Dr. Muhammad Iqbal  
   Member  
   Associate Professor  
   Deptt of Plant Breeding & Genetics  
   Islamia University Bahawalpur  
   Bahawalpur

10. Dr. Sher Muhammad Mangrio  
     Member  
     Professor  
     Institute of Plant Sciences  
     University of Sindh,  
     Jamshoro

11. Dr. Hamad Raza  
     Member  
     Assistant Professor  
     Deptt of Botany  
     GC University, Faisalabad

The meeting started with recitation from the Holy Quran by Dr. M.Tahir Ali Shah. After the recitation, Muhammad Javed Khan, Advisor Academics, HEC, welcomed the participants and highlighted the importance of curriculum development process at national level. Mr. Khan gave a quick rundown of efforts made by HEC to promote Higher Education in Pakistan with special reference to the development of curriculum and its accreditation and uniformity. Dr. Tahir Shah, Deputy Director (Curriculum) HEC, briefed the participants about the outcomes of the preliminary meeting. The technical proceedings of the meeting began with Prof. Dr. Hidayat-ur-Rahman as Convener and Dr. Saif Ullah Ajmal as Secretary who were unanimously elected in NCRC preliminary.

The participants reviewed each course keeping in view the comments of their colleagues at their respective universities/colleges. Accordingly, some courses were modified and some new courses were added to the curriculum in Plant Breeding & Genetics.

The Committee finalized the draft curriculum for Under-graduate and Post-graduate level for Plant Breeding and Genetics and suggested some recommendations to HEC. Finally, the meeting was concluded with the vote of thanks by the Chair.
Template for 4-Year BS/B.Sc. (Hons) in Agricultural Disciplines

1. **Compulsory Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics / Biology (2 courses)</td>
<td>6</td>
<td>(3-0) (2-1)</td>
</tr>
<tr>
<td>Statistics 1 &amp; 2</td>
<td>6</td>
<td>(3-0) (3-0)</td>
</tr>
<tr>
<td>Computers / IT</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Pakistan Studies</td>
<td>2</td>
<td>(2-0)</td>
</tr>
<tr>
<td>Islamic Studies</td>
<td>2</td>
<td>(2-0)</td>
</tr>
<tr>
<td>Communications Skills</td>
<td>3</td>
<td>(3-0)</td>
</tr>
<tr>
<td>English</td>
<td>3</td>
<td>(3-0)</td>
</tr>
<tr>
<td>Basic Agriculture</td>
<td>3</td>
<td>(2-1)</td>
</tr>
</tbody>
</table>

**Sub-Total 28**

2. **Interdisciplinary Foundation Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agronomy</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Plant Breeding &amp; Genetics</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Entomology</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Plant Pathology</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Food Technology</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Horticulture</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Soil Sciences</td>
<td>3</td>
<td>(2-1)</td>
</tr>
<tr>
<td>Agriculture Economics</td>
<td>3</td>
<td>(2-1)</td>
</tr>
</tbody>
</table>

**Sub-Total 24**

3. **Supporting Courses** {6-8 courses (3 Cr. hr) amongst below}

- Agriculture Extension
- Forestry & Range Management
- Animal Science
- Marketing & Agri Business
- Rural Development
- Human Nutrition
- Agriculture Chemistry
- Agriculture Engineering
- Water Management
- Any other discipline recommended by the university

**Sub-Total 18-24**

<table>
<thead>
<tr>
<th>Sub-Total during the first four semesters</th>
<th>70-76</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester 5, 6, 7 &amp; 8</td>
<td>56-60</td>
</tr>
<tr>
<td>Project / Internship</td>
<td>04</td>
</tr>
<tr>
<td>Grand Total</td>
<td>130-140</td>
</tr>
</tbody>
</table>

- 1 credit of theory = one contact hour per week for 16-18 weeks and 1 practical/Lab hour = 3 contact hours per week for 16-18 weeks.
- In case of non availability of department of supporting courses, courses from foundation courses can be opted.
Scheme of Studies for BS/B.Sc. (Hons.) in Plant Breeding and Genetics

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 401</td>
<td>Introductory Genetics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 402</td>
<td>Introductory Plant Breeding</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

5th Semester Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 501</td>
<td>Principles of Genetics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 503</td>
<td>Breeding Field Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 505</td>
<td>Cytogenetics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 507</td>
<td>Morphology and Reproductive Systems of Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 509</td>
<td>Breeding Cereal Crops</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

Total= 15

6th Semester Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 502</td>
<td>Breeding Fibre Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 504</td>
<td>Breeding Sugar Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 506</td>
<td>Breeding Maize and Millets</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 508</td>
<td>Biodiversity and Plant Genetic Resources</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>PBG 510</td>
<td>Molecular Genetics</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

Total= 15

7th Semester Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 601</td>
<td>Breeding Oilseed Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 603</td>
<td>Breeding Pulse Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 605</td>
<td>Breeding Vegetable Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 607</td>
<td>Modern Techniques in Plant Breeding</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 609</td>
<td>Fundamentals of Plant Biometry</td>
<td>3(3-0)</td>
</tr>
</tbody>
</table>

Total= 15

8th Semester Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 602</td>
<td>Breeding Fodder and Forage Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 604</td>
<td>Breeding Minor Crops</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PBG 606</td>
<td>Intellectual Property Rights in Crop Varieties</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>PBG 608</td>
<td>Internship or Research Project</td>
<td>4(0-4)</td>
</tr>
</tbody>
</table>

Total= 13
Objectives

To enable the students understand:
- Basic concepts of genetics
- Mechanism of heredity
- Effects of environment on organisms
- Chemical and molecular nature of gene

Theory

Definition of genetics, concepts of heredity and variation, cell and cell divisions; Chromosome theory of heredity; Mendelian Genetics, Monohybrid, dihybrid phenotypic and genotypic ratios. Differences between allelic and non-allelic interactions (epistasis), illustration of epistasis with suitable examples, Pleiotropy and multiple alleleism. Multiple factor hypothesis. Linkage and crossing over. Sex determination, Sex linked and sex influenced traits. Chromosomal aberrations. Physical, chemical and molecular nature of gene.

Practical

Cell structure, cell cycle and gametogenesis. Calculation of monohybrid and dihybrid ratios. Numerical problems relating to gene interaction, multiple alleles and multiple factor inheritance. Calculation of linkage from test cross and $F_2$ data.

Books recommended


World Wide Web

Objectives

To make the students know about:
- Basic concepts of plant breeding
- Reproductive mechanisms in major crops
- Application of genetic principles in crop improvement
- Breeding methods in self and cross pollinated crops

Theory


Practical

Descriptive study of floral biology, scientific names and chromosome number of important field crops. Selfing and crossing techniques in self and cross-pollinated crops.

Books recommended

Objectives
To enable students to understand:
- Chemical nature of genetic material
- Genetic control of protein synthesis
- Molecular basis of gene
- Mutation and its types

Theory

Practical
Solving problems on dihybrid and multihybrid segregating generations and backcrosses. Numerical problems relating to polygenic inheritance, sex linked inheritance, linkage and crossing over. Gene mapping.

Books recommended

world wide web
Objectives

To enable students to understand:
- Developmental history of various fibre crops
- Breeding fibre crops for yield and quality characteristics
- Breeding methods for incorporating resistance against biotic and abiotic stresses

Theory


Practical


Books recommended


Practical

Selfing and crossing techniques in self- and cross-pollinated crops. Assessment of variability in crops for biotic and abiotic stresses.

Books recommended


PBG 504 Breeding Sugar Crops 3(2-1)

Objectives

To enable students to understand

- Constraints in sugarcane breeding
- Different genetic systems in sugar crops
- Breeding methods in sugar crops

Theory

Origin, classification and botanical features of sugar crops. Genetics of *Saccharum officinarum* canes, evolution of noble canes and present status, flowering: a breeding constraint; Artificial induction of flowering and hybridization techniques; Selection strategies and development of new varieties. Improvement through modern approaches, Co-products of sugarcane. Exploitation of somaclonal variation and micropropagation for
improvement of sugarcane. Sugarbeet: botany and genetics, induction of flowering. Seed production strategies.

Practical
Identification of sugarcane species and varieties using morphogenetic features; Study of sugarcane flowering mechanisms. Morphogenetic features of sugar beet. Evaluation of sugarcane and sugar beet for quality parameters. Visit to sugar industries/research institutes.

Books recommended

World Wide Web
1. http://sugarcane-breeding.tn.nic.in/

PBG 505 Cytogenetics 3(2-1)

Objectives
To enable students to understand:
- Structure and functions of cell organelles
- Chromosomal structure, functions and their abnormalities

Theory
Description of cell organelles and their role in inheritance. Gross morphology and functions of chromosomes. Fine structure of chromosomes. Heterochromatin and euchromatin; Cytological differences in mitosis and meiosis. Karyotype studies of plant species; construction of ideograms; arm ratio and centromere index. Structural changes and breakage of chromosome, changes in chromosome number. Cytological basis and proofs of crossing over; Factors affecting crossing over. Gene mapping.
Practical


Books recommended


World Wide Web

1. en.wikipedia.org/wiki/Cytogenetics
2. www.molecularcytogenetics.org/

PBG 506 Breeding Maize and Millets 3(2-1)

Objectives

To enable students to understand
- Evolutionary pathways of maize and millet
- Breeding methods in maize and millet
- Hybrid maize production and its scope

Theory


Practical

Handling of inbred lines and hybrid material in maize. Development of various crosses, populations in maize and millets. Layout of experiments and
recording of data on various plant parameters. Visit to maize and millets research institutes and industry.

Books recommended

PBG 507 Morphology and Reproductive Systems of Crops 3(2-1)

Objectives
To enable students to understand:
- Floral morphology in various self and cross pollinated crops
- Reproductive systems of major crops
- Familiarize the students regarding hybridization techniques

Theory
Morphology and anatomy of root, stem and leaf in major crops. Description of growth and reproductive stages. Floral biology and pollination behavior, sexual reproduction, self sterility, incompatibility and factors responsible. Heteromorphy, dicyliny, dichogamy, asexual reproduction in different crops. Economic traits commonly measured in crop plants.

Practical
Study of root, stem, leaf and other plant parts of major crops. Study of floral morphology, various techniques employed to emasculate and pollinate flowers.

Books recommended
Objectives
To enable students to understand:
- Importance of biodiversity in plant breeding
- Strategies of germplasm collection and conservation
- Role of biotechnology in identification and preservation

Theory

Books recommended

Objectives
To enable students to understand:
- Application of genetic principles in cereal breeding
- Various reproductive systems in cereals
- Variety development and release procedures

Theory
Importance of food cereals; wheat, rice, barley and oats. Status of cereals; global and local perspective. Evolution, origin, and phenology of cereal crops.

Practical


Books recommended


PBG 510 Molecular Genetics 3(2-1)

Objectives

To enable students to understand:
- Concept of genetic codes and gene function
- Basics of genetic engineering and biotechnology

Theory


Practical

DNA extraction, isolation and quantification. Gel electrophoresis, DNA amplification.
Books Recommended


| PBG 601 | Breeding Oil Seed Crops | 3(2-1) |

Objectives

To enable students to understand:
- Status and situation of oilseeds in Pakistan
- Significance of conventional and non-conventional oilseed crops
- Breeding methodology in oilseeds

Theory


Practical


Books recommended


World Wide Web

PBG 602 Breeding Fodder and Forage Crops 3(2-1)

Objectives
To enable students to understand:
- Significance of fodder and forages in livestock
- Genetic and cytoplasmic basis of reproductive systems
- Various breeding methods in fodder and forages

Theory

Practical
Pollination, fertilization and seed setting in fodder and forage crops. Handling of apomictic, self and cross-pollinated fodder and forage species. Determination of nutritive quality; nutritive value. Visit to research organizations, livestock farms and feed industry.

Books recommended

### PBG 603 Breeding Pulse Crops 3(2-1)

#### Objectives

To enable students to understand:
- Significance and status of pulses
- Biotic and abiotic stresses
- Constraints in pulse breeding

#### Theory


#### Practical

Reproductive biology of important pulses, Crossing and hybridization techniques in major pulses. Study of rhizobium nodulation and nitrogen fixation in various pulse crops. Visit to research stations.

#### Books recommended


### PBG 604 Breeding Minor Crops 3(2-1)

#### Objectives

To enable students to understand
- Significance and status of minor crops
• Breeding methods in minor crops

Theory

Importance of minor crops: guar, sesame, linseed, sorghum, tobacco. Breeding objectives, methodologies and selection procedures; recurrent selection, general and specific combining ability. Use of male sterility in hybrid seed production. Breeding for biotic and abiotic stresses.

Practical

Handling of inbred lines and hybrid materials. Layout of experiments, recording and analysis of data on various plant parameters, visit to research Institutes and industry.

Books recommended

1. Ed., Iowa State University Press, Ames, USA

Objectives

To enable students to understand:
• Significance and classification of vegetables
• Reproductive mechanisms in various vegetables
• Role of biotechnology in vegetable improvement

Theory

Introduction, classification and importance of vegetable crops. Reproductive systems of important vegetables. Breeding objectives of important vegetable crops. Breeding and hybridization constraints of vegetables and possible improvement strategies. Hybrid seed production in vegetables. Breeding for quality, biotic and abiotic stresses and shelf- life. Role of biotechnology in improvement of vegetable crops.

Practical

Study of reproductive biology of important vegetables. Selfing and crossing techniques in major vegetables. Layout of field experiments and data recording for various genetic parameters. Visit to research stations.
Books recommended


Books recommended

Objectives

To enable students to understand:
  • Modern breeding tools and techniques in crop improvement.
  • Application of new techniques in plant breeding.

Theory


Practical


Books recommended


World Wide Web

1. en.wikipedia.org/wiki/Tissue_culture
2. www.accessexcellence.org/LC/ST/st2bgplant.html -
**Objectives**

To enable students to understand:
- Importance of planning and conducting research project
- Data collection, analysing and interpretation
- Logical presentation of results

**Practical**

Students will be required to undertake internship at various agricultural research organizations, private companies, extension/adaptive farms and private farms or undertake a research project at university fields/laboratories aimed at their practical training. Upon completion of internship/research project, students are required to submit a report and give presentation of internship/research experiment.

**Books recommended**


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**Objectives**

To enable students to understand
- Application of biometrical techniques in genetics and breeding
- Recording data on qualitative and quantitative traits
- Various statistical techniques used in plant breeding

**Theory**


**Books recommended**

SCHEME OF STUDIES
FOR MS/M.Sc (HONS) IN PLANT BREEDING & GENETICS

PBG 701 Advanced Methods in Plant Breeding 3(2-1)
PBG 702 Cytogenetics in Crop Plants 3(2-1)
PBG 703 Advanced Genetics 3(3-0)
PBG 719 Seminar 1(1-0)
PBG 720 Thesis 10(0-10)

General Courses for Post Graduate Students

PBG-704 Principles of Plant Breeding 3(2-1)
PBG-705 Breeding Fodder Crops 3(2-1)
PBG-706 Breeding for Stress Environments 3(2-1)
PBG-707 Mutation Breeding 3(2-1)
PBG-708 Population Genetics 3(3-0)
PBG-709 Cereal Genetics 3(2-1)
PBG-710 Cotton Genetics 3(2-1)
PBG-711 Genetics of Oilseed Crops 3(2-1)
PBG-712 Genetics of Sugar Crops 3(2-1)
PBG-713 Genetic Engineering in Plants 3(2-1)
PBG-718 Special Problems 1(1-0)
PBG-721 Evolution of Field Crops 3(3-0)
PBG-722 Genetics of Plant Disease and Insect Resistance 3(2-1)
PBG-723 Advanced Cytogenetics 3(2-1)
PBG-724 Hybrid Seed Production. 3(2-1)
PBG-725 Biometrical Techniques in Plant Breeding 3(2-1)
PBG-726 Special Problems 1(1-0)
PBG-728 Seminar-I 1(1-0)
PBG-729 Seminar-II 1(1-0)
PBG-730 Dissertation 20(0-20)
DETAIL OF COURSES
FOR MS/M.Sc (HONS) IN PLANT BREEDING & GENETICS

PBG 701  Advanced Methods in Plant Breeding  3(2-1)

Theory


Practical


Books Recommended


PBG 702  Cytogenetics of Crop Plants  3(2-1)

Theory

Cytogenetics and its importance in crop improvement. Ultra fine structure of cell and its contents. Overview of cell cycle. Cytological evidences of crossing over. Chromosomal aberrations; deficiencies and duplications, their phenotypic effects, genetic and cytological tests, use of translocations and

**Practical**

Slide preparation of mitotic and meiotic cell divisions from different plant material. Karyotype study of different crop plants: Banding techniques. Study of chromosomal structural changes.

**Books Recommended**


**PBG 703**

<table>
<thead>
<tr>
<th><strong>Advanced Genetics</strong></th>
<th>3(3-0)</th>
</tr>
</thead>
</table>

**Theory**


**Books Recommended**


### PBG 704  
**Principles of Plant Breeding**  
3(2-1)

**Theory**


**Practical**


**Books Recommended**


### PBG 705  
**Breeding Fodder Crops**  
3(2-1)

**Theory**

Breeding for greater seedling vigour, persistence of stand and disease and insect resistance.

Practical

Classification of various rabi and kharif fodders. Study of floral structure in different fodder crops. Selfing and crossing techniques for various fodders; handling breeding material and its evaluation.

Books Recommended


PBG 706 Breeding for Stress Environment 3(2-1)

Theory


Practical

Field and laboratory study of stress parameters; screening under simulated conditions; genetic analysis of tolerance related traits.

Books Recommended


### PBG 707  Mutation Breeding  3(2-1)

#### Theory

Mutation: importance and achievements in plant breeding. Classes of mutagens. Induction of mutation, detection, evaluation and utilization of induced mutants. Factors modifying the effectiveness of irradiation in seed treatment. Determination of LD50. Effectiveness and efficiency for inducing cytological changes. Gamma garden. Molecular basis of Mutation: Targeting Induced Local Lesions in Genomes (TILLING); making Kill Curve, development and handling of TILLING populations, high throughput screening of point mutations. Observations in M1, procedure for selection in later generations, use of mutants in hybridization programme. Improvement of specific characters through induced mutation. Mutation breeding research in some vegetatively propagated plants.

#### Practical

Radiation treatment techniques; Radio sensitivity of field crops; Cytological analysis of mutants; Field observations and selection procedure of irradiated material.

#### Books Recommended


#### World Wide Web

http://tilling.fhcrc.org:9366/files/Welcome_to_ATP.html
http://www.licor.com/bio/applications/4300_applications/tilling.jsp
Population Genetics

Theory


Books Recommended

Cereal Genetics

Theory


Practical

Problems relating to genetic analysis in wheat, rice, maize and barley. Estimation of grain quality. Identification of cereal diseases, screening of cereal cultivars for drought resistance and salt tolerance in lab and field conditions.
Books Recommended

PBG 710 Cotton Genetics 3(2-1)

Theory

Practical
Study of various physiological and morphological parameters. Collection of data on different plant and fibre characters and their genetic analysis.

Books Recommended

World Wide Web:
http://www.cotton.org/journal/archive.cfm
Theory

Practical
Specification and characteristics of edible oil, oil content, fatty acid, iodine number. Genetic evaluation of different fatty acids in oilseeds.

Books Recommended

World Wide Web

Theory

**Practical**

Estimation of brix value of sugarcane plant. Collection of data for various plant traits in sugar crops and their genetic analysis. Visit to research institutes and sugar industries.

**Books Recommended**


**World Wide Web**


| PBG 713 | Genetic Engineering in Plants | 3(2-1) |

**Theory**


**Practical**


**Books Recommended**


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBG 718</td>
<td>Special Problem</td>
<td>1(1-0)</td>
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<tr>
<td>PBG 719</td>
<td>Seminar</td>
<td>1(1-0)</td>
</tr>
<tr>
<td>PBG 720</td>
<td>Thesis</td>
<td>10(0-10)</td>
</tr>
<tr>
<td>PBG 721</td>
<td>Evolution of Field Crops</td>
<td>3(3-0)</td>
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</table>

**Theory**


**Books Recommended**


| PBG 722 | Genetics of Plant Disease and Insect Resistance | 3(2-1) |

**Theory**


**Practical**


**Books Recommended**

Theory

Books Recommended

Theory

Practical
Development of inbred lines. Estimation of GCA and SCA. Selection and maintenance of A, B and R lines under field conditions. Use of gametocides, induction of male sterility and evaluation of hybrids.

Books Recommended

| PBG 725 | **Biometrical Techniques in Plant Breeding** | 3(2-1) |

**Theory**

Importance of biometry in plant improvement. Selection indices; Diallel cross system. Genetic analysis of additive-dominance model, adequacy tests, limitations and assumptions for additive-dominance model, combining ability analysis, line x tester analysis and generation mean analysis; Regression and correlation analysis; Genotypic and phenotypic correlation analysis; Path coefficient analysis. Multivariate analysis. Principal Component Analysis.

**Practical**

Numerical examples regarding genetic analysis. Assessment of genotypic and phenotypic correlations, and partitioning of genotypic correlation into direct and indirect path ways. Use of software for biometrical analysis.

**Books Recommended**
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
b) Writing

c) Reading/Comprehension

d) Speaking
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**

b) **Writing**

c) **Reading**
2. Reading and Study Skills by John Langan
3. Study Skills by Riachard Yorky.
English III (Technical Writing and Presentation Skills)  
Credit Hrh. 3

Objectives: Enhance language skills and develop critical thinking

Course Contents
  Presentation skills
  Essay writing
  Descriptive, narrative, discursive, argumentative
  Academic writing
  How to write a proposal for research paper/term paper
  How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)
  Technical Report writing
  Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended books:
Technical Writing and Presentation Skills
  a) Essay Writing and Academic Writing
  b) Presentation Skills
  c) Reading
     The Mercury Reader. A Custom Publication. Compiled by Northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).
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 Holy 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 Holy 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 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) Quranic & 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,”
6) Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
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
   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. **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:**  
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:
Thomas GB, Finney AR, *Calculus* (11th 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:
Kaufmann JE, College Algebra and Trigonometry, 1987, 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.
Annexure - E

Statistics-I

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

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, 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 k enosis

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
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 X2 (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

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, 6th International 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

Functional Biology-II

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

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

1. In under-graduate scheme of studies, PBG-501, PBG-503, PBG-505, PBG-508, PBG 607 and PBG-609 were declared as core courses for students majoring in Plant Breeding and Genetics which will be taught at all agricultural universities and colleges. However, other courses on different crops may be changed according to regional specific agricultural requirements.

2. All agricultural universities and colleges have adopted semester system except the Faculty of Agriculture, Gomal University, D.I. Khan and Balochistan Agricultural College, Quetta. The Committee showed serious concern about this matter and again recommended them for the adoption of semester system as was recommended during the meeting of the NCRC held 2005 at HEC/UGC Regional Center, Karachi.

3. Representatives of Agriculture College, Quetta proclaimed about the deficiency of course related books, laboratory facilities and teaching faculty. They were advised to take the advantage of the projects launched by HEC. The information and details of these projects are available on HEC website (www.hec.gov.pk)

4. At post-graduate level, all the universities and colleges have been following the scheme of studies approved by the HEC with minor differences due to site/regional requirements. The committee discussed the course contents in detail and made improvements wherever necessary.

5. The courses PBG-701, PBG-702 and PBG-703 were decided as core courses in the scheme of studies of Plant Breeding and Genetics at post-graduate level and these courses will be taught in every agricultural university/college of the country.

6. Members of the committee showed concern about the change in the nomenclature of the degree being offered by Faculty of Agriculture Rawalakot, University of AJK. Muzaffarabad. The members after thorough discussion recommended that uniformity in nomenclature of the degree must be ensured and maintained.

7. Exchange of softwares between universities was recommended for strengthening collaboration and interaction among universities.

8. Workshop sponsored by HEC/Training of Trainers were strongly recommended to ensure regular updating of young teaching faculty about new developments in their area of expertise.

9. Visit to Institutes to National Research Institutes (NIFA/NIAB/CEMB) were emphasized so that Plant Breeding students are kept abreast of newly emerging techniques in plant Breeding and Genetics.