MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE

SEMESTER END EXAMINATION

B.Sc. Hons. (Agri.)

Semester	:	II (New)	**Academic year**	:	Monsoon 2017-18
Credits	:	3 (2+1)	**Title**	:	Fundamentals of Genetics
Course No.	:	GPB-121	**Total marks**	:	80
Day & time	:		**Time**	:	3 hrs

Note
1. Solve any **Eight** questions from **SECTION "A"**.
2. All questions from **SECTION "B"** are compulsory
3. All questions carry equal marks.
4. Draw neat diagram wherever necessary.

Model's Answer

SECTION "A"

Q.1. **a. Define Genetics and enlist different branches of Genetics.** **(4)**

Ans. Genetics is defined as the branch of biological science which deals with the study of mechanism of heredity and causes of variations in living beings.

Branches of genetics : (Explanation of each in brief).

1. Transmission genetics 2. Molecular and Bio-chemical genetics
3. Population and Bio-metrical genetics

b. Explain importance and scope of Genetics in crop improvement. **(4)**

Ans. **Importance of genetics :**

Development of new wheat strain called Marquis developed in Canada which is resistant to disease which matures two weeks earlier.

Changing the genetics make up harmful insects geneticist have become successful to reduce their fertility.

1. Green revolution 2. Biotechnology 3. Genetic Therapy.

Scope of genetics :

- It is useful in the improvement of plants and domestic animals for economic importance.
- It is used in improvement of health and intelligence.
- It is useful in the field of medicine e.g. in the study of disease transmission from one generation to other like diabetes heart trouble cancer, tubor-culosis (TB).
- It is useful in avoiding abnormalities and diseases through preventive medicines.
- It is useful legal tool in judiciary, court, law involving dispute of parents DNA tests can be used to decide real parents.

Q.2. **a. Define gene interaction and enlist different types of gene interaction with ratios.** **(4)**

Ans. When expression of one gene depends on the presence or absence of another gene in an individual, it is known as gene interaction.

Types of gene interaction

1. Recessive Epistasis (9:3:4 Ratio).
2. Dominant Epistasis (12:3:1 Ratio).
3. Dominant (Inhibitory) Epistasis (13:3 Ratio).
4. Duplicate Recessive Epistasis (9:7 Ratio).
5. Duplicate Dominant Epistasis (15:1 Ratio).
6. Polymeric Gene Interaction (9:6:1 Ratio).
7. Dihybrid gene interaction (9:3:3:1 Ratio).

b. Explain complementary gene interaction with suitable example.

Ans. Explanation of these with suitable example and recombination's by checker board.

Q.3. **a. What is linkage? Explain the phases of linkage**

Ans. Tendency of two or more gens to remain together in the same chromosome during inheritance is referred to as linkage.

There are two phases of linkage viz. coupling phase and repulsion phase.
Coupling: The linkage between two or more either dominant (AB) or recessive (ab) alleles is referred to as coupling. A good example or coupling was reported by Hutchinson in maize for the genes governing colour of seed 9coloured and colourless) and shape of seed (full and shrunken).
Repulsion: The linkage of dominant allele with that of the recessive allele (Ab or aB) is known as repulsion.

b. Write down the significance of linkage in crop improvement. (4)

Ans. **Significance of linkage :**

1. **Effect on selection**
2. **Effect on genetic variance**
3. **Effect on genetic correlation**

Q.4. **State Mendel's second law of inheritance.** (2)

Ans. **Mendel's Second law of inheritance :** when alleles for two contrasting characters come together in a hybrid, they do not blend, contaminate or affect each other while together these factors assort themselves at random and freely during the formation of gametes.

b. Enlist the various exceptions to Mendel's laws of inheritance. (3)

Ans. Exceptions to mendel's lows

1. Incomplete dominance
2. Co-dominance
3. Lethal genes
4. Over dominance
5. Penetrance
6. Expressivity
7. Pleiotropism
8. Multiple alleles
9. Gene interaction and Various modifications

c. Explain any one exception with suitable example.

Ans. Explain any one of the above with suitable example (3)

Q.5. **a. Define mutagen. Enlist various physical mutagens.**

Ans. **Mutagen :** Any agent which used to induce or to create the mutations is cold at mutagen. (4)
Physical Mutagen : X rays, Gamma rays, Alfa rays, Beta rays, Fast and Thermal Neutrons, UV rays

b. Describe the applications of induced mutations in crop improvement.

Ans. **Applications in crop Improvement** (4)
Induced mutations are useful in crop improvement in five principal ways, viz. 1) Development of improved varieties 2) Induction of male sterility 3) Production of haploids 4) Creation of genetic variability and 5) Overcoming self incompatibility. These are briefly discussed below.

Q.6. **a. Define mitosis. Explain different stages of mitosis.**

Ans. Mitosis is type of cell division in which each chromosome of the parent cell splits up longitudinally into two identical halves each half going to each of the daughter cells. (6)
Stages of mitosis : (Explanation of each in detail)
1. Interphase 2. Prophase 3. Metaphase 4. Anaphase 5. Citokinesis

b. Give the significance of mitosis.

Ans. (2)

1. The process of mitosis cell division helps to maintain equilibrium in the amount of DNA and RNA contents.
2. The cells resulting from mitotic division have same chromosome number as the parental cell.
3. Mitosis provides an opportunity for growth and development of an organism in

Q.7. **a. What is structural chromosomal aberration? Enlist different kinds of structural aberrations.** (4)

Ans. Any change which alters the normal structure of a chromosome is called structural chromosomal aberration.

Types of structural chromosomal aberrations :

1. Interchromosomal aberrations.
   a. Deletion or deficiencies b. Duplicate
2. Intrachromosomal aberrations.
   a. Inversions b. Trans location

b. Explain inversion in detail. (4)

Ans. (Explanation of any two chromosomal aberration in short)

Q.8. **a. What is chromosome? Describe external structure of chromosome.** (4)

Ans. The chromosomes are the unclear components of special organization, individuality and function. They are capable of self reproduction and play a vital role in heredity, mutation, variation and evolutionary development of the species.

External parts :

1. Arms 2. Centro mere 3. Telomere 4. Secondary constriction 5. Satellites

(Explanation of each part in short)

b. Describe ultra structure of DNA double helix model proposed by Watson and Crick. (4)

Ans. The structure of DNA was first discovered by Watson and Crick in 1953. It was realized that the structure of DNA should provide explanation for two essential mechanisms:

1. Transmission of hereditary characters and
2. Ability for self – duplication.

- The DNA molecule is an elongated polymer (polynucleotide) consisting of the four nucleotides.
- The diameter of a deoxyribose nucleotide is 10 A° (1nm) while that of DNA is 20 A° (2nm) and a pitch (one round) of 34A°.
- A = T and G = C : The amount of purines (adenines and guanines) in a polynucleotide is equal to the amount to the amount of pyrimidines (thymines and cytosines)
- DNA double helix
- Phosphate Backbones
- Hydrogen bonds
- Sequence of bases
- DNA dimensions
- Groves in DNA

} Explanation of these points short.

Q.9. **Write short notes on (Any Four)**

a) **1. Central dogma**

Ans. The transfer of genetic information from DNA to RNA to protein is called as central dogma. The cetral dogma proposed by Watson and Crick 1963.

b) **2. Multiple factor hypothesis**

Ans. This hypothesis assumes that a given quantitative character is controlled by a series of independent genes having additive and cumulative effects. Each gene is assumed to contribute a unit of quantity like height, kernel colour, R 1 and R2. Swedish genetist, Nilson Ehle published the multiple factor hypotheses on kernel colour in wheat in 1908. He made crosses between true breeding strains of what with red kernels and those with white kernels. In some crosses of red with white the F1 and in F2 a ratio of 3 red : 1 white was obtained indicating a single gene difference. Two type of red grains were obtained in F2 one type of red grains were as dark as those or parent and others as light as those of F1 as shown below in cross No. 1.

3. Lac operon model

Ans. The operon model of gene regulation was proposed by Jacob and Monod in 1961. They were awarded Nobel prize for discovery in 1965. The operon refers to a group of closely linked genes which act together and code for various enzymes of particular bio-chemical path ways. The operon model was developed working with tactose region (Lac region) of the human intestine bacteria *E. coli*. The gene regulation was studies for degradation of sugar lactose. The operon model consist of seven main components 1. Structural genes, 2. Operator gene, 3. Promoter gene, 4. Regulator gene, 5. Repressor, 6. Co-repressor and 7. Inducer

4. Cytoplasmic inheritance.

Ans. When the transmission of characters from parents to offspring is governed by cytoplasmic genes, it is known as cytoplasmic inheritance.

Important features of cytoplasmic inheritance are :

1. Reciprocal differences.
2. Maternal effects
3. Mappability.
4. Non-mendelian segreagation.
5. Somatic segregation.
6. Infection like transmission.
7. Governed by plasma genes.

5. Mendel's reasons for success

Ans.

1. Proper Maintenance of Records
2. Study of Individual Character
3. Choice of metarial
4. Maintenance of purity
5. Knowledge of shortfalls of earlier warkers
6. Mathematical background
7. Proper choice of characters

Q.10 Differentiate between the following (Any Four)

1. DNA and RNA

Ans.

DNA	RNA
1. Usually two stranded	1. Usually single stranded.
2. Sugar is deoxyribose	2. Sugar is ribose.
3. The bases are Adenine, guanine, cytosine and thymine.	3. The bases are Adenine, guanine, cytosine and uracil.
4. Mostly found in chromosomes, some in mitochondria and chloroplasts.	4. Mostly found in chromosomes and ribosomes.
5. It is self replicating.	5. It is formed from DNA.
6. Size of DNA is 4.3 million ucleotides.	6. Size of RNA is 12,000 million ucleotides.

2. Mitosis and meiosis

Ans.

Mitosis	Meiosis
1. Consists of one nuclear division.	1. Consists of two nuclear division.
2. One cell cycle results in production of two daughter cell.	2. one cell cycle results in the formation of 4 daughter cells.
3. The chromosome number of daughter cell is the same as that of mother cell (2n).	3. Daughter cells contain half the chromosome number of mother cell (n).
4. Daughter cells are identical with mother cell in structure and chromosome composition.	4. Daughter cells are different from mother cell in chromosome number and composition.
5. Mitosis occurs in somatic tissues.	5. It occurs in reproduction tissues.

Ans.

3. Qualitative and quantitative traits

Qualitative	Quantitative traits.
1. Governed by few genes. 2. Effect of each gene is detectable. 3. Governed by no-additive genes. 4. Variation is discontinuous. 5. Separation into different classes is possible. 6. Little influenced by environmental factors.	1. Governed by several genes. 2. Effect of each gene is not detactable. 3. Usually governed by additive genes. 4. Variation is continuous. 5. Separation into different classes is not possible. 6. Highly influenced by environmental factors.

Ans.

4. Back cross and Test cross

Back cross	Test cross
1. Cross of F_1 with one of its parents is called as back cross. 2. Back cross is not test cross.	1. Cross of F_1 with its recessive parents is called as test cross. 2. Test cross is always back cross.

Ans.

5. Autosomes and allosomes

Autosomes	Allosomes
1. Refer to other than sex chromosomes. 2. Morphology is similar in male and female sex. 3. The number is same in both the sexes. 4. Generally control traits other than sex. 5. Number of autosomes differs from species to species. 6. Do not exhibit sex linkage.	1. These are sex chromosomes. 2. Morphology is different in male and female sex. 3. The number is sometimes different in male and female sex. 4. Usually determine sex of an individual. 5. Each diploid organism usually has tow allosomes. 6. Exhibit sex linkage.

SECTION "B"

Q.11. Give the contribution of following scientists.

1. Erwin Chargaff

Ans. He demonstrated that adenine and thymine groups are equal to the guanine and cytosine.

2. Barbara McClintock

Ans. She discovered the jumping genes in maize.

3. Seymour Benzer

Ans. He gave the sub divisions of genes.

4. Har Gobind Khorana

Ans. He discovered how the genetic components of the cell nucleus control the synthesis of protein.

5. Flemming

Ans. He discovered mitosis

6. H. J. Muller

Ans. He showed that X-rays can speed up the natural process of mutation.

7. Hugo De Vries

Ans. He coined the term mutation

8. W. L. Johannsen

Ans. He coined the pureline

Q.12. Define the following terms.

1. Allele

Ans. The alternative form of gene is called as allele.

2. Karyotype

Ans. Karyotype referes to the characteristic features of chromosomes of a species.

3. Homozygous

Ans. Individuals having similar alleles on the corresponding locus of homologous chroromosome is called as Homozygous.

4. Heredity

Ans. The transfer of characters from one generation to other generation is called as Heredity.

5. Mutation

Ans. Sudden hen table change in an individual is

6. Back cross

Ans. A cross between a hybrid and either of its patents in called back cross

7. Genotype

Ans. The entire genetic constitution of an organism

8. Crossing over

Ans. An exchange of corresponding segments between non-sister chromatids of homologus chromosome during pachytene prophase.