MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMIANTION BOARD, PUNE

Semester End Examination

B. Sc. (Agri.)

Semester	:	II (New)	Academic year	:	Summer 2011-12
Course No.	:	BOT-122	Title	:	Principles of Genetics
Credits	:	3 (2+1)	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 ANSWER SHEET

SECTION "A"

Q.1 **a. Define gene interaction.** (1)

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

b. Enlist its different types. (3)

Ans :
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).

c. Explain complementary gene interaction with suitable example. (4)

Ans : When recessive alleles at either of the two loci can mask the expression of dominant alleles at the two loci, it is called duplicate recessive epistasis. This is also known as complementary epistasis.

The best example of duplicate recesive epistasis if found for flower colour in sweet pea. The purple colour of flower in sweet pea is governed by two dominant genes say A and B. When these genes are in separate indi-viduals (AAbb or aaBB) or recessive (aabb) they produce white flower. A cross between purple flower (AABB) and white flower (aabb) strains produced purple colour in F_1. Intermating of F_1 plants produced purple and white flower plants in 9:7 ratio in F_2 generation.

Q.2 **a. State Mendel's first laws of inheritance.** (2)

Ans : Law of Segregation: This law states that alleles segregate or separate from each other during gamete formation and pass on to different gametes in equal number. In other words, when alleles for two contrasting characters come together in a hybrid, they do not blend, contaminate or affect each other while together.

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

Ans : Some of the new concepts were at variance with the findings of Mendel. These are called as Mendelian deviations or exception or anomalies. Such investigation, include (1) Incomplete dominance, (2) Codominance, (3) Multiple alleles, (4) Linkage, (5) Lethal genes, (6) Gene interactions, (7) pleiotropic gene effect. (8) Polygenes, (9) environmental effects and (10) cytoplasmic or maternal effects. (3)

c. Explain any one exception with suitable example.

Ans : Explain any of them. (3)

Q.3 **a. Define meiosis.**

Ans : Two spindle using divisions which reduce the chromosome number from diploid to haploid consitutue meiosis. The main fuction of meiosis is to produce gametes in an organism. (1)

b. Describe in detail the various stages of meiosis I.

Ans : The first meiotic division consists of four different phases, viz. 1) prophase, 2) metaphase, 3) anaphase and 4) telophase. (4)

Prophase consistas of sub stage viz.; leptotene, zygotene, pachytene, diplotene and diakinesis.

c. Write down the significance of meiosis.

Ans : (3)

1. It helps in maintaining the chromosome number constant in a species. Meiosis results in production of gametes with haploid (half) chromosome number.
2. Meiosis facilitiates segregation and independent assortment of chromosomes and genes.
3. The recombination of genes also takes place during meiosis. Recombination of genes results in generation of variability in a biological population which is important from evolution points of view.
4. In sexually reproducing species, meiosis is essential for the continuity of generation because meiosis results in the formation of male and female gametes and union of such gametes leads to the development of zygote and thereby new individual.

Q.4 **a. Define cell organelles.**

Ans : Various membrane bound structures that are found within a cell are known as cell organelles. (1)

b. Enlist the various structures found in plant cells.

Ans : The various structures found in plant cells. (3)

1. Nucleus, 2. Plastids 3. Mitochondria, 4. Endoplasmic reticulum, 5. Ribosomes, 6. Lysosomes, 7. Golgo bodies, 8. Centrioles, 9. Cell wall, 10. Plasma membrane etc.

c. Describe in detail the structure and function of mitochondria.

Ans : Mitochondrion is a rod-like cytoplasmic organelle which is the main site of cellular respiration. They are sources of energy and are often called as the power house of the cell. They have average length of 3-4 μ and diameter of 0.5-1μ. Under light microscope, they appear as rod shaped, filamentous or granular structures in majority of the cells. Their average number varies from 200-800 per cell. In some protozoa, the number has been recorded upto 500,000 per cell. (4)

6. The code is degenerate or redundant
7. The code is has polarity.

Q.8 **a. Define mutagen.** (1)

Ans : Mutagens refer to physical or chemical agents which greatly enhance the frequency of mutations.

b. Enlist the various physical mutagenes. (3)

Ans : Physical mutagens includes :

1. X-rays
2. Gamma rays
3. Alpha particles
4. Beta rays particles
5. Fast and thermal neutrons
6. Ultra violet rays.

c. Describe the applications of induced mutations in crop improvement. 4)

Ans : Induced mutations ae 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
5. Overcoming self incompatibility.

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

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.

2 **Multiple alleles**

Ans : The existence of more than two alleles at a locus is referred to a multiple alleles.

Important features of multiple alleles are.

1. Multiple alleles always belong to the same locus and one allele is present at a locus at a time in a chromosome.
2. Multiple alleles always control the same character f an individual.
3. There is no crossing over in the multiple allelic series.
4. In a series of multiple alleles, wild type is always dominant.

3 **Lac operon model**

Ans : The operon refers to a group of closely linked genes which act together and code for various enzymes of a particular biochemical pathway. The operon model of gene regulation was proposed by Jacob and Monod in 1961. The operon model was was developed working with lactose region (lac region) of the muman intestine bacteria. The gene regulation was studied for degradation of the sugar lactose. The operon model consists of seven main components viz. 1. Structural genes, 2. Operator gene. 3. Promoter gene. 4. Regulator gene, 5. Repressor, 6. Corepressor, 7. Inducer.

Mitochondria, contain about 65-70 per cent proteins, 25-30 per cent lipids, 1 per cent RNA and less than 1 per cent DNA. Mitochondria consists of three main parts viz. 1). Membrane, 2. Christae and 3. Matrix.

Q.5 **a. What is polyploidy?** (1)

Ans : Polyploidy : An organism or individual having more than two basic or monoploid sets of chromosomes is called ploypoid ans such condition is known as polyploidy.

b. How polyploidy can be induced. (3)

Ans : Polyploidy is manily induced by treatment with a chemical known as colchicines. This is an alkaloid which is obtained from the seeds of aplant known as colchicum autumnale, which belongs to the family liliaceae. Colchicines does not affect colchicum from which it is extracted, because this plant has an anticolchicine substance. Colchicines is applied in a very low concentration, because high concentration is highly toxic to the cells.

c. Write down the application of polyploidy in crop improvement. (4)

Ans :
1. Tracing the origin of crop species.
2. Creation new species.
3. Interspecific gene transfer.
4. Bridging cross.

Q.6 **a. What is linkage?** (1)

Ans : Tendency of two or more gnes to remain together in the same chromosome durin inheritance is referred to as linkage.

b. Describe the phases of linkage. (4)

Ans : 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 reffered 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.

c. Write down the significance of linkage in crop improvement. (3)

Ans : Signficance of lingake in plant breeding:
1. Effect on selection.
2. Effect on Genetic variance.
3. Effect on Genetic correlation.

Q.7 **a. Define genetic code.** (1)

Ans : Genetic code referes to the relationship between the sequence of bases in RNA and the sequence of amino acids in a polypeptide chain.

b. Describe in detail the important feacturs/properties of genetic code. (7)

Ans : Nature of genetic code:
1. The code is triplet
2. The code is universal.
3. The code is commaless.
4. The code is non-overlapping
5. The code is non-ambigous.

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 material
4. Maintenance of purity
5. Knowledge of shortfalls of earlier workers.
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 DNA.
6. Size of DNA is 4.3 million nucleotides.	6. Size of RNA is 12,000 million nucleotides.

2. **Mitosis and Meiosis.**

Ans :

Mitosis	Meiosis
1. Consists of one nuclear division.	1. Consists of two nuclear divisions.
2. One cell cycle results in productin of two daughter cells.	2. One cell cycle results in the formation of 4 daughter cells.
3. The chromosome number of daughter cells 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 reproductive tissues

3. **Qualitative and Quantitative traits.**

Ans :

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

4. **Back cross and Test cross.**

Ans :

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

5. **Autosomes and Allosomes.**

Ans :

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

SECTION "B"

Q.11 A. **Use the appropriate term.**

1. **A basic unit of structure and function found in all living organisms.**

Ans : Cell

2. **A stage of cell division when chromosomes are arranged at equatorial plate.**

Ans : Metaphase

3. **The somatic chromosome number of the species.**

Ans : 2n

4. The cross in which the order of the parents is reversed.

Ans : Reciprocal cross.

B Write true or false.

1 Ribose sugar is found in DNA.

Ans : false

2 Plygenes are also called as major genes.

Ans : false

3 Monohybrid test cross ratio is 2:1.

Ans : false

4 The term gene was cloned by Mendel.

Ans : false

Q.12 A. Define the following terms.

1 **Heredity:** The transfer of characters from one generation to other generation is called as Heredity.

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

3 **Allele :** The alternative form of gene is called as allele.

4 **Karyotype:** Karyotype referes to the characteristic features of chromosomes of a species.

B. Write down the contribution of following scientist.

1 **B. McClintock**

Ans : She discovered the jumping genes in maize.

2 **H. J. Muller**

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

3 **S. Benzer**

Ans : He gave the sub divisions of genes.

4. **H. G. Khorana**

Ans : He discovered how the genetic componenets of the cell nucleus control ghe synthesis of protein.

Signature of Course Instructor
Name : Dr. A. B. Bagade
Mob.No. 7588082159, 9822720273

Signature of Head of the Department
Dr. I. A. Madrap
Phone No.02452-248660 Mob No.7588082153

MODEL ANSWER

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END EXAMINATION
B.Sc. (Agri.)

Semester	: II (New)	Term : II	Academic Year	:	2013-14
Course No.	: BOT 122		Title	:	Principles of Gene
Credit	: 3 (2+1)				
Day & Date	:	Time :Three hour	Total Marks	:	80

SECTION "A"

Q.1 a) Describe the functions of cell organelles.

Ans:

	Cell organelles		Functions
1	Nucleus	:	1. Nucleous of nucleus forms the ribosomes and Synthesis the RNA. 2. Chromatin of nucleus plays important role in the inheritance of the characters from the parents to their offspring.
2	Plastids	:	1. Leucoplasts are associated with storage of starch, protein and fat. 2. Chloroplasts are associated with photosynthesis.
3	Mitochondria	:	1. They the sites of cell respiration. The oxidation of carbohydrates, lipids and proteins occur in the mitochondria. They supply energy to various processes of cell in the form of ATP. 2. Associated with cytoplasmic inheritance as it contain DNA
4	Endoplasmic reticulum	:	1.Associated with the synthesis of proteins (rough ER),lipids and glycogen (rough and smooth ER). 2. Act as an inter-cellular transport system for various substances. 3. Contain lot of enzymes. 4. Provide passage for mRNA from nucleus to the cytoplasm.
5	Ribosomes	:	Protein synthesis with the help of mRNA.
6	Lysosomes	:	1. Digestion of intracellular substances and particles. 2.Autophagy:- during adverse conditions they digest their own cell inclusions. 3. Autolysis: - perform the function of removing dead cells.
7	Golgi bodies	:	1.Packaging of food materials such as proteins, lipids and phospholipids for transport to other cells. 2. Lysosomes are believed to be originated from golgi bodies.
8	Centrioles	:	Formation of spindle apparatus during cell division.
9	Cell wall	:	1. To protect inner part of cell. 2. To give a definite shape to the cell. 3. To provide mechanical support to the tissues.
10	Plasma membrane	:	1. It regulates the passage in and out of the cell. 2. It acts as a selectively permeable membrane. 3. It checks the entry of toxic elements from outside in to the cytoplasm.

Q.1 b) Give the classification of chromosome on the basis of centromere position.

Ans:

	Types /Classes	Brief description
1	Metacentric Chromosome	A chromosome in which centromere is located in the middle portion, such chromosome assume **V** shape at anaphase.
2	Sub-metacentric Chromosome	A chromosome in which centromere is located slightly away from the centre point or has sub median position, such chromosome assume **J** shape at anaphase.
3	Acrocentric Chromosome	A chromosome in which centromere is located very near to one end or has sub- terminal position. Also called as sub-terminal chromosome. Such chromosome assumes **J** shape or rod shape during anaphase.
4	Telocentric chromosome	A chromosome in which centromere is located at one end. Such chromosome assumes rod shape during anaphase.
5	Holokinetic chromosome	A chromosome with diffused centromere. Centromere does not occupy a specific position, but is diffused throughout the body of chromosome. Whole body of such chromosome exhibits centromeric activity. Also called holocentric chromosome.

(04)

Q.2 a) What are the types of crossing over and give the different factors which affect the crossing over?

Ans:

Depending upon the number of chiasmata involved, crossing over may be of three types,*viz.*, Single, double and multiple.

	Types /Kinds	Brief description
1	Single Crossing over	It refers to formation of a single chiasma between non –sister chromatids of homologus chromosome. Such cross involves only two chromatids out of four.
2	Double Crossing over	It refers to formation of a two chiasmata between non –sister chromatids of homologus chromosome. Double crossovers may involve either two strands or three or all the four strands. The ratio of recombinants and parental types under these three situations are observed as 2:2:3:1 and 4:0, respectively.
3	Multiple Crossing over	Presence of more than two cross overs between non-sister chromatids of homologus chromosomes is referred to as multiple crossing overs. Frequency of such type of crossing over is extremely low.

(02)

Factors affecting crossing over:

The frequency of crossing over is influenced by several factors which are briefly discussed below:

	Factors	Brief description
1	Distance	The distance between the genes affects the frequency of crossing over. Greater the distance between genes higher is the chance of crossing over and. *vice versa.*
2	Age	Generally crossing over decreases with advancement in the age in the female **Drossophila.**
3	Temperature	The rate of crossing over in **Drossophila** increases above and below the temperature of 22^0c.
4	Sex	The rate of crossing over also differs according to sex. There is lack of crossing over in **Drossophila** male and female silk moth.
5	Nutrition	Presence of metallic ions like calcium and magnesium in the food caused reduction in recombination in **Drossophila.** However, removal of such chemicals from the diet increased the rate of crossing over.
6	Chemicals	Treatment with mutagenic chemicals like alkylating agents was found to increase the frequency of crossing over in **Drosophila** female.
7	Irradiation	Irradiation with X-rays and gamma rays was found to enhance the frequency of crossing over in **Drossophila** female.
8	Structural Changes	Structural chromosomal changes especially inversions and translocations reduce the frequency of crossing over in the chromosome where such changes are involved.
9	Centromere effect	Generally genes that are located adjacent to the centromere show reduced frequency of crossing over.
10	Cytoplasmic genes	In some species cytoplasmic genes also lead to reduction in crossing over. For example. Tifton male sterile in pearl millet.

Q.2 b) What are the important characteristic features of cytoplasmic inheritance?

Ans: Cytoplasmic inheritance differs from Mendelian inheritance in several aspects and exhibits some characteristic features. The important characteristics features of cytoplasmic inheritance are briefly described below.

	Features	Brief description
1	Reciprocal Differences	Character which are governed by cytoplasmic inheritance invariably exhibit marked differences in reciprocal crosses in F_1, Whereas in case of nuclear inheritance such differences are not observed except in case of sex linked genes.
2	Maternal effects.	In case of cytoplasmic inheritance, distinct maternal effects are observed. This is mainly due to more contribution of cytoplasm to the zygote by female parent than male parent. Generally ovum contributes more cytoplasm to the zygote than sperm.
3	Mappability	Nuclear genes can be easily mapped on chromosomes, but it is very difficult to map cytoplasmic genes or prepare linkage map for such genes. Now chloroplasts genes in Chlamydomonas and maize, and mitochondrial genes in human and yeast have been mapped.

4	Non-Mendelian Segregation	The mendelian inheritance exhibits typical segregation pattern. Such typical segregation is not observed in case of cytoplasmic inheritance. The segregation when occurs, is different from mendelian segregation.
5	Somatic Segregation	Characters which are governed by cytoplasmic genes usually exhibit segregation in somatic tissues such as leaf variegation. Such segregation is very rare for nuclear genes.
6	Infection-like transmission	Cytoplasmic traits in some organisms exhibit infections like transmission. They are associated with parasites, symbionts or viruses present in the cytoplasm. Such cases do not come under true cytoplasmic inheritance.
7	Governed by Plasma genes	The true cases of cytoplasm inheritance are governed by chloroplast or mitochondrial DNA. In other words,Plasma genes are made of cp-DNA or mt-DNA.

Q.3 What is Mitosis? Describe the various stages of Mitosis and how it differs from Meiosis?

Ans: The spindle using nuclear division which produces two identical daughter cells from a mother cell is called **mitosis.**

The period in which one cycle of cell division is completed is called cell cycle. A cell cycle consists of two phases, *viz.*, 1.Interphase and 2.Mitotic phase. (4)

	Stages / Phases		Brief description
1	**Inetrphase**	:	Interphase is generally known as DNA synthesis phase and mitotic phase refers to the period of nuclear division. Inetrphase consists of G_1, S and G_2 sub phases.
a	G_1	:	It is a pre-DNA replication phase. It lies between telophase and S phase. This is the longest phase. Protein and RNA synthesis takes place during this phase.
b	S	:	This comes after G_1. The chromosome and DNA replication takes place during this phase.
c	G_2	:	This is a post-DNA replication phase. This is the last Stage of interphase. Protein and RNA synthesis occur during this stage.
2	**Mitotic phase**	:	A phase of separation of replicated DNA into two identical daughter nuclei without recombination is called mitotic phase. Thus, the daughter nuclei have the same chromosome combination as that of parent nucleus. The mitotic phase consists of four stages, *viz.*, 1.prophase, 2.metaphase, 3. anaphase and telophase.
a	Prophase	:	Prophase starts immediately after G_2 stage of interphase. Chromosomes look like thin thread and uncoiled in the early prophase, but become shortened, coiled and more distinct during mid prophase. In the late prophase, chromosomes appear more conspicuous, short and thick and longitudinally double. The two chromatids of each chromosome held at centromere are visible under light microscope. The nucleolus becomes smaller in size. The nuclear membrane and nucleolus disappear at the end of prophase. Among all the four phases of mitosis, prophase takes longest duration.

b	Metaphase	:	This phase begins after prophase. The spindle tubes are formed and chromosomes are oriented in the centre at equatorial plate. Chromosomes are attached to the spindle tubes at the centromere. Chromosomes are clearly visible at metaphase. Sister chromatids of each chromosome are joined together at the point of centromere, but their arms are free.
c	Anaphase	:	This is the phase when chromatids separate at the centromere and move towards opposite sides or poles. Chromatids of each chromosome become free at the centromere, but each chromatid is attached to spindle tube. These chromatids suddenly move apart, one goes to one pole and the other toward the other pole. After separation, each chromatid becomes a chromosome.
d	Telophase	:	When chromosomes reach the pole, the last stage, telophase begins. The spindle tubes disintegrate, A new nuclear membrane is formed at each pole covering the chromosomes. The nucleoli also reappear at each pole Chromosome again become thinner and longer by uncoiling and unfolding and look like a single thread under light microscope. Then the nucleus enter interphase.
e	Cytokinesis	:	The division of nucleus is known as **Karyokinesis.** It is followed by division of cytoplasm, which is known as **cytokinesis**. The division of cytoplasm into two daughter cells may take place in two ways. In plants, the division of cytoplasm takes place due to formation of cell plate. The formation of such plate begins in the centre of cell, which moves towards periphery in both side dividing the cytoplasm in to two daughter cells. In animals, the separation of cytoplasm starts by furrowing of plasma takes place.

Difference between Mitosis and Meiosis.

	Mitosis	Meiosis.
1	Consist of one nuclear division.	Consist of two nuclear division.
2	One cell cycle results in production of two daughter cells.	One cell cycle results in the formation of four daughter cells.
3	The chromosome number of daughter cells is the same as that of mother cell (2n).	Daughter cells contain half the chromosome number of mother cell (n).
4	Daughter cells are identical with mother cell in structure and chromosome composition	Daughter cells are different from mother cell in chromosome number and composition
5	Mitiosis occurs in somatic tissues.	Meiosis occurs in reproductive tissues.
6	Total DNA of nucleus replicates during S phase.	99.7% DNA replicates during S phase and remaining 0.3% during zygotene stage.
7	There is no pairing between homologous chromosome.	Homologous chromosomes pair during pachytene.
8	Segregation and recombination do not occur.	Crossing over takes place during pachytene.
9	Chromosomes are in the form of dyad at metaphase.	Chromosomes are in the form of tetrad at metaphase.
10	At metaphase, centromere of each bivalent divides longitudinally.	The centromere does not divide at metaphase.
11	One member of sister chromatids move to opposite pole during anaphase.	One member of homologus chromosome moves to opposite pole during anaphase.
12	Maintains purity due to lack of segregation and recombination.	Generates variability due to segregation and recombination.

Q.4 **Explain the law of segregation with example. What were the reasons of Mendel's success?**

Ans: This law state that alleles segregate or separate from each other during gamete formation and pass on to different gametes in equal number. In other words, when alleles for two contrasting characters come together in a hybrid, they do not blend, contaminate or affect each other while together. The different genes separate from each other in pure form, pass on to different gametes formed by a hybrid and then go to different offspring of the hybrid. Law of segregation is also known as law of purity of gametes. (2)

Example: (3)

When we make a cross between red (RR) and white (rr) flowered plants, we get red colour of flower in F_1. In the F_1 both the alleles R and r remain together without blending or mixing with each other, though only the effect of dominant allele is visible. In F_2, allele for red flower colour and white flower colour segregate during gamete formation and pass on to the gametes in equal number. Thus two types of gametes, *viz.*, R and r are formed. Each gamete has either R or r allele. When the F_1 is self-pollinated, individuals with three genotypes, viz., RR, Rr and rr are obtained in F_2. Here RR and Rr are all red and only rr individuals are white. Thus a phenotypic ratio of 3 red: 1 white is obtained. The overall mechanism is represented below.

Parents — Red flower RR × White flower rr

⇩

F_1 — Rr (Red)

F_2

Gametes	R	r
R	RR (Red)	Rr (Red)
r	Rr (Red)	rr (white)

Reasons of Mendel's success: (3

Main reasons of Mendel's success are given below:

1. He maintained proper records of observations.
2. He analysed individual character.
3. His choice of material *i.e.* garden pea, which is self pollinated species, was proper.
4. He maintained purity of characters.
5. He had knowledge of the shortfalls of earlier workers.
6. He selected contrasting characters for study which could be easily grouped in distinct classes.
7. He had good background of Mathematics which helped in proper interpretation of results.

Q.5 **Define gene interaction. Enlist different types of gene interaction along with its F_2 ratio and explain complementary gene interaction (duplicate recessive epistasis) with suitable example.**

Ans: **Gene interaction:** Change in the expression of one gene depending on the presence or absence another gene affecting the same character is called gene interaction.

Different types of gene interaction along with its F_2 ratio:

	Gene interaction	F_2 ratio
1.	Interaction without modification of normal F_2 phenotypic ratio.	9:3:3:1
2.	Recessive epistasis (Supplementary gene interaction)	9:3:4
3.	Dominant epistasis (Simple epistasis)	12:3:1
4.	Inhibitory gene interaction	13:3
5.	Duplicate recessive epistasis (Complementary gene interaction)	9:7
6.	Duplicate dominant epistasis (Duplicate gene interaction)	15:1
7.	Polymeric gene interaction	9:6:1

Complementary gene interaction (duplicate recessive epistasis):

When recessive alleles at either of the two loci can mask the expression of dominant alleles the two loci, it is called duplicate recessive epistasis. This is also known as complementary epistas /gene interaction.

The best example of duplicate recessive epistasis is found for flower colour in sweet pe The purple colour of flower in sweet pea is governed by two dominant genes say A and B. Wh these genes are in separate individual (AAbb or aaBB) or recessive (aabb) they produce white flowe A cross between purple flower (AABB) and white flower (aabb) strains produced purple colour F_1.Intermating of F_1 plants produce purple and white flower plants in 9:7 ratio in F_2 generation. Th can be explained as follows.

Here recessive alleles a is epistatic to B/b alleles and mask the expression of these alleles. Another recessive allele b is epistatic to A/a alleles and mask the expression. Hence in F_2, plants wit A-B-(9/16) genotypes will have purple flower and plants with aaB-(3/16),A-bb-(3/16) and aab (1/16) genotypes produce white flowers. Thus only two phenotypic classes *viz.*,purple and white ar produced and the normal dihybrid segregation ratio 9:3:3:1 is changed to 9:7 ratio in F_2 generation.

Parents Purple flower AABB × White flower aabb

F_1 ⇩ AaBb (Purple flower)

F_2

Gametes

	AB	Ab	aB	ab
AB	AABB (P)	AABb (P)	AaBB (P)	AaBb (P)
Ab	AABb (P)	AAbb (W)	AaBb (P)	Aabb (W)
aB	AaBB (P)	AaBb (P)	aaBB (W)	aaBb (W)
ab	AaBb (P)	Aabb (W)	aaBb (W)	aabb (W)

P= Purple flower ,W= White flower

Q.6 a) Define mutation. What are the different types of mutation?

Ans: **Mutation:** It refers to sudden heritable change in the phenotype of an individual. In molecular terms mutation is defined as the permanent and relatively rare change in the number or sequence of nucleotide. (1)

Different types of mutation. (3)

Mutation has been classified in various ways as follows.

	Basis of classification	Types of Mutation
1	Origin	Spontaneous and induced mutation
2	Direction of change	Forward and reverse mutation
3	Tissue involved	Somatic and germinal mutation
4	Site	Point and cytoplasmic mutation
5	Character involved	Morphological and biochemical mutation
6	Visibility/ Phenotypic effect	Macro and Micro mutation
7	Survival	Lethal,sub-lethal, sub-vital and vital mutations.

Q.6 b) What are the features of quantitative traits?

Ans: Main features of polygenic character or quantitative traits are as follows: (4)

1. They are governed by several genes.
2. Effect of each gene is not detectable.
3. The variation is continuous.
4. Separation in to clearcut classes is not possible.
5. Such characters are highly influenced by environmental factors.
6. Statistical analysis is based on means, variances and covariances.
7. Such characters exhibit transgressive segregation.
8. The heritability of such characters is low as compare to oligogenic characters.

Q.7 a) What is Multiple allele? Give the main features of multiple alleles.

Ans: **Multiple allele:** Existence of more than two alleles at a locus is referred to as multiple alleles. (1)

Main features of multiple allele: (3)

1. They belong to the same locus.
2. At a time one allele is present at a locus.
3. They control the same character.
4. There is no crossing over within multiple allele series.
5. The wild type is dominant on all other types of alleles.
6. Multiple alleles do not exhibit complementation.

Q.7 b) Explain the phases of linkage and give the significance of linkage in plant breeding.

Ans: **Phases of Linkage:** (2)

There are two types of phases.

1. Coupling phase:- The linkage either between dominant genes (AB) or between recessive genes (ab) is called coupling phase.
2. Repulsion phase:- The linkage between dominant and recessive genes (Ab or aB) is called repulsion phase.

Significance of linkage in plant breeding.

Linkage between two or more desirable characters is advantageous because desirable alleles appear together more frequently than would be expected from independent assortment. This enhance the progress of selection. On the other hand linkage between desirable and undesirable g will hinder the progress breeding.

Q.8 a) Describe the various types of aneuploids.

Ans: **Types of aneuploids.**

	Types of aneuploid	Definition / brief description
	Aneuploidy	Change in one or few chromosome of a genome.
1.	**Hypopliody**	Loss of one or two chromosomes from a diploid set.
a)	Monosomic	Loss of one chromosome from one pair (2n-1)
b)	Double monosomic	Loss of two chromosome from one pair (2n-1-1)
c)	Nullisomic	Loss of one chromosome pair (2n-2)
2)	**Hyperpliody**	Addition of one or two chromosomes to one pair or two different pair
a)	Trisomic	Addition of one chromosome to one pair only (2n +1)
b)	Double Trisomic	Addition of one chromosome to two different pair (2n +1+1)
c)	Tetrasomic	Addition of two chromosomes to one pair (2n +2)
d)	Double Tetrasomic	Addition of two chromosomes to two different pairs (2n +2+2)

Q.8 b) Enlist the different types of chromosomal aberration and explain any one with suitable diagram.

Ans: **Different types of chromosomal aberration**

1.Deletion
2.Duplication
3.Translocation
4. Inversion.

(Explanation of above any one type)

Q.9 Differentiate between the following (Any two)

Ans: **1. DNA and RNA**

	Particulars	DNA	RNA
1	Strands	Usually two, rarely one	Usually one, rarely two
2	Sugar	Deoxyribose	Ribose
3	Bases	Adenine, guanine, cytosine and thymine.	Adenine, guanine, cytosine and uracil.
4	Pairing	AT and GC	AU and GC
5	Location	Mostly in chromosomes, some in mitochondria and chloroplasts	In chromosomes and ribosomes
6	Replication	Self replicating	Formed from DNA. Self replication or in some viruses.
7	Size	Contains up to 4.3 million nucleotides	Contains up to 12,000 nucleotides
8	Function	Genetic role	Protein synthesis, genetic in some viruses
9	Types	There are several forms of DNA	Three types viz., mRNA, tRNA and rRNA

2. Transcription and Translation

	Transcription	Translation
1	The process involoving the synthesis of mRNA from DNA is called Transcription	Translation is a process of formation of polypeptide chain (Protein) by using sequence of codon on mRNA.
2	Transcription occurs in the nucleous only.	It occurs in cytoplasm only.
3	In this one of the DNA strand acts as a template for the synthesis of mRNA.	The codons of mRNA act as a Template for the synthesis of proteins.
4	It requires the presence of polymerase enzyme	It requires the presence of amino acyl synthetase enzyme
5	It does not require the participation of tRNA, r-RNA, ribosomes and codons.	It requires the participation of tRNA, r-RNA, ribosomes and codons.

3. Autosomes and allosomes.

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

Q.10 Write short notes on (Any two)

Ans: **1.Main components of operon model:**

The main components of operon model are given below.

	Components of operon model	Brief description
1	Structural genes	Genes (z,y and a) in lac operon of *E.Coli* which control the synthesis c protein from mRNA are called structural genes.
2	Operator gene	The gene which is located between promoter gene and structural gene i operon model of *E.Coli* is operator gene. It control the function o structural genes.
3	Promoter gene	In operon model of *E.Coli* a gene which is located between regulator gen and operator gene is called promoter gene. The main function of promote gene is to initiate transcription
4	Regulator gene	In operon model of *E.Coli* a gene which is located on one end of operon near promoter gene is called is regulator gene. The function of regulato gene is to direct the synthesis of repressor which is a protein molecule.
5	Repressor	Repressor is a protein molecule. It synthesis is directed by regulaor gene.
6	Corepressor and	Corepressor is perhaps a product of one of the enzymes synthesized by structural genes. Repressor-corepressor complex can block the operator gene and stop protein synthesis by structural genes.
7	Inducer	Inducer is substrate (i.e. lactose in lac operon) which promotes transcription. It binds with repressor molecule and inactivate the same. The repressor then cannot bind with operator gene. Hence, the transcription and protein synthesis take place.

Q.10 2. Penetrance and Expressivity:

Penetrance: The frequency with which a gene produces a phenotypic (visible) effect in the individuals that carry it, is called penetrance. It is of two types.*viz.*, Complete and Incomplete

a) Complete penetrance: Expression of a gene in all the individuals which carry it, is called complete penetrance.

b) Incomplete penetrance: Expression of a gene in less than 100% of it carriers is called incomplete penetrance.

Expressivity: The degree of expression of a penetrant gene in its carriers is called expressivity. It is of two types' *viz.*, uniform and variable.

a) Uniform expressivity:- uniform expression of a gene in all the individuals carrying such genes is termed as uniform expressivity.

b) Variable expressivity:- differential or variable expression of a gene in all the individuals carrying such genes is called as variable expressivity.

Q.10 **3.Mendelian deviations:** (4)

Some of the new concepts were at variance with the finding of Mendel, these are called as mendelian deviations or exceptions or anomalies. Such investigations include

Mendelian deviations		Brief description
1	Incomplete dominance	Cases of incomplete dominance were reported .For example: In four 'o'clock plant (*Mirabilis jalapa*). A cross between red and white flower plants produced plants with intermediate flower colour *.i.e.* Pink colour in F_1 and modified ratio of 1 red : 2 pink : 1white was observed in F_2.
2.	Co-dominance	In case of co-dominance both allel express their phenotypes in heterozygote. The example is AB blood group in human. The main difference between co-dominance and incomplete dominance lies in the way in which genes act. In case of co-dominance, both alleles are active while in case of incomplete dominance only one allele is active.
3	Multiple alleles	Exhistance of more than two alleles for a gene is called multiple alleles. Example of multiple alleles is ABO blood group alleles in human, Coat colour in rabbit and self incompatibility alleles in tobacco.
4	Linkage	Cases of linkage were reported by Bateson and Punnet in 1906 in pea. Hutchinson in Maize and Morgan (1910) in **Drosophila.** In a dihybrid test cross they observed higher frequencies of parental types than recombinants instead of 1:1:1:1 ratio.This led to modification of the concepts of independent assortment.
5	Lethal genes	Gene which causes the death of its carrier when in Homozygous condition is called lethal genes. They have been reported in both animal as well as plants.
6	Gene interactions	When the expression of an allele of one gene pair depends on the presence of specific alleles of another pair, is known as gene interactions. The modified F_2 ratios included 9:7,9:3:4,12:3:1,13:3,15:1 and 9:6:1 in different crop plants
7	Pleiotropic gene effect	A gene which governs two or more character is known as Pleiotropic gene effect. Example: White eye allele in **Drossophila.**
8	Polygenes	Nilson Ehle observed that some characters are controlled by several genes and each of such genes has additive effects in the expression of characters.
9	Environmental effects	Phenotype is the result of the interaction between genotype and environment. The importance of environment was first realized by Johannsen. He coined the term genotype and phenotype.
10	Cytoplasmic or maternal effects	Inheritance which is governed by plasma genes or cytoplasmic genes is called cytoplasmic or maternal inheritance. The first case of cytoplasmic inheritance was reported by Correns in 1909 in *Mirabilis jalapa* for leaf colour.

SECTION "B"

Q.11 a) Match the pairs (one mark each)

	"A"		"B"
(1)	Theory of acquired character	D)	Lamarck
2)	Multiple factor hypothesis	C)	Nilson Ehle
3)	Coined the term Genetics	A)	Bateson
4)	Sex chromosomes	B)	Mc Lung

b) Define the following terms. (one mark each)

1) Genotype : The genetic constitution of an individual, such as RR, Rr or rr.
2 Variation : Differences for various characters among the individuals of the same species.
3 Maternal effect : Influence of the genotype of female parent on the expression of a character.
4 Genetic code : The relationship between the sequences of bases in RNA and the sequences of amino acids and the sequence of amino acids in a polypeptide chain.

Q.12 Fill in the blanks: (one mark each)

1) **mRNA** carries information from nuclear DNA to cytoplasm for protein synthesis.
2) Crossing over occurs during **pachytene** stage.
3) An individual having more than two basic sets of chromosomes is known **polyploids**
4) The **dominant** character expresses in F_1.
5) A phenomenon in which a gene has more than one phenotypic effects (manifold effects), su genes are called **pleiotropic** genes.
6) A cross in which the order of the parents is reversed is known as **reciprocal** cross.
7) **Ribosomes** are sites of protein synthesis.
8) **Allele** refers to alternative form of a gene.

Signature of Course Instructor:

Dr. D. S. Phad,
Assistant Professor of Agril. Botany
College of Agriculture Akola
Phone No. (0724) 2259117, Mobile No: 9422875179

Signature of the Head of Department:

Dr. R.S.Nandanwar
Head, Department of Agril. Botany
Dept. of Agril. Botany
Dr. P.D.K.V, Akola
Fax No. (0724) 2258299, Mobile No: 901 10

Model Answer

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUN

SEMESTER END THEORY EXAMINATION

B. Sc. (Agri)

Semester	: II (New)	Academic year	: 2014-15		
Course No.	: BOT-122	Course Title	: Principles of Genetics		
Credits	: 3 (2+1)	Time	: 3 hours	Total marks	: 80
Day & Date	:				

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

SECTION "A"

Q. 1 Define mutagenc. Enlist the various physical and chemical mutagenes. Describe the classification of mutation.

Definition- Mutagene refer to physical or chemical agents which greatly enhance the frequency of mutations. 1

Physical Mutagenes- 3

- X-rays
- Gamma rays
- Alpha particles
- Beta rays particles
- Fast and thermal neutrans
- Ultraviolet rays

Chemical Mutagenes

- Alkylating agents
- Base Analogues
- Acridine dyes
- Other mutagenes

Classification of Mutation

1. Based on source- 4
   a. Spaontaneous
   b. Induced

2. Based on Direction
   a. Forward mutation
   b. Reverse mutation
3. Based on tissue
   a. Somatic mutation
   b. Germinal mutation
4. **Based on survival**
   a. Lethal
   b. Sub-lethal
   c. Sub-vital
   d. Vital
5. **Based on site**
   a. Nuclear mutation
   b. Cytoplasmic mutation
6. **Based on character**
   a. Morphological
   b. Biochemical
7. **Based on visibility**
   a. Micro- mutation
   b. Macro-mutation

(Short explanation of above is to be given)

Q. 2 Define gene interaction. Enlist different gene interactions with modification F_2 phenotypic ratios. Explain complementary gene interaction with suitable example.

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

Gene Interaction with F_2 phenotypic ratio-

Sr. No.	Type	Ratio
1	Supplementary factor	9:3:4
2	Epistasis	12:3:1
3	Inhibitory factor	13:3
4	Complementary factor	9:7
5	Duplicate factor	15:1
6	Additive factor	9:6:1
7	Lethal factor	2:1

Description on complementary gene interaction along with example is to be given in brief 4

Q. 3 What is crossing over? Enlist the type of crossing over and mention the factors affecting crossing over.

Ans. **Definition-**. Crossing over refers to the interchange of parts between non-sister chromatids of homologous chromosomes during pachytene stage of Meiosis. 1

Types of crossing over 3

- Single crossing over
- Double crossing over
- Multiple crossing over

Factors affecting crossing over 4

1. Distance
2. Age
3. Temperature
4. Sex
5. Nutrtion
6. Chemicals
7. Irradiation
8. Structural changes
9. Centromere effect
10. Cytoplasmic genes

(Explanation of above point is to be given in brief)

Q. 4 Define meiosis. Describe in detail the various stages of meiosis I. Write down the significance of meiosis

Ans. **Definition:** Two spindle using divisions which reduce the chromosome number from diploid to haploid constitute meiosis. 1

Stages of Meiosis-I 4

- First Meiotic division- The first meiotic division consists of four different phases

I. Prophase-I

- This phase starts after inter phase and is of maximum duration.
- This consists of five sub stages.

i. **Leptotene-**

- Chromosomes look like thin thread under light microscope. They are inter-woven like a loose ball of wool.
- Chromosomes are scattered throughout the nucleus in a random manner.
- In some cases, chromomeres are visible on the chromosomes in the form of condensed regions.

- RNA and protein synthesis also take place.

ii. **Zygotene-**

- Homologous chromosomes being to pair is called as synapsis.
- Chromosomes become shorter and thicker.
- The synthesis of remaining 0.3% DNA which has not taken place during S phase also occurs during this stage.
- Synaptonemal complex also develops during this stage.

Synaptonemal complex- A protein frame work which is found between paired chromosomes.

Pachytene-

- Chromosomes look like bivalents. Each bivalent has two chromatids. Thus each pair has four chromatids generally known as tetrad.
- The structure produced by pairing between homologous chromosomes is known as bivalent.
- The chromosome number looks like haploid number.
- Nucleolus is present and attached to a chromosome.
- Formation of chiasma and crossing over takes place during pachytene stage.
- Chiasma- Point of contact between non-sister chromatids.

Diplotene-

- Separation of homologous chromosomes begins. It starts at centromere and moves towards the end.
- The separating chromosomes are attached at some points. These points are called as chiasmata.
- These chiasmata are terminalized towards the end of diplotene.
- Chiasma terminalization- Chiasma slowly moves towards the ends of homologous chromosome.
- Chromosomes are further condensed and become still shorter and thicker.
- Nucleolus decreases in size.

Diakinesis

- This stage begins after complete terminilization of chiasmata.
- Chromosomes are further condensed.
- Bivalents are distributed throughout the cell.
- Nucleolus and nuclear membrane disappear towards the end of diakinesis.

(Description on significance of meiosis is to be given in brief)

Q. 5 State Mendel's laws of inheritance. Enlist the character studied by Mendel. Describe the law of independent assortment with suitable example.

Ans. **Mendel's Laws of Inheritance** 2

1. Law of segregation- When alleles for two contrasting character come together in a hybrid, they do not blend, contaminate or affect each other while together. The different genes separate from each other in pure form; pass on to different gamets formed by a hybrid and then go to different individuals in the offspring of the hybrid.
2. **Law of Independent Assortment**- This law states that when two pairs of gene enter in F1 combination, both of them have their have independent dominant effect.

Characters studied by Mendel- 2

1. Plant Stature- Tall and Dwarf
2. Position of flower- Axial and Terminal
3. Shape of Pod- Inflated and Constricted
4. Colour of Pod- Green and Yellow
5. Seed Shape- Round and Wrinkled
6. Seed colour- Yellow and Green
7. Seed- coat Colour- Grey and White

Description on Law of Independent Assortment along with example is to be given in brief 4

Q. 6 What is linkage? Describe phases of linkage. Write down the significance of linkage in plant breeding.

Ans. **Definition:** Tendency of genes to remain together in the same chromosome during hereditary transmission. 1

Phases of Linkage- 4

1. **Coupling Phase**- The linkage between two or more either dominant (AB) or recessive (ab) alleles is referred as coupling. A good example of coupling was reported by Hutchinson in maize for the genes governing colour of seed (coloured and colourless) and shape of seed (full and shrunken). The coloured seed is governed by dominant gene (C) and full seed is also governed by dominant gene (S). He made cross between plants having coloured full seeds (CCSS) and colourless shrunken seeds (ccss). The F1 seed were coloured full. When the F_1 was test crossed with double recessive parent the following results were obtained instead of 1:1:1:1 ratio.

Parents	Coloured full	X	Colourless shrunken
Genotype	CCSS	↓	ccss
F_1	CcSs		Coloured full
Test cross	CcSs	X	ccss
		↓	
Test cross progeny			
Coloured full	CS	4032	Parental type
Coloured shrunken	Cs	149	Recombinant type
Coloured full	cS	152	Recombinant type
Colourless shrinken	cs	4035	Parental type

This indicates that parental combinations are higher than recombinations, indicating presence of linkage.

2. **Repulsion Phase**- The linkage of dominant allele with that of the recessive allele (Ab or aB) is known as repulsion. Hutchinson also observed repulsion phase of linkage in maize. He observed this type of linkage when he made cross between plants having coloured shrunken seed (Cs) with those having colourless full seed (cS). In F1, the seeds were colored full. By crossing of F1 with double recessive parent the following results were obtained instead of 1:1:1:1

Parents	Colourless full	X	Coloured shrunken
Genotype	ccSS	↓	CCss
F_1	CcSs		Coloured full
Test cross	CcSs	X	ccss
		↓	
Test cross progeny			
Coloured full	CS	639	Recombinant type
Coloured shrunken	Cs	21379	Parental type
Coloured full	cS	21906	Parental type
Colourless shrunken	cs	672	Recombinant type

Again parental combinations were higher than expected and recombinations were lower than expected.

Significance in plant breeding-

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

3

Description of above point is to be given in brief

Q. 7 a. Define cell organelles. Describe the functions of cell organelles.

Definition: Various membrane bound structures that are found within cell are known as cell organelles. 1

Functions of Cell Organelles- 3

Sr. No.	Name of cell Organelles	Function
1	Nucleus	Nucleolus of nucleus forms the ribosomes and synthesis the RNA
2	Plastid	Chloroplasts are associated with photosynthesis
3	Mitochondria	1.They supply energy to various of cell in the form of ATP 2. Associated with cytoplasmic inheritance as it contain DNA
4	Endoplasmic reticulum	1. Associated with the synthesis of protein, lipids and glycogen 2. Acts as an intercellular transport system for various substances.
5	Ribosomes	Protein synthesis with the help of mRNA
6	Lysosomes	Digestion of intracellular substances and particles.
7	Golgi bodies	Packaging of food materials such as proteins, lipids and phospholipids.
8	Centrioles	Formation of spindle apparatus during cell division
9	Cell Wall	1. To protect inner part of cell. 2. To give definite shape to the cell. 3. To provide mechanical support to the tissues.
10	Plasma membrane	1. It regulates the passage in and out of the cell. 2. It acts as a selectively permeable membrane. 3. It checks the entry of toxic elements from outside in to the cytoplasm.

b. Enlist different parts of chromosome. Classify the chromosome on the basis of position of centromere.

Parts of Chromosomes- 1

1.Centromere	5. Chromatid
2.Secondary Constriction	6. Telomere
3.Chromomeres	7. Chromonema
4.Matrix	

Classification of Chromosome on the basis centromere position 3

1. Metacentric chromosome- Centromere is located in the middle portion
2. Sub-metacentric- Centromere is located slightly away from the cenre point.
3. Acrocentric- Centromere is located very near to one end.
4. Telocentric- Centromere is located at one end
5. Holokinetic- A chromosome with diffused centromere.

Q. 8 a) Define aneuploidy. Explain types of aneuploidy along with its symbol.

Definition- The change in chromosome number which involves one or few chromosomes of the genome is called aneuploidy.

Types of aneuploidy- 3

Types	Description	Symbol
Hypoploidy	Loss of one or two chromosomes from a diploid set	
a. Monosomic	Loss of one chromosome from one pair or from two different pair	2n-1 2n-1-1
b. Nullisomic	Loss of one chromosome pair	2n-2
Hyperploidy	Addition of one or two chromosomes to one pair or two different pairs	
a.Trisomic	Addition of one chromosome to one pair or two different pairs	2n+1 2n+1+1
b. Tetrasomic	Addition of two chromosome to one pair or two different pairs	2n+2+2

b) What is genetic code? Enlist the features of genetic code.

Definition- The relationship between the sequence of bases in RNA and the sequence of amino acids in polypeptide chain. 1

Features of Genetic Code- 3

1. Triplet
2. Universal
3. Commaless
4. Non-overlapping
5. Non-ambiguous
6. Degenerate or redundant
7. Polarity

Description of above point is to be given in brief

Q. 9 What is cytoplasmic inheritance? Explain important features of cytoplasmic inheritance. Describe its significance in plant breeding.

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

Important features:

1. Reciprocal Differences- Character which are governed by cytoplasmic inheritance invariably exhibit marked differences in recoprocal crosses in F1, whereas in case of nuclear inheritance such differences are not observed in case of sex linked genes.
2. Maternal effect- In case of cytoplasmic inheritance, distinct maternal effects are observed. This is mainly due to more contribution of cytoplasm to the zygote by female parent tham male parent.
3. Mappability- Nuclear genes can be easily mapped on chromosomes, but it is very difficult to map cytoplasmic genes or prepare linkage map for such genes.
4. Non-mendelian segregation- The mendelian inheritance exhibit typical segregation pattern. Such typical segregation is not observed in case of cytoplasmic inheritance.
5. Somatic segregation- Character which are governed by cytoplasmic genes usually exhibit segregation in somatic tissues such as leaf variegation.
6. Infection-like cytoplasm- Cytoplasmic tritts in some organisms exhibit infections like transmission. They are associated with parasites, symbionts,or viruses present in the cytoplasm.
7. Governed by plasma genes- The true cases of cytoplasmic inheritance are governed by chloroplast or mitochondrial DNA.

Significance in pla it Breeding

1. Cytoplasmic inheritance has been useful in explaining the role of various cytoplasmic organelles in the transmission of character in different organisms.
2. Studies of cytoplasmic inheritance have played key role in mapping of chloroplast and mitochondrial genome in several species.
3. Development of cytoplasmic male sterility. CMS lines have been developed in several crops like maize, rice, sorghum, cotton etc.
4. Availability of CMS lines has facilitated the production of hybrid seed in these crops in cheaper cost.
5. Role of mitochondria in the manifestation of heterosis is gaining increasing importance these days.
6. Mutation of chloroplast DNA and mitochondrial DNA leads to generation of new variants.

Q.10 Differentiate between the following (Any two)

a) Mitosis and Meiosis

Sr. No.	Mitosis	Meiosis
1	Consist of one nuclear division	Consist of two nuclear division
2	One cell cycle results in production of two daughter cells.	One cell cycle results in the formation four daughter cells.
3	The chromosome number of daughter cells is the same as that of mother cell.	Daughter cells contain half the chromosome number of mother cell
4	Mitosis occurs in somatic tissues	It occurs in meiosis tissues.
5	Total DNA replicates during S phase	99.7% of DNA replicates during S phase and remaining 0.3% during zygotene stage.
6	There is no pairing between homologous chromosome	Homologous chromosome pair during pachytene stage
7	Segregation and recombination do not occur	Crossing over takes place during pachytene
8	Maintains purity due to lack of segregation and recombination	Generates variability due to segregation and recombination

b. DNA and RNA

Sr. No.	DNA	RNA
1	Usually two strand rarely one	Usually one or rarely two.
2	Sugar is deoxyribose	Sugar is ribose
3	The bases are Adenine, guanine, cytosine, and thymine	The bases are Adenine, guanine, cytosine and uracil
4	Mostly found in chromosomes, some in mitochondria and chloroplast	Mostly found in chromosomes and ribosomes
5	It is self replicating	It is formed in chromosomes and ribosomes
6	Size of DNA is 4.3 million	Size of RNA is 12000 million nucleotides

c. Qualitative character and Quantitative character

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

SECTION " B "

Q. 11 A Use the appropriate term

1 The cross in which the F1 is crossed with its homozygous recessive parent.

Ans Test cross

2 The cell organelle which is associated with photosynthesis.

Ans Chloroplast

3 The new crop species which has been synthesized from a cross between wheat and rye.

Ans Triticale

4 The alternative form of gene.

Ans Allele

Q.11 B State true or false.

1 Monohybrid test cross ratio is 3:1.

Ans False

2 Basic number can be a haploid number but all haploid numbers cannot be basic number.

Ans True

3 rRNA carries information from nuclear DNA to cytoplasm for protein synthesis.

Ans False

4 The gametic chromosome number is denoted by 'n'.

Ans True

Q.12 A Give the contribution of the following scientist

1 Hugo de Vries- Coined the term Mutation

2 Bateson- Coined the term Genetics

3 H. J. Muller-Mutation induction by X-rays in Drosophila

4 B. McClintock- Jumping gene in maize

Q.12 B Define the following terms

1. **Sex limited trait-** A character, which is expressed in one of the two sexes only. 1
2. **Expressivity-**The degree of phenotypic expression of a gene in the different individuals, it may be uniform or variable 1
3. **Heredity-** Transmission of character from parents to offspring. 1
4. **Lethal gene-** That allele of a gene, which causes the death of all those individuals that carry in it appropriate genotype. 1

Signature of course instructor
Name : Mr. M. G. Palshetkar
(M) : 8087963276

Signature of Head of the Department
Name : Dr. S. G. Bhave
(M) : 9422556565

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END EXAMINATION

B.Sc. (Agri.)

Semester	: **II (New)**	**Term**	: **II**	**Academic Year**	: **2015-16**
Course No.	: BOT 122	**Title**	: **Principles of Genetics**		
Credits	: 3 (2+1)				
Day & Date	: Monday, 02.05.2016	**Time**	: 09.00 to 12.00	**Total Marks**	: **80**

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 diagrams wherever necessary.

SECTION "A"

Q.1 a) Define mutagen. Enlist various physical and chemical mutagens with examples.
b) Describe types of structural chromosomal aberrations.

Q.2 a) Define gene interaction. Enlist its different types.
b) Explain complementary gene action with suitable example.

Q.3 a) Explain the Mendel's first law of segregation with example.
b) Enlist the various exceptions to Mendel's laws of inheritance and explain any one of them.

Q.4 a) What is linkage? Describe the phases of linkage.
b) What is crossing over? Describe the factors affecting crossing over.

Q.5 a) Define polyploidy. Explain the applications of polyploidy in crop improvement.
b) What is aneuploid? Describe the various types of aneuploids.

Q.6 a) Define genetic code. Describe in brief different properties of genetic code.
b) Enlist the various structures found in plant cell. Give the functions of endoplasmic reticulum.

Q.7 a) What is mitosis? Describe the various stages of mitosis.
b) What is multiple allele? Give the main features of multiple alleles.

Q.8 a) Explain the types of chromosome on the basis of centromere position.
b) Describe important features of cytoplasmic inheritance.

Q.9 Differentiate between (Any two)
1) Qualitative character and quantitative character.
2) Transcription and translation.
3) DNA and RNA

Q.10 Write short notes on (Any two).
1) Lac operoan model.
2) Sex determination.
3) Types of RNA

(P.T.O.)

SECTION "B"

Q.11 A) Give the contribution of following scientists.

1) Lamarck
2) McClintock B.
3) Mc Lung
4) Nilson Ehle

B) Define the following terms.

1) Penentrance
2) Pleiotropic effect
3) Homozygous
4) Autosomes

Q.12 A) Fill in the blanks.

1) A cross in which the order of parents is reversed is known as _____ cross.
2) F_1 generation has all individuals are _____.
3) _____ is associated with photosynthesis.
4) _____ are sites of protein synthesis.

B) State True or False.

1) The heritability of quantitative character is low as compared to qualitative character.
2) Autosomes are sex chromosomes.
3) Cross of F_1 with its parents is test cross.
4) Mitosis helps in maintaining the chromosome number constant in a species.

✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧

Q.2 a) Define gene interaction. Enlist its different types . 4

Ans The modification of the normal phenotype of certain genes by other gene is known as gene interaction.

1) Supplementary gene action/ Recessive epitasis (9:3:4)
2) Dominant epistasis (12:3:1)
3) Dominant and recessive (inhibitory) epistasis (13:3)
4) Complimentary gene action /Duplicate recessive epistasis (9:7)
5) Duplicate dominant epistasis (15:1)
6) Polymeric gene interaction (9:6:1).
7) Dihybrid gene interaction (9:3:3:1)

b) **Explain complementary gene action with suitable example.** 4

Ans When recessive alleles at either of the two loci can mask the expression of dominant alleles at the two loci, it is called duplicate recessive epistasis. This is also known as complementary epistasis. The best example of duplicate recessive epistasis if found for flower colour in sweet pea. The purple colour of flower in sweet pea is governed by two dominant gene say A and B when these genes are in separate individuals (Aabb or aaBB) and (aabb) they produce white flower. A cross between purple flower (AABB) and white flower (aabb) strains produced purple colour in F_1 intermating of F_1 plants produced purple and white flower plants in 9:7 ratio in F_2 generation. Here the recessive allele .a. is epistatic to B/b alleles and mask the expression of these alleles, another recessive allele b is epistatic to A/a alleles and mask their expression.

Parents Purple flower x White flower
AABB ⇩ aabb
(AB) (ab)

F_1 Purple flower
AaBb

F_2 Gametes

	AB	Ab	aB	ab
AB	AABB Purple	AABb Purple	AaBB Purple	AaBb Purple
Ab	AABb Purple	AAbb White	AaBb Purple	Aabb White
aB	AaBB Purple	AaBb Purple	aaBB White	aaBb White
ab	AaBb Purple	Aabb White	aaBb White	aabb White

Purple (9) : White (7)

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END THEORY EXAMINATION
B. Sc (Agri.)

Semester	: II (New)	Term : II	Academic Year : 2015-16
Course No	: BOT 122	Title	: Principles of Genetics
Credits	: 3(2+1)	Total marks	: 80
Days & Date	:	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 diagrams wherever necessary.

MODEL ANSWER SHEET

SECTION-A

Q.1 a) Define mutagen. Enlist various types of mutagens with examples.

Ans A mutagen is any substance or agent that can cause a mutation or change in the sequence or structure of DNA.

Types of mutagens:

1) **Physical mutagens :** It includes various types of radiations.
   a) Ionizing radiations: e. g. Alfa rays, Beta rays, fast neutrons, X-rays, gamma rays etc.
   b) Non-ionizing radiations (Electromagnetic radiations): e. g Ultra-violet radiations(UV)
2) **Chemical mutagens:**
   a) Alkylating Agents: e. g Ethylmethane sulphonate (EMS),Methylmethane sulphonate (MMS), Sulphur mustards etc
   b) Base Analogs : e. g 5-bromouracil, 5 chlorouracil
   c) Acridine Dyes : e. g Acriflavine, proflavin, acridine orange, ethidium bromide (ED) etc.
   d) Other chemical mutagens : e. g Nitrous acid, hydroxyl amine, sodium azide etc.

b) Describe types of structural chromosomal aberrations

Ans Chromosomal Aberration is an abnormality of chromosome number or structure

Changes in the structure of chomosomes.

a. Loss or addition of segment of chromosome.
b. Changes in the normal arrangement of genes in the chromosome.

Deletion (deficiency) :- Loss of a segment of a chromosome

Duplication :- Repetition of a segment of a chromosome.

Translocation :- Exchange of segments between two non - homologous chromosomes resulting in new chromosomes.

Inversion :- Change in the linear order of genes by rotation of a section of a chromosome through 180 degrees

Q.3 a) **Explain the Mendel's first law of segregation with example.** 4

Mendel's first law of segregation state that alleles segregates or separate from each other during gamete formation and pass on to different gametes in equal number.

Parents Red flower x White flower

RR ⇩ rr

(R) (r)

F_1 Red flower

Rr

F_2 Gametes

	R	r
R	RR Red	Rr Red
r	Rr Red	rr White

b) **Enlist the various exceptions to Mendel's laws of inheritance and Explain any one.** 4

Mendelian deviations or exceptions or anomalies includes

1) Incomplete dominance 2) Codominance 3) Lethal genes 4) Multiple alleles 5) Linkages 6) Gene interactions 7) Pleiotropic genes 8) Polygenes 9) Environmental effects 10) Cytoplasmic or maternal effects

Q.4 a) **What is linkage? Describe the phases of linkage.** 4

The tendency of two or more genes to remain together, in their original combination in the same chromosome during inheritance is called linkage. The phenomenon of linkage was first reported by Bateson and Punnet in 1906

There are two phases of linkage

a) Coupling phase: All dominant alleles are present on the same chromosome or all recessive alleles are present on same chromosome.

(b) Repulsion phase: Dominant alleles of some genes are linked with recessive alleles of other genes on same chromosome.

b) **What is crossing over? Describe the factors affecting crossing over.** 4

The exchange of homologous segments between non-sister chromatids of homologous chromosomes is called crossing over. The term crossing over was first used by Morgan and Cattell in 1912. Crossing over takes place during pachytene

Factors affecting crossing over:

1. Distance between the genes: positive associated with the distance two genes
2. Sex: No crossing over occurs between sex linked genes
3. Age of female: Progressive decline with the advancing age

4. **Temperature:** The frequency of recombination tends to increase both at the lower and higher temperatures than 22^0C.
5. **Nutrition:** Higher the amount metallic ions like Ca+2 and Mg+2 in its food lower will be the crossing over frequency and vice-versa. .
6. **Chemicals Treatment :** Treatments with mutagenic chemicals like alkalyting agents was found to increase the requency of crossing over in drosophila.
7. **Radiations treatment :** With x-rays and g-rays increase frequency of crossing over.
8. **Plasmagenes:** Reduces the frequency of crossing over in bajra.
9. **Chromosomal aberrations:** Reduce recombination between the genes
10. **Distance from centromere:** Centromere tends to suppress recombination

Q.5 a) **Define polyploidy. Explain the applications of polyploidy in crop improvement.** 4

An organism or individual having more than two basic sets of chromosome is called as polyploidy.

Applications:

1) Creation of new crop species
2) Identification of origin of species
3) Widening genetic base
4) Utilization as a Bridging species

b) **What is aneuploid? Describe the various types of aneuploids.** 4

Ans Variation in the number of chromosomes of a set or change in one or few chromosome of a genome or an addition of one or more entire chromosome or as a loss of such chromosomes to a genomic number

Types of Aneuploids

	Types of Aneuploid	Brief Description
1	**Hypoploidy**	Loss of one or two chromosome from diploid set.
a	Monosomic	Loss of one chromosome from one pair (2n-1)
b	Double Monosomic	Loss of two chromosome from one pair (2n-1-1)
c	Nullisomic	Loss of one chromosome pair (2n-2)
2	**Hyperploidy**	Addition of one or two chromosome to one pair or two different pairs
a	Trisomic	Addition of one chromosome to one pair (2n+1)
b	Double Trisomic	Addition of one chromosome to two different pairs (2n+1+1)
c	Tetrasomic	Addition of two chromosome to one pair (2n+2)
d	Double tetrasomic	Addition of two chromosome to two different pairs (2n+2+2)

Q.6 a) **Define genetic code. Describe in brief different properties of genetic code.**

Ans Genetic code refers to the relationship between the sequences of bases in RNA and sequence of amino acid in a polypeptide chain.

Properties of genetic code :

1.The code is triplet.
2.The code is universal.
3.The code is comma less.
4.The code is non- overlapping.
5.The code is non ambiguous
6.The code is degenerate or redundant
7.The code has polarity

b) **Enlist the various structures found in plant cells. Give the functions of endoplasmic reticulum.**

Ans Various structures found in plant cells.

1. Cell wall 2. Endoplasmic reticulum 3. Ribosomes 4. Mitochondria 5. Golgi apparatus 6. Plastids 7. Nucleus 8. Plant cell vacuoles 9. Peroxisomes 10. Lysosomes 11. spherosomes 12. Plasma membrane etc.

Functions of endoplasmic reticulum.

1. Associated with the synthesis of proteins (Rough ER), lipids and glycogen.
2. Acts as an inter cellular transport system for various substances
3. Contains lot of enzymes.
4. Provide passage for mRNA from nucleus to the cytoplasm.

Q.7 a) **What is Mitosis ? Describe the various stages of Mitosis.**

Ans Mitosis produces two daughter cells that are identical to the parent cell. It is the process by which the somatic cells of all multicellular organisms multiply. In addition, plants produce gametes by mitosis.

Stages of Mitosis

The process of mitosis is divided into 6 stages.

1. Interphase : it is DNA synthesis phase. It consists of G_1 S and G_2 sub phases
2. Prophase : Chromosome look like thin thread and uncoiled.
3. Metaphase : Spindle tube formed, chromosome oriented in the centre at equatorial plate
4. Anaphase : Chromatids separate at centromere and move towards opposite poles.
5. Telophase : Spindle tube disintegrate, formation of nuclear membrane at each pole, reappear of nucleoli.
6. Cytokinasis : division of cytoplasm

b) What is multiple allele? Give the main features of multiple alleles.

Ans A character is produced by a specific gene. Each gene has two alternative forms. These forms are known as alleles. When certain genes have more than two alternate forms/ alleles at a locus known as multiple alleles.

Important features of multiple alleles :

1)Multiple alleles always belong to the same locus

2) one allele is present at a locus at a time in a chromosome

2) Multiple alleles always control the same character of an individual

3) There is no crossing over in the multiple alleles

5) In a series of mutiple alleles wild type is always dominant

6) When two mutant types are crossed wild form cannot be recovered

7) The cross between two mutant alleles will always produce mutant phenotype

Q.8 a) **Explain the types of chromosome on the basis of centromere position.** 4

a) **Metacentric:** Centromere is located exactly at the centre of chromosome, i.e. both arms are equal in size. Such chromosomes assume 'V' shape at anaphase.

b) **Sub-metacentric:** The centromere is located on one side of the centre point such that one arm is longer than the other. These chromosomes become 'J' or 'L' shaped at anaphase.

c) **Acrocentric:** Centromere is located close to one end of the chromosome and thus giving a very chort arm and a very long arm. These chromosomes acquire ' J' shape or rod shape during anaphase.

d) **Telocentric:** Centromere is located at one end of the chromosome so that the chromosome has only one arm. These chromosomes are 'I" shaped or rod shaped.

b) **Describe important features of cytoplasmic inheritance .** 4

1.Reciprocal difference : Reciprocal crosses show marked differences for characters governed by plasmagenes.

2. Lack of segregation : In general, F_1, F_2, F_3 and subsequent generations do not show segregation for a cytoplasmically inherited trait, as F_1 individuals receive plasmagenes from female parent only.

3. Somatic segregation : such as leaf variegation features which is of rare occurrence in case of nuclear genes.

4. Association with organelle DNA: For example: Cytoplasmic Male Sterility (CMS) in sorghum and maize is associated with mitochondrial DNA.

5. Nuclear transplantation: Nuclear transplantation means nucleus of a cell is removed and replaced by nucleus of another genotype from a different cell.

6. Mutagenesis: Some mutagens are highly specific mutagens which act only on the plasmagenes and do not affect nuclear genes Eg; ethidium bromide,Induction of mutations by such agents or chemicals in a gene clearly indicates that it is a plasmagene.

7. Lack of chromosomal location: In many organisms extensive linkage maps of nuclear genes are available. If a gene is shown to be located in one of these linkage groups, obviously it cannot be a plasmagene.

8. Transfer of nuclear genes [illegible] species may be transferred into cytoplasm of another variety or species

through repeated back crossing with former which is used as recurrent male parent. Lines produced in this way are called alloplasmic lines, since they have cytoplasm and nucleus from different species.

9. Lack of association with a parasite or symbiont or virus : Only those cytoplasmically inherited traits which are not associated with parasites, symbionts or viruses can be regarded to be governed by plasmagenes.

Q.9 **Differentiate between (Any Two).**

Ans **1) Qualitative character and Quantitative characters**

Qualitative character	Quantitative characters
Governed by few genes	Governed by several genes
Effect of each gene is large and detectable	Effect of each gene is small and not detectable
Governed by non additive genes	Governed by additive genes
Grouping in to different classes is possible	Grouping in to different classes is not possible
Little influenced by environmental factors	Highly influenced by environmental factors
Variation is discontinuous	Variation is continuous
Metric measurement is not possible	Metric measurement is possible
2) Transcription and Translation	
Transcription	**Translation**
Synthesis of mRNA from DNA	Synthesis of Polypeptide chain (Protein)
Occur in nucleus only	Occur in cytoplasm only
One of DNA strand acts as template	Codons of mRNA acts as template
Does not requires mRNA, rRNA, ribosomes, 20 kinds of amino acids and their specific tRNA	Requires mRNA, rRNA, ribosomes, 20 kinds of amino acids and their specific tRNA
Enzyme RNA polymerase is required	Aminoacyl tRNA synthetase enzyme is required
3) DNA and RNA	
DNA	**RNA**
Usually two stranded	Usually single stranded
Sugar is deoxyribose	Sugar is ribose
The bases are Adenine, guanine ,cytosine and thymine	The bases are Adenine, guanine ,cytosine and uracil
It is self replicating	It is formed from DNA
Mostly in chromosome, some in mitochondria and chloroplast	In chromosome and ribosome
There are several forms of DNA	There are three forms of RNA, mRNA and tRNA

Q. 10 Write short notes on. (Any Two) 4

Ans 1) **Lac operon model:** The operon refers to a group of closely linked genes which act together and code for various enzymes of a particular biochemical pathway. In other words, operon is a model which explains about the on-off mechanism of protein synthesis in a systematic manner. The operon model of gene regulation was proposed by Jacob and Monod in 1961. They were awarded Nobel prize for this discovery in 1965. The operon model was developed working with lactose region (lac region) of the human intestine bacteria *E.coli*. The gene regulation was studied for degradation of the sugar lactose. The operon model consists of seven main components, viz, (1) structural genes, (2) operator gene, (3) promotor gene, (4) regulator gene, (5) repressor, (6) corepressor, and (7) inducer.

2) **Sex determination :** Sex refers to the contrasting features of male and female individuals of the same species. Thus sex is usually of two types *viz., male and female. Sex* determination is a process of sex differentiation which utilizes various genetical concepts to decide whether a particular individual will develop into male or female

The various mechanisms of sex determination are:

1. Chromosomal sex determination 2. Genic balance mechanism 3. Male haploidy or Haplodiploidy mechanism. 4. Single gene effects (or) monofactorial mechanism of sex determination. 5. Metabolically controlled mechanism. 6. Hormonally controlled mechanism. 7. Sex determination in *Coccinia indica and Melandrium album*. 8. Sex determination due to environmental factors

3) **Types of RNA.:**

There are three main types or forms of RNA.

1. Messenger RNA (m-RNA):

It constitutes about 5-10% of the total cellular RNA. It is a single stranded base for base complementary copy of one of the DNA strands of a gene. It provides the information for the amino acid sequence of the polypeptide specified by that gene.

2. Ribosomal RNA (r – RNA):

It constitutes about 80% of the total cellular RNA. The function of rRNA is binding of mRNA and tRNA to ribosomes.

3. Transfer RNA (t – RNA):

It is also known as soluble RNA(sRNA). It constitutes about 10-15% of total RNA of the cell. It's main function is to carry various types of amino acidsand attach them to mRNA template for synthesis of protein. Each t – RNA species has a specific anticodon which base pairs with the appropriate m – RNA codon.

SECTION-B

Q.11 a **Give the contribution of following scientists** 2

1. Lamarck : Theory of acquired character
2. McClintock B.: She discovered the jumping genes in Maize.
3. Mc Lung : Sex chromosome
4. Nilson Ehle .: Multiple factor hypothesis

b **Define the following terms.** 2

1. **Penetrance :** The frequency with which a gene produces a phenotypic effects in the individual that carry it is called as penetrance
2. **Pleiotropic effect :** A gene which governs two or more characters is known as pleiotropic effect
3. **Homozygous:** Individual having similar alleles on the corresponding locus of homologous chromosome is called as Homozygous
4. **Autosomes :** Autosome refers to other than sex chromosome

Q.12 a **Fill in blanks.** 2

1. A cross in which the order of parents is reversed is known as **reciprocal** cross.
2. F_1 generation has all individuals are **heterozygous.**
3. **Chloroplast** is associated with photosynthesis.
4. **Ribosomes** are sites of protein synthesis

b. **State true or False.** 2

1. The heritability of quantitative character is low as compared to qualitative character. : **True**
2. Autosomes are sex chromosome. : **False**
3. Cross of F_1 with its parents is test cross.: **False**
4. Mitosis helps in maintaining the chromosome number constant in a species.: **False**

Signature of Course Instructor

Dr. V. N. Toprope
Associate Professor
College of Agriculture, Latur
Mobile. No 9403970616

Signature of the Head of the Department

Dr. K. R. kamble
Professor
Department of Agril. Botany
College of Agriculture, Latur (M.S.)
Mobile. No 9421325575

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END EXAMINATION

B.Sc. (Agri.)

Semester	: **II (New)**	**Term**	: **II**	**Academic Year**	: **2016-17**
Course No.	: BOT 122				
Credits	: 3 (2+1)	**Title**	: **Principles of Genetics**		
Day & Date	: Saturday, 06.05.2017	**Time**	: 09.00 to 12.00	**Total Marks**	: **80**

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 diagrams wherever necessary.

SECTION "A"

Q.1 Define genetics. Discuss the Pre-Mendelian era.

Q.2 State the law of segregation. Explain it with suitable example and state the reasons for Mendel's success in his work.

Q.3 What do you mean by DNA replication? State the different types of DNA replication and explain semi-conservative DNA replication.

Q.4 Define crossing over and describe its mechanism.

Q.5 What is cell division? Enlist different stages and sub stages of mitosis and meiosis cell division. Explain mitosis with figures.

Q.6 Describe in brief the operon model of protein synthesis.

Q.7 What are chromosomal aberrations? Enlist different types and sub types of Chromosomal aberrations. Explain in detail duplication.

Q.8 State the different theories of sex – determination. Explain the chromosomal theory of sex- determination.

Q.9 Write short notes (Any Two).

1) Types of RNA

2) Allopolyploid

3) Gene interaction

Q.10 What is genetic code? Describe in short features of genetic code.

SECTION "B"

Q.11 Define the following terms.

1) Penetrance

2) Transcription

3) Linkage map

4) Synapsis

5) Genome

6) Sex-linked characters

7) Multiple alleles

8) Incomplete dominance

(P.T.O.)

Q.12 Fill in the blanks.

1) Linkage is broken down due to the _____.
2) An autopolyploid individual with a genotype AAAA is called _____.
3) Chromosome number is reduced in_____cell division.
4) Presence of kappa particles in paramecium is an example of _____ inheritance.
5) Mendel studied _____pairs of contrasting characters.
6) _____ coined the term genetics in1906.
7) _____ described the sex chromosome in1902.
8) Union of two dissimilar gamets that is male and female is known as _____.

✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE

MODEL ANSWERS OF SEMESTER END EXAMINATION

B.Sc. (Agri.)

Semester	:	II (New)	Academic Year :		2016-2017		
Course No.	:	BOT - 122	Title	:	Principles of Genetics		
Credits	:	3 (2+1)					
Day and Date	:		Time	:	Total Marks	:	80
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 diagrams wherever necessary.						

SECTION "A"

Q.1. **Define genetics. Discuss the pre- mendelian era.**

Answer:

Genetics is the science which seeks into account for the resemblances and differences which are exhibited by an organism related by descent.

Pre-Mendelian Era: Some of the scientists prior to Mendel (1900) tried to account for the differences existing among individuals and suggested theories to explain their inheritance. (2) (6)

1. **Lamarck's theory of acquired characters (1744 - 1829)**

Jean Baptiste de Lamarck's stated that environmental changes causes modifications in organisms and such modifications are transmitted from parents to off-springs.

2. **Darwin's theory of Natural Selection (1809 - 1882)**

In 1858 English naturelist Charles Darwin proposed theory of natural selection. According to this theory many more individuals of each species are born than can possibly survive and consequently there is always struggle for existence.

Variation is constant, overproduction struggle for existence, natural selection and survival of fittest are thus important principles of this theory. He published the book 'Origin of species'. He Put-forth theory of pangenes. The hereditary particles pangenes are produced by every part of body and transferred through blood stream to the sex organs and forms germ cells and give rise to new individuals.

3. **Schleiden and Schwann : (1838 - 39)**

They proposed cell theory stating that all organisms are composed of one or more cells and cell is basic unit of life. While Virchow (1858) made generalization that cells arise from pre existing cell under 'Theory of cell Lineage'.

4. **Weismann's theory of germ plasm, (1834 - 1914)**

He proposed that reduction in chromosome number take since during formation of egg and sperm and the original number was restored when egg and sperm fused. In 1892 he suggested that maternal and paternal chromosomes separate during reduction division and recombine when the gametes united.

According to him hereditary particles 'genes' are situated on the chromosomes constitute germ plasm which is transmitted from one generation to the other. It is independent of body cells or somatoplasm which was not able to enter the sex cells

Q.2. State the law of segregation. Explain it with suitable example and state the reasons for mendel's success in his work.

Law of segregation : (2)

This law states that when a pair of alleles brought together in F1 (hybrid) they remain together without affecting each other and they separate complete and pure during the formation of gametes formed by a hybrid and move to the respective individuals in the offspring's of hybrid.

When Mendel crossed a true breeding red flowered plant with white one. The progeny (4) (F1) was similar to red flowered plant. When the F1 was selfed he found that F2 consisted two different types i. e. Red and white. The red character was shown in 3/4 individuals in F_2 while 1/4 were white. Thus Mendel obtained a ratio of 3 :1 Further he observed that when white plants from F_2 were self fertilized bred true. One third of F_2 plants having red flowers, bred true while remaining 2/3 individuals segregated into 3 red : 1 white proportion.

Monohybrid ratio involves only one pair of genes affecting one character and giving 3:1 ratio in F_2 when dominance is said to be comple

Parents:	Red	X	White
(Phenotype)	(Homozygous)		(Homozygous)
Genotype	RR		rr
Gametes	R		r

F1 Rr Red (Heterozygous)

Mendel's first law of segregation can be explained with example:

	R	r
R	RR Red	Rr Red
r	Rr Red	rr White

F_2

Genotypic Ratio : 1 RR : 2 Rr : 1rr ,phenotypic Ratio : 3 Red : 1 White

Why Mendel was successful in his work? (2)

1. He had selected garden pea as his experimental material.
2. He concentrated his attention on only one character at a time.
3. He kept accurate record of progenies in successive generations.
4. He divided the off springs in each generation into definite classes according to visible contrasting characters.
5. He studied large population to avoid sampling error.
6. He analyzed the data by statistical methods and found out the ratio of [illegible] character.

Q.3. What do you mean by DNA replication? State the different types of DNA Replication and explain semi-conservative DNA replication

Answer:

The process by which a DNA molecule makes identical copies is known as DNA replication. There are three types of DNA replication. (2)

1. Dispersive 2. Conservative 3. Semi-conservative (1)

Semi-conservative DNA replication: (5)

In this method (Watson and crick) both strands of parental DNA separates from each other. Each old strand synthesizes a new strand. Thus each of the two resulting molecule are with one old and one new strand. This method has been universally accepted, because there are several evidences in support of Semiconservative method. This method consists with several steps.

a. **Initiation of replication** : DNA replication starts at specific point on the chromosome. This site is known as origin.

b. **Unwinding of strands** : The two strands unwind. The opening of DNA strands takes place with help of DNA unwinding protein

c. **Formation of RNA Primer** : Synthesis of RNA primer is essential for initiation of DNA synthesis. RNA primer is synthesized by the DNA template near the origin with the help of special type of RNA polymerase

d. **Synthesis of DNA on RNA primer** : After formation of RNA primer, DNA synthesis starts on the RNA primer. Deoxyribose nucleotides are added to the 3 end position of RNA primer. The main DNA strand is synthesized on the DNA template with help of DNA polymerase. The DNA synthesis takes place in short pieces which are known as okazaki fragments. Synthesis on the new strand takes place in 5 - 3 and that of other in opposite 3-5 direction. It is possible that during replication, one strand is synthesized continuously while other discontinuous in pieces. The strand synthesize continuously is known as leading strand and discontinusly synthesized strand is lagging strand.

e. **Removal of RNA primer** : The RNA primer is degraded by DNA polymerase I. This DNA enzyme also catalyzes the synthesis of short DNA to replace the RNA primer. The newly synthesize segment is joined to main DNA strand with help of DNA ligase enzyme.

f. **Union of okazaki segment** : The discontinuous fragments of okazaki are joined to make continuous strand. The union of okazaki segment is takes place by using joining enzyme polynucleotide ligase.

Q.4. Define crossing over and describe its mechanism.

Ans: Crossing over:

It is the mechanism of the recombination of the genes due to interchange of corresponding chromosomal segments between non sister chromatids of homologous chromosomes. (2)

Mechanism of crossing over:

The mechanism of crossing over can be explained by the following theories (6)

Janssens's partial chaisma type theory : This theory was proposed by janssens and later on elaborated by Belling and Darlington. According to this theory, first crossing over occurs and then chiasma is formed. The crossing over occurs sometimes during

early meiotic stages, perhaps at pachytene, when homologous chromatids are closely paired. As the meiotic cell moves towards metaphase and reductional division, a chiasma is formed at the point where crossing over has occurred. Thus according to this theory each chiasma represents one genetic cross over. This theory remains at present the most accepted explanation for the relation ship between genetic crossing over and cytologically observed chiasmata.

2. **Copy choice theory:**

This theory was proposed by Belling (1932). According to this theory, the paired chromosomes duplicate their genes before the fibers join them to form strands when the

Chromosomes are twisted around each other, reciprocal exchange of the chromatids take place during pachytene or just before. There may be some recombination during the period of DNA synthesis affecting short unpaired segments of the chromosomes. A small part of DNA helix being synthesized may copy a non sister helix rather than a sister helix to produce recombination in a very short period. There are two main objection.

a) Only two chromatids out of four involved in crossing over thus newly fromed chromatids would be altered by recombination.

b) Duplication should occur during late meiotic prophase but now it is clear that DNA duplication occurs even before synapsis

3. **Breakage and Reunion Theory:**

This theory is based on the assumption that

1. Prior to crossing over each chromosome of each bivalent get duplicated to form tetrad
2. Crossing over occur only between non sister chromatids.
3. Crossing over involves the mechanical breaks in non sister chromatids due to twisting around each other and reunion or recombination of chromatids take place. According to this theory first of all, chromatids break and then form chiasmata and crossing over does not produce chiasmata but it is caused by chiasmata

Q.5 What is cell division? Enlist different stages and sub stages of mitosis and meiosis cell division. Explain mitosis with figures.

Ans: The division of nucleate cell is achieved by two activities such as division of nucleus i.e. karyokinesis and the division of cytoplasm i.e. cytokinesis. Both plant and animal cells are essentially alike in terms of having genes arranged in line arrays on nuclear structures called chromosomes. Chromosomes are involved in the division cycle of individual cells and reproduction of the entire organism. (2)

Stages of mitosis (2)

i) Prophase ii)Metaphase iii)Anaphase iv) Telophase v) Cytokinesis

Stages of meiosis

a) First prophase: i) Leptotene or leptonema ii) Zygotene or zygonema iii) Pachytene or pachynema iv) Diplotene or diplonema v) Diakinesis

b) First metaphase c) First anaphase d) First telophase

c) Meiosis second: I) Metaphase II. 2) Anaphase II 3)Telophase II 4) Diakinesis

Mitosis cell division

Prophase: (4)

i) Cell becomes spheroid, refractive and viscous.

ii) Disintegration of nuclear envelope starts

iii) Chromatid remains connected at centromere and they become shortened and