**AS-2917**

**B.Sc. (First Semester) Examination, 2013**

**Forestry, Wildlife and Environmental Sciences**

**Guru Ghasidas Vishwavidyalaya University, Bilaspure (C.G)**

**Cytogenetics and Plant Breeding**

**Time allowed: Three hours**

**Maximum Marks: 60**

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## I. Answer the following questions (20 X 1 = 20)

### Multiple choice questions

1. An individual having both dominant alles of a gene is known as called as
   a) Homozygous b) Heterozygous
   c) Dominance d) Codominance
   **Answer: a) Homozygous**

2. The cross in which the F1 hybrid is crossed with recessive parent is called as
   a) Poly cross b) Back cross
   c) Self cross d) Test cross
   **Answer: d) Test cross**

3. The process of mitotic cell division includes
   a) Prophase and metaphase b) Anaphase and telophase
   c) Metaphase and Anaphase d) All
   **Answer: d) All**

4. The protoplast containing either no nucleus or inactive nucleus
   a) Proplast b) Cytoplast
   c) Mitochondria d Nucleic acid
   **Answer: b) Cytoplast**

5. The last stage in cell division is called as

   a) Anaphase b) Metaphase
   c) Telophase d) Interphase
   **Answer: c) Telophase**

### True or false

6. A gene is a carbohydrate molecule
   **Answer: False**
7. The phenotypic ratio of monohybrid cross is 9:3:3:1
   **Answer: False**

8. The blending of both dominant and recessive traits appear in the F1 and F2 heterozygote due to incomplete dominance
   **Answer: True**
9. The phenomenon of a single gene affecting two or more different characters is called as epistasis
   **Answer: False**
10. In order to break the linkage between desirable and undesirable genes the breeder has to grow large breeding population
    **Answer: True**
11. Asexual reproduction involves the fusion of male and female gamets
    **Answer: False**
12. The aim of plant breeding is to improve the characteristic of plants so that they become more desirable agronomically and economically
    **Answer: True**
13. The existing best variety used for evaluation of selected individual is checks
    **Answer: True**
14. The selection favours the intermediate phenotype and acts against the extreme phenotype is known as disruptive selection
    **Answer: False**
15. Megasporogenesis occurs in ovules
    **Answer: True**

**Fill in the blanks**

16. Linkage between dominant and recessive alleles of two or more genes is ----------
    **Answer: In complete linkage / Trans arrangement**
17. Transfer of pollen grains from anthers to stigma is ----------
    **Answer: Pollination**
18. Papaya and coconut are ---------- pollinated species
    **Answer: Cross**
19. The dominant genes are functional while recessive genes are ----------
    **Answer: Non-functional**
20. The F2 ratio in supplementary gene action is ----------
    **Answer: 9:3:4**

**II. Write any four of the following questions. (4 X10 = 40)**

**Q.1. Write the importance of mitosis and meiosis in plant breeding?**

**Importance of mitosis**

Mitosis is an important cellular mechanisms which has the following importance

a) Equal distribution of chromosomes

b) Surface – volume ratio

c) Nucleoplasmic index

d) Repair

**Equal distribution of chromosomes**
As a result of mitosis, there is an equal distribution of chromososmes from a parent nucleus to the daughter nuclei
**Surface – volume ratio**
A small cell has a greater available surface. As the cell increases in size the available surface area in relation to increased volume become less. By undergoing division, the cell becomes smaller in size and the surface-volume ration is restored.

**Nucleoplasmic index**

Growth of a multi-cellular organism is due to mitosis. After reaching a particular size the cell divides to restore the nucleoplasmic index.

**Repair**

Repair of the body takes place because of addition of cells by mitosis.Dead cells of the upper layer of the epidermis or red blood corpuscules are constantly being replaced by mitosis

**Importance of meiosis**

- The formation of four monoploid (haploid) nuclei from a single diploid one
- Crossing over occur in prophase I provides new combination of genetical substance and hence new combination of characters in offspring
- The two members of a homologous pair of chromosomes pass on to different daughter cells called segregation of chromosomes and it results different combination of characters in both daughter cells.

**Q.2. What is the chromosome theory of linear arrangement of linked genes?**

- The chromosome theory of linear arrangement of linked genes was proposed by Morgan and Castle
- The pairs of genes from homologous parent (RR/R0R0) tend to enter in same gamet and remain together.

- The genes from heterozygous parents (Rr/R0r0) tend to enter in different gamets and remain apart from each other

- The tendency of linked genes remaining together is due to their location in same chromosome

- The degree of strength of linkage depends upon the distance between the linked genes in the chromosomes
- Example: More closely located – the linkage will be strong
    - More widely located – the linkage will be weak.

- The linked genes arranged in linear fashion on the chromosome and each linked gene has a definite and constant order in its arrangement.

**Q.3. Draw the structure of typical plant cell and mark different plant parts with short explanation?**

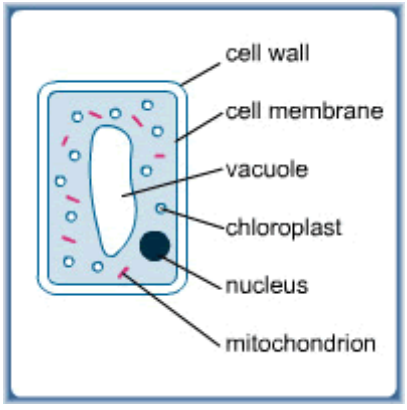
**Plant Cell**

Plant cells are eukaryotic cells, or cells with a membrane-bound nucleus. Unlike prokaryotic cells, the DNA in a plant cell is housed within the nucleus. In addition to having a nucleus, plant cells also contain other membrane-bound organelles, or tiny cellular structures, that carry out specific functions necessary for normal cellular operation. Organelles have a wide range of responsibilities that include everything from producing hormones and enzymes to providing energy for a plant cell.

Plant cells are similar to animal cells in that they are both eukaryotic cells and have similar organelles. Plant cells are generally larger than animal cells. While animal cells come in various sizes and tend to have irregular shapes, plant cells are more similar in size and are typically rectangular or cube shaped. A plant cell also contains structures not found in an animal cell. Some of these include a cell wall, a large vacuole, and plastids. Animal cells also contain structures such as centrioles, lysosomes, and cilia and flagella that are not typically found in plant cells.

**Plant Cell: Structures and Organelles**

The following are examples of structures and organelles that can be found in typical plant cells:



- **Cell (Plasma) Membrane** - a thin, semi-permeable membrane that surrounds the cytoplasm of a cell, enclosing its contents.
- **Cell Wall** - outer covering of the cell that protects the plant cell and gives it shape.
- **Chloroplasts** - the sites of photosynthesis in a plant cell. They contain chlorophyll, a green pigment that absorbs energy from sunlight.
- **Cytoplasm** - gel-like substance within the cell membrane containing water, enzymes, salts, organelles, and various organic molecules.
- **Cytoskeleton** - a network of fibers throughout the cytoplasm that helps the cell maintain its shape and gives support to the cell.
- **Endoplasmic Reticulum (ER)** - extensive network of membranes composed of both regions with ribosomes (rough ER) and regions without ribosomes (smooth ER).
- **Golgi Complex** - responsible for manufacturing, storing and shipping certain cellular products
- **Mitochondria** - this organelle generates energy for the cell.
- **Nucleus** - membrane bound structure that contains the cell's hereditary information.
- **Nucleolus** - structure within the nucleus that helps in the synthesis of ribosomes.
- **Nucleopore** - tiny hole within the nuclear membrane that allows nucleic acids and proteinsto move into and out of the nucleus.
- **Vacuole** - structure in a plant cell that provides support and participates in a variety of cellular functions including storage, detoxification, protection, and growth. When a plant cell matures, it typically contains one large liquid-filled vacuole.

**Q.4. What is chromosomal aberration? Explain different kinds of chromosomal aberration in plants?**

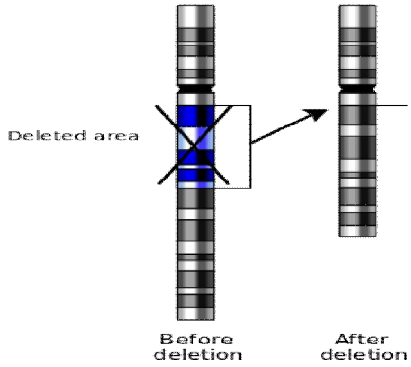
Changes in chromosome structure are called as chromosomal aberrations.

It is of two types

I. Intra chromosomal aberrations
II. Inter chromosomal aberrations

**I. Intra chromosomal aberrations:**

1. **Deletions:** A portion of the chromosome is missing or deleted



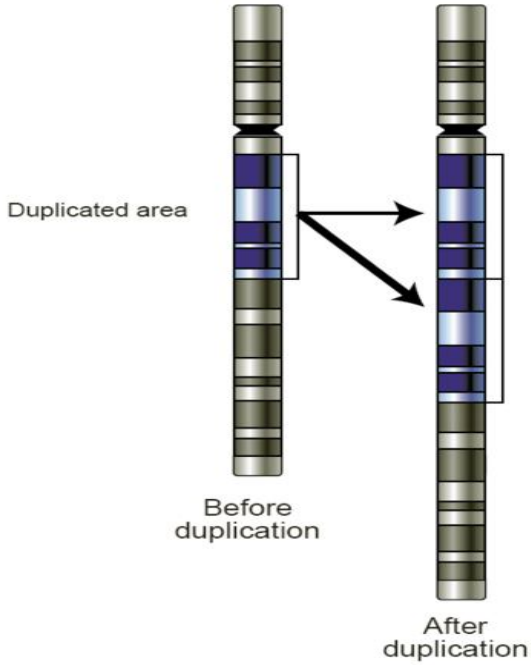
**Causes include the following**:

- Losses from translocation
- Chromosomal crossovers within a chromosomal inversion
- Unequal crossing over
- Breaking without rejoining

**Types of deletion include the following:**

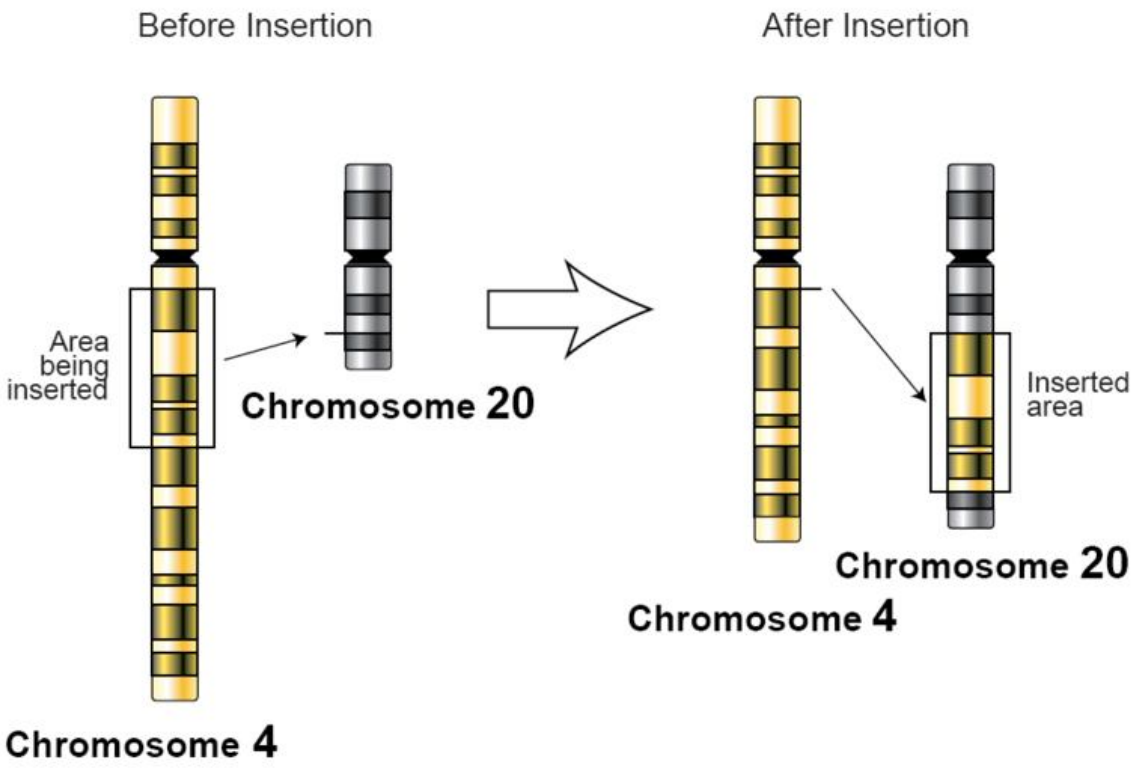
- **Terminal Deletion** - a deletion that occurs towards the end of a chromosome.
- **Intercalary Deletion / Interstitial Deletion** - a deletion that occurs from the interior of a chromosome.

2. **Duplications:** A portion of the chromosome is duplicated, resulting in extra genetic material.




3. **Inversions:** A portion of the chromosome has broken off, turned upside down and reattached, therefore the genetic material is inverted.
    - An **inversion** is a chromosome rearrangement in which a segment of a chromosome is reversed end to end. An inversion occurs when a single chromosome undergoes breakage and rearrangement within itself. Inversions are of two types: **paracentric** and**pericentric**.
    - Paracentric inversions do not include the centromere and both breaks occur in one arm of the chromosome. Pericentric inversions include the centromere and there is a break point in each arm.

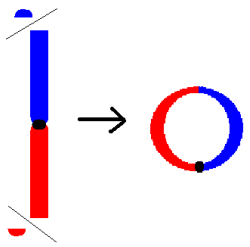
1. **Insertions:** A portion of one chromosome has been deleted from its normal place and inserted into another chromosome.




An **insertion** is the addition of one or more nucleotide base pairs into a DNA sequence. This can often happen in microsatellite regions due to the DNA polymerase slipping. Insertions can be anywhere in size from one base pair incorrectly inserted into a DNA sequence to a section of one chromosome inserted into another.

On a chromosome level, an *insertion* refers to the insertion of a larger sequence into a chromosome. This can happen due to unequal crossover during meiosis.

2. **Rings:** A portion of a chromosome has broken off and formed a circle or ring. This can happen with or without loss of genetic material.

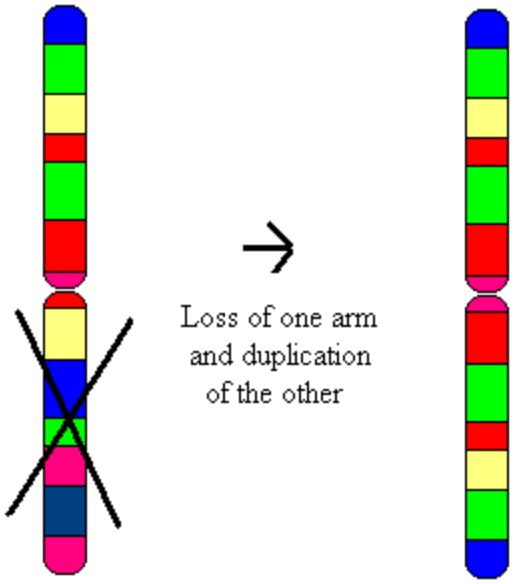


A **ring chromosome** is a chromosome whose arms have fused together to form a ring. A ring chromosome is denoted by the symbol r in human genetics or R in Drosophila genetics. Ring chromosomes may form in cells following genetic damage by mutagens like radiation, but they may also arise spontaneously during development.

Normally, the ends of a chromosome are lost, enabling the arms to fuse together. However, ring formation can also occur with only one end being lost. In rare cases, the telomeres at the ends of a chromosome fuse without any disappearance of material

3. **Isochromosome:** Formed by the mirror image copy of a chromosome segment including the centromere.

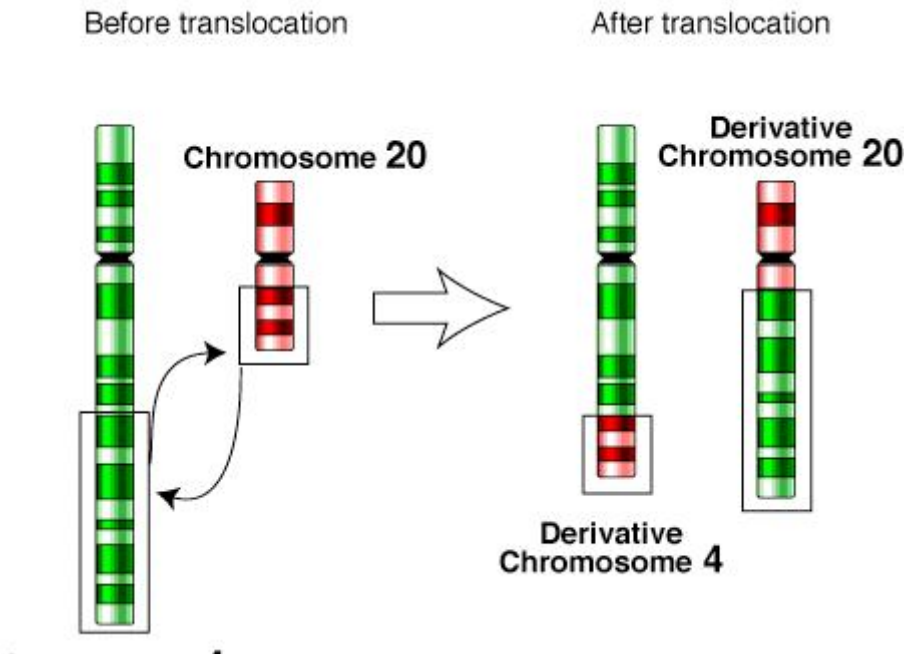
An **isochromosome** is a chromosome that has lost one of its arms and replaced it with an exact copy of the other arm. This is sometimes seen in some females with Turner syndrome or in tumor cells. This may also cause an isochromosome to have two centromeres




## II. Interchromosomal aberrations

**Translocations:** A portion of one chromosome is transferred to another chromosome. There are two main types of translocations:

a **chromosome translocation** is a chromosome abnormality caused by rearrangement of parts between nonhomologouschromosomes. A gene fusion may be created when the translocation joins two otherwise separated genes, the occurrence of which is common in cancer. Translocations can be **balanced** (in an even exchange of material with no genetic information extra or missing, and ideally full functionality) or **unbalanced** (where the exchange ofchromosome material is unequal resulting in extra or missing genes).



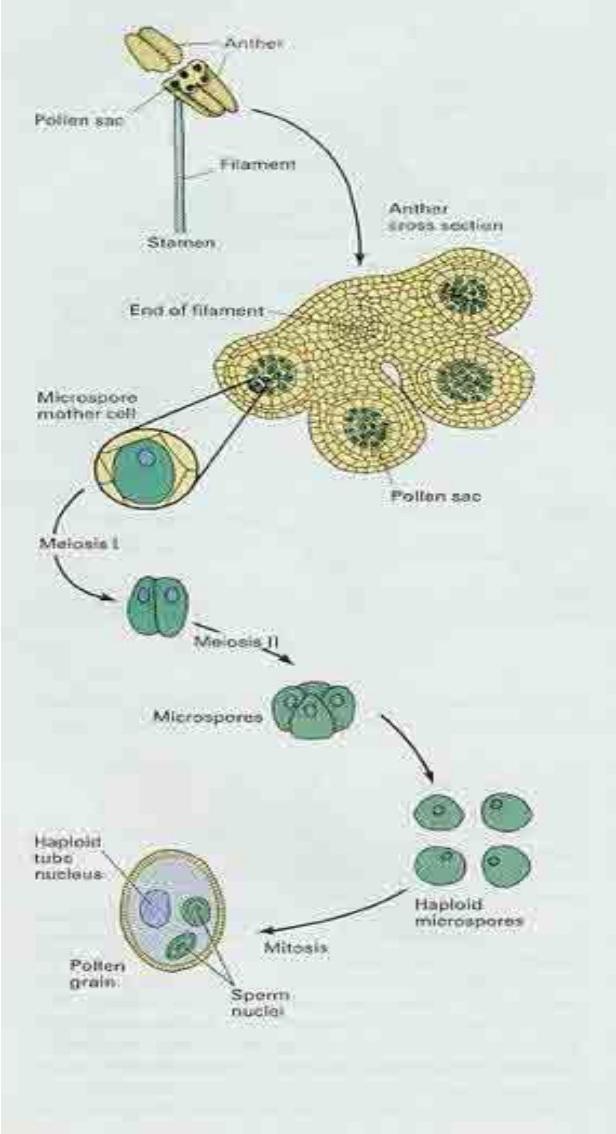

a. Reciprocal translocation: Segments from two different chromosomes have been exchanged.
b. Robertsonian translocation: An entire chromosome has attached to another at the centromere - in humans these only occur with chromosomes 13, 14, 15, 21 and 22.

**Q.5.What is sporogenesis? Explain microsporogenesis with suitable diagrams?**

Sporogenesis is the development of microspore and megaspore in pollen and ovule respectively.

**Microsporogenesis (Development of Pollen grains):**
Sporogenous tissue fills the whole interior of a microsporangium. Its cells divide with the growth of anther and increase their number. Ultimately they are transformed into microspore or pollen mother cells (PMC). The latter are diploid, that is, they possess two genomes or sets of chromosomes.

The microspore mother cells or microsporocytes develop an internal layer of callose (β-1, 3 glucan) which breaks the plasmodesmal connections among themselves. The separated mother cells round off and undergo meiosis to produce tetrads of haploid microspores or pollen grains. The phenomenon is called micro-sporogenesis. The pollen grains of a tetrad grow and separate from one another. Usually the arrangement of microspores in a tetrad is tetrahedral




- It is meiotic formation of haploid microspores from diploid microspore mother cell.
- The arrangement of microspores in a tetrad is generally tetrahedral.
- All the four microspores of a spore terad are functional.
- Micro sporogenesis is found inside microsporangium.
- A large number of microspore mother cells are functional in a microsporangium.

**Q.6. Write short answer for the following question**

**a) Quantitative characters**

A character which is governed by many genes is called as quantitative characters. It is also called as polygenic characters.

- It is affected by the environmental factors.

- It shows continuous variation

- Most of the characters observed in forestry species are quantitative traits.

**b) Linkage**

The phenomenon of inheritance of linkage genes in same linkage group is called as linkage.

- It may be arranged in cis-arrangement or trans-arrangement.

- It may be complete linkage or incomplete linkage.

**c) Mutation**

A sudden heritable change in a characteristic of an organism is called as mutation.

- Mutations are generally recessive
- They are randomly occur
- They are recurrent
- They are generally harmful
- They commonly show pleiotropy.

**d) Selection**

It is a process of choosing the individuals for its desirable traits

Selection based on single traits

- Mass selection
- Family selection
- Sib selection
- Progeny selection
- With-in family selection
- Family and with-in family selection

Selection based on multiple traits

- Tandem selection
- Independent culling
- Selection Index

**e) Back cross**

- A cross between a hybrid (F1 or segregating generations) and one of its parents is known as back cross

- The high yielding desirable variety but lacks disease resistant is called as recipient variety, which is crossed with disease resistant variety for several times to transfer resistance so it is called as recurrent parent.

- The resistant variety is called as donor variety, which is used only once in the breeding programme to produce F1 hybrid so it is called as non- recurrent parent.