SECTION-A (Multiple choice questions)

Q. 1-Answer

(i) **a** (ii) **a** **(iii) a** **(iv) b** **(v) a** (vi) **b** **(vii) c**

(viii) a **(ix) a** **(x) d**

SECTION –B (Descriptive type questions)

Q. 2- Answer:

Mendel postulated three laws of inheritance.

Based on monohybrid cross

1. The Principle of Dominance: In a heterozygote, one allele may conceal the presence of another.

2. The Principle of Segregation: In a heterozygote, two different alleles segregate from each other during the formation of gametes.

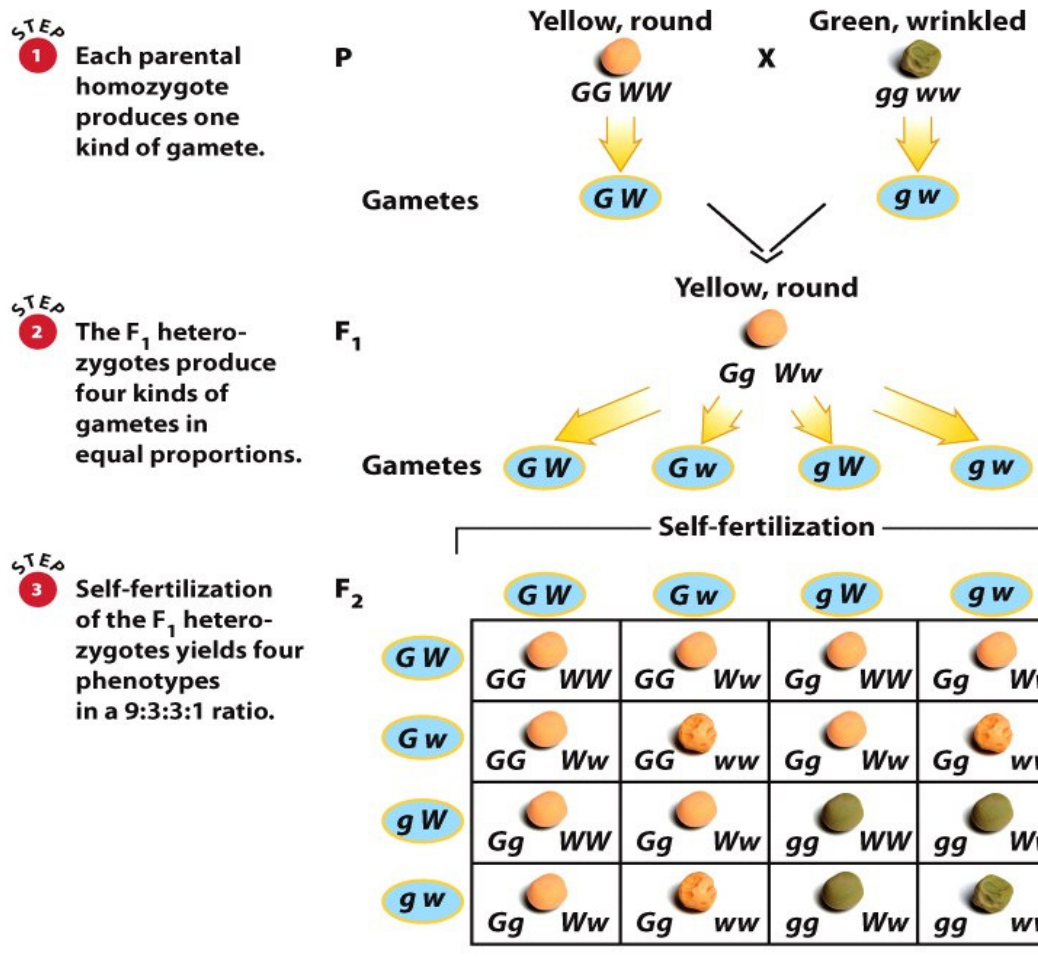
Based on dihybrid cross

3. The Principle of Independent Assortment: The alleles of different genes segregate, or as we sometimes say, assort, independently of each other.

Dihybrid crosses:

Mendel performed experiments with plants that differed in two traits. He crossed plants that produced yellow, round seeds with plants that produced green, wrinkled seeds. This is known as two-factor, or **dihybrid cross.** The purpose of the experiments was to see if the two seed traits, color and texture, were inherited independently. Because the F1seeds were all yellow and round, the alleles for these two characteristics were dominant. Mendel grew plants from these seeds and allowed them to self-fertilize. He then classified the seeds and counted them by phenotype.

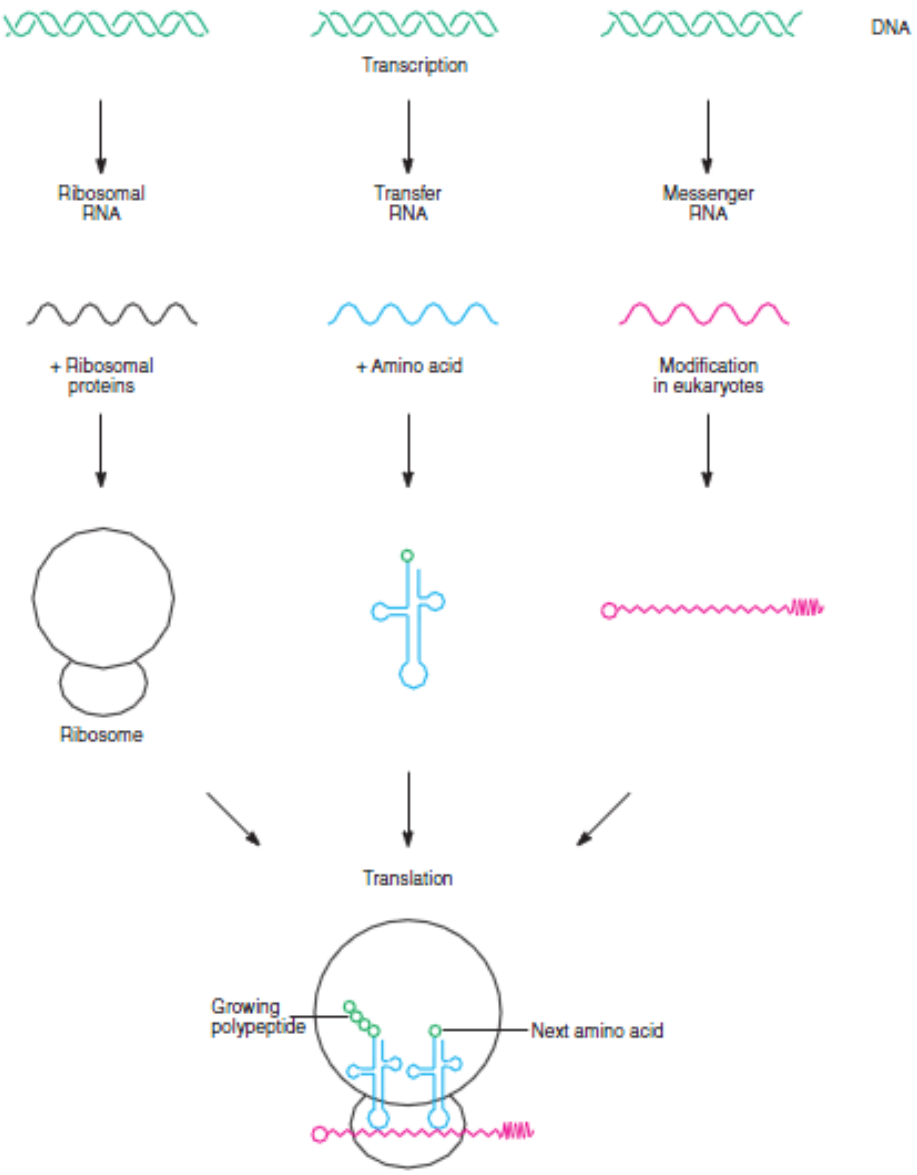
The four phenotypic classes in the F2 represented all possible combinations of the color and texture traits. Two classes—yellow, round seeds and green, wrinkled seeds—resembled the parental strains. The other two—green, round seeds and yellow, wrinkled seeds—showed new combinations of traits. The four classes had an approximate ratio of 9 yellow, round:3 green, round:3 yellow, wrinkled:1 green, wrinkled. To Mendel's insightful mind, these numerical relationships suggested a simple explanation: Each trait was controlled by a different gene segregating two alleles, and the two genes were inherited independently



F_2 Phenotypes	Genotypes	Genotypic ratio	Phenotypic ratio
Yellow, round	GG WW	1	9
	GG Ww	2	
	Gg WW	2	
	Gg Ww	4	
Yellow, wrinkled	GG ww	1	3
	Gg ww	2	
Green, round	gg WW	1	3
	gg Ww	2	
Green, wrinkled	gg ww	1	1

Q. 3- Answer:

In the protein synthesis process, three different kinds of RNA serve in three different roles. The first type is **messenger RNA (mRNA),** which carries the DNA sequence information to particles in the cytoplasm known as **ribosomes,** where the messenger RNA is translated. The second type is **transfer RNA (tRNA),** which brings the amino acids to the ribosomes, where protein synthesis takes place. The third type of RNA is a structural and functional part of the ribosome called **ribosomal RNA (rRNA).** The general relationship of the roles of these three types of RNA is diagrammed in figure given below. In addition, **small RNAs (snRNA)** play other roles in cellular metabolism, some of which are described later in the chapter.

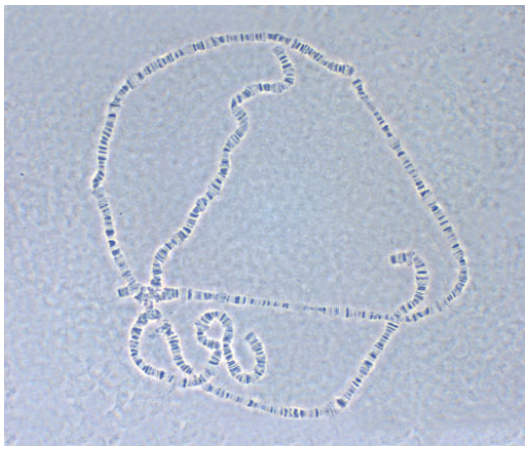


Q. 4- Answer:

Endomitosis: In some organisms, certain tissues become polyploid during development. This polyploidization is probably a response to the need for multiple copies of each chromosome and the genes it carries. The process that produces such polyploid cells, called **endomitosis,** involves chromosome duplication, followed by separation of the resulting sister chromatids. However, because there is no accompanying cell division, extra chromosome sets accumulate within a single nucleus. In the human liver and kidney, for example, one round of endomitosis produces tetraploid cells.

Polytene chromosomes:

Sometimes polyploidization occurs without the separation of sister chromatids. In these cases, the duplicated chromosomes pile up next to each other, forming a bundle of strands that are aligned in parallel. The resulting chromosomes are said to be **polytene,** from the Greek words meaning "many threads." The most spectacular examples of polytene chromosomes are found in the salivary glands of *Drosophila* larvae. Each chromosome undergoes about nine rounds of replication, producing a total of about 500 copies in each cell. All the copies pair tightly, forming a thick bundle of chromatin fibers. This bundle is so large that it can be seen under low magnification with a dissecting microscope. Differential coiling along the length of the bundle causes variation in the density of the chromatin. When dyes are applied to these chromosomes, the denser chromatin stains more deeply, creating a pattern of dark and light bands. This pattern is highly reproducible, permitting detailed analysis of chromosome structure.



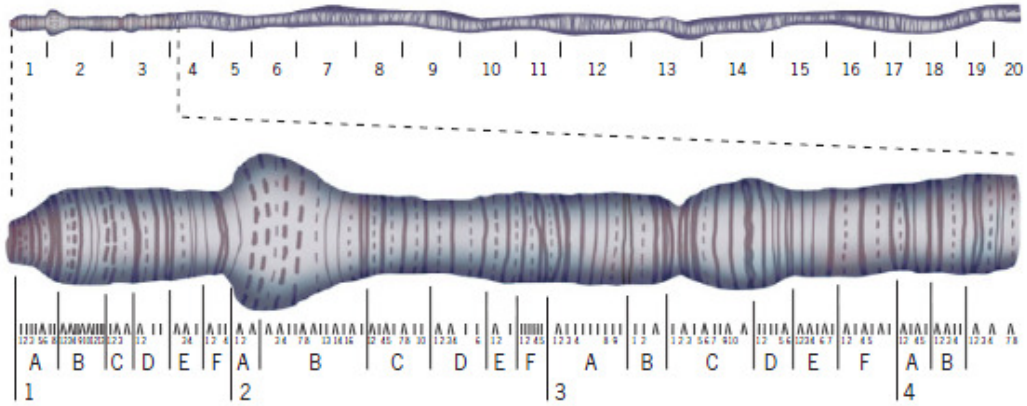
The polytene chromosomes of *Drosophila* show two additional features:

1. Homologous Polytene Chromosomes Pair. Ordinarily, we think of pairing as a property of meiotic chromosomes; however, in many insect species the somatic chromosomes also pair—probably as a way of organizing the chromosomes within the nucleus. When *Drosophila* polytene chromosomes pair, the large chromatin bundles become even larger. Because this pairing is precise—point-for-point along the length of the chromosome—the two homologues come into perfect alignment. Thus, the banding patterns of each are exactly in register, so much so that it is almost impossible to distinguish the individual members of a pair.

2. All the Centromeres of *Drosophila* Polytene Chromosomes Congeal into a Body Called the Chromocenter. Material flanking the centromeres is also drawn into this mass. The result is that the chromosome arms seem to emanate out of the chromocenter. These arms, which are banded, consist of euchromatin, that portion of the chromosome that contains most of the genes; the chromocenter consists of heterochromatin, a gene-poor material that surrounds the centromere. Unlike the euchromatic chromosome arms, this centric heterochromatin does not become polytene. Thus, compared to the euchromatin, it is vastly underreplicated.

In the 1930s C. B. Bridges published detailed drawings of the polytene chromosomes. Bridges arbitrarily divided each of the chromosomes into sections, which he numbered; each section was then divided into subsections, which were designated by the letters *A* to *F*. Within each subsection, Bridges enumerated all the dark bands, creating an alphanumeric directory of sites along the length of each chromosome. Bridges' alphanumeric system is still used today to describe the features of these remarkable chromosomes.

The polytene chromosomes of *Drosophila* are trapped in the interphase of the cell cycle. Thus, although most cytological analyses are performed on mitotic chromosomes, the most thorough and detailed analyses are performed on polytenized interphase chromosomes. Such chromosomes are found in many species within the insect order Diptera, including flies and mosquitoes. Unfortunately, humans do not have polytene chromosomes; thus, the high-resolution cytological analysis that is possible for *Drosophila* is not possible for our own species.



Q. 5- Answer:

Anomalies of chromosome number occur as either **euploidy** or **aneuploidy.** Euploidy involves changes in whole *sets* of chromosomes; aneuploidy involves changes in chromosome *number* by additions or deletions of less than a whole set.

Monosomy and trisomy are the terminology used to explain aneuploid changes.

A diploid cell missing a single chromosome is **monosomic.** A cell missing both copies of that chromosome is **nullisomic.** A cell missing two nonhomologous chromosomes is a double monosomic. A similar terminology exists for extra chromosomes. For example, a diploid cell with an extra chromosome is **trisomic.**

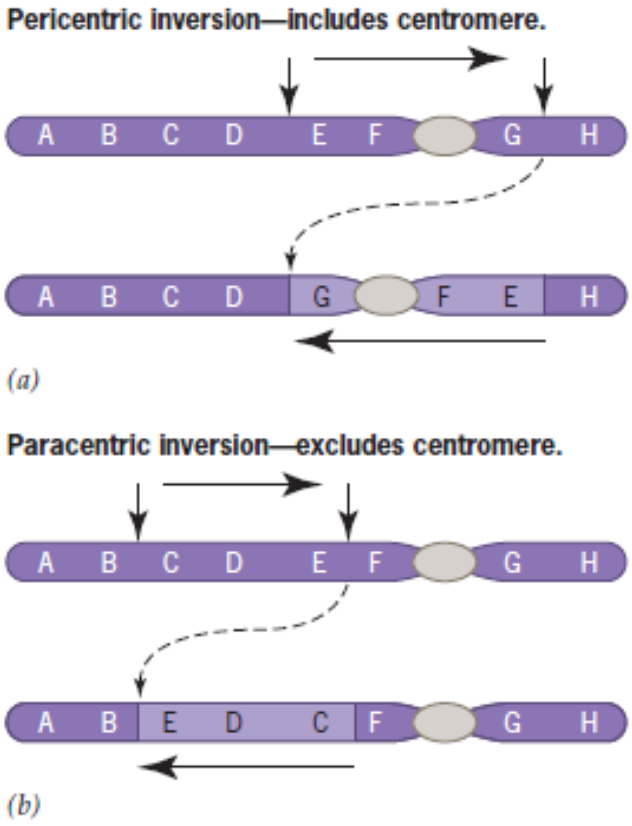
Aneuploidy results from nondisjunction in meiosis or by chromosomal lagging whereby one chromosome moves more slowly than the others during anaphase, is excluded from the telophase nucleus, and is thus lost.

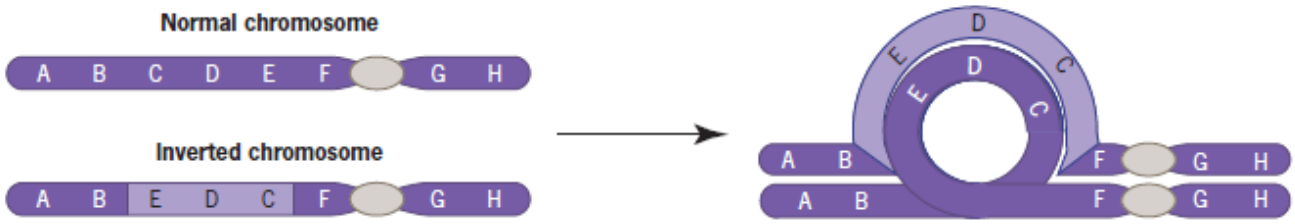
Inversion: An **inversion** occurs when a chromosome segment is detached, flipped around 180^0, and reattached to the rest of the chromosome; as a result, the order of the segment's genes is reversed.

Cytogeneticists distinguish between two types of inversions based on whether or not the inverted segment includes the chromosome's centromere. **Pericentric** inversions include the

centromere, whereas **paracentric** inversions do not. The consequence is that a pericentric inversion may change the relative lengths of the two arms of the chromosome, whereas a paracentric inversion has no such effect. Thus, if an acrocentric chromosome acquires an inversion with a breakpoint in each of the chromosome's arms (that is, a pericentric inversion), it can be transformed into a metacentric chromosome. However, if an acrocentric chromosome acquires an inversion in which both of the breaks are in the chromosome's long arm (that is, a paracentric inversion), the morphology of the chromosome will not be changed. Hence, with the use of standard cytological methods, pericentric inversions are much easier to detect than paracentric inversions.

An individual in which one chromosome is inverted but its homologue is not is said to be an inversion heterozygote. During meiosis, the inverted and noninverted chromosomes pair point-for-point along their length. However, because of the inversion, the chromosomes must form a loop to allow for pairing in the region where their genes are in reversed order.





Q. 6- Answer:

A **karyotype** (Greek *karyon* = kernel, seed or nucleus) is the number and appearance of chromosomes in the nucleus of a eukaryotic cell. The term is also used for the complete set of chromosomes in a species, or an individual organism. The total chromosomal complement of a cell, the **karyotype,** can be photographed during mitosis and rearranged in pairs to make a picture called a karyotype or **idiogram**. Karyotypes describe the number of chromosomes, and what they look like under a light microscope. Attention is paid to their length, the position of the centromeres, banding pattern, any differences between the sex chromosomes, and any other physical characteristics. The preparation and study of karyotypes is part of cytogenetics.

Banding patterns of chromosomes:

The study of karyotypes is made possible by staining. Until the late 1960s and early 1970s, chromosome spreads were usually stained with Feulgen's reagent, a purple dye that reacts with the sugar molecules in DNA, or with aceto-carmine, a deep red dye. Because these types of dyes stain the chromosomes uniformly, they do not allow a researcher to distinguish one chromosome from another unless the chromosomes are very different in size or in the positions of their centromeres. Today, cytogeneticists use dyes that stain chromosomes differentially along their lengths. *Quinacrine,* a chemical relative of the antimalarial drug quinine, was one of the first of these more discriminating reagents. Chromosomes that have been stained with quinacrine show a characteristic pattern of bright bands on a darker background. However, because quinacrine is a fluorescent compound, the bands appear only when the chromosomes are exposed to ultraviolet

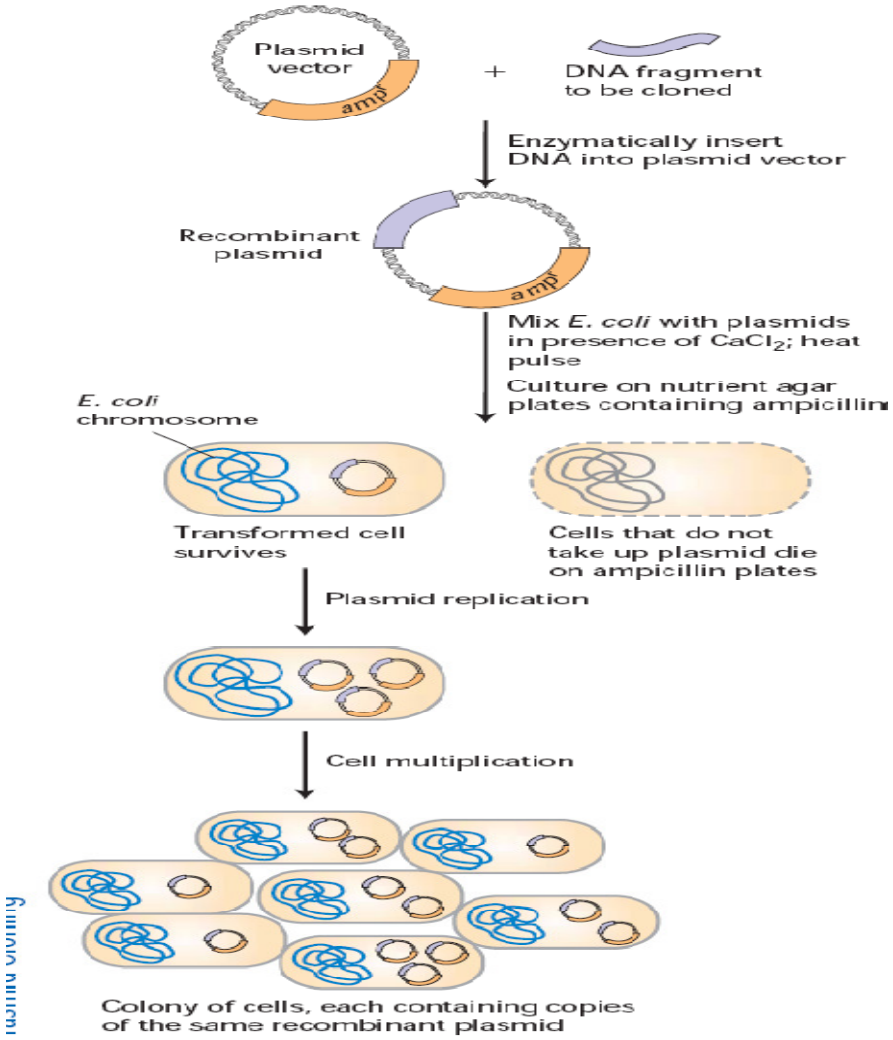
(UV) light. Ultraviolet irradiation causes some of the quinacrine molecules that have inserted into the chromosome to emit energy. Parts of the chromosome shine brightly, whereas other parts remain dark. This bright-dark banding pattern is highly reproducible and is also specific for each chromosome. Thus with quinacrine banding, cytogeneticists can identify particular chromosomes in a cell, and they can also determine if a chromosome is structurally abnormal—for example, if it is missing certain bands.

Excellent nonfluorescent staining techniques have also been developed. The most popular of these uses *Giemsa* stain, a mixture of dyes named after its inventor, Gustav Giemsa. Like quinacrine, Giemsa creates a reproducible pattern of bands on each chromosome. It is still not clear why chromosomes show bands when they are stained with quinacrine or Giemsa. It may be that these types of dyes react preferentially with certain DNA sequences, or with the proteins associated with them, and that these target DNA sequences are distributed in a characteristic way within each chromosome.

Q. 7- Answer:

Recombinant DNA (rDNA) is a form of artificial DNA that is created by combining two or more sequences usually originating from different organism.

Recombinant DNA technology is a technology which allows DNA to be produced via artificial means. A series of procedures have been used to change DNA in living organisms and may have even more practical uses in the future.These steps include isolating of the target gene and the vector, specific cutting of DNA at defined sites, joining or splicing of DNA fragments, transforming of replicon to host cell, cloning, selecting of the positive cells containing recombinant DNA, and either express or not in the end.



Applications of Recombinant DNA Technology

Genetic engineering is more applicable in following sector.

1. Health and Medicine sector

2. Agriculture sector

3. Food sector

4. Industry sector

5. Environmental sector

Health and Medicine sector

i. Production of hormonal peptides: Somatotrophin, somatostatin, insulin, β-endorphin

ii. Production of lymphokines

iii. Production of recombinant subunits vaccines

iv. Production of monoclonal antibody

v. Production of urokinase, TPA & α-antitrypsin

vi. Gene therapy

Agriculture & Food sectors

i. Production of Herbicide resistant plants

ii. Insect resistant plants

iii. Virus resistant plant

iv. Production of flavor saver tomato by antisense RNA technology

Environmental sector

i. Control of petroleum oil pollution: Super bug

ii. Bioremidation

Q. 8- Answer:

Pedigrees are diagrams that show the relationships among the members of a family (Figure 3.13*a*). It is customary to represent males as squares and females as circles. A horizontal line connecting a circle and a square represents a mating. The offspring of the mating are shown beneath the mates, starting with the first born at the left and proceeding through the birth order to the right. Individuals that have a genetic condition are indicated by coloring or shading. The generations in a pedigree are usually denoted by Roman numerals, and particular individuals within a generation are referred to by Arabic numerals following the Roman numeral.

On the basis of the information in a pedigree, geneticists attempt to determine the mode of inheritance of a trait. There are two types of questions the pedigree might be used to answer. First, are there patterns within the pedigree that are consistent with a particular mode of inheritance? Second, are there patterns within the pedigree that are inconsistent with a particular mode of inheritance? Often, it is not possible to determine the mode of inheritance of a particular trait with certainty. McKusick has reported that, as of 2001, the mode of inheritance of over nine thousand loci in human beings was known with some confidence, including autosomal dominant, autosomal recessive, and sex-linked genes.

Example: Dominant Inheritance

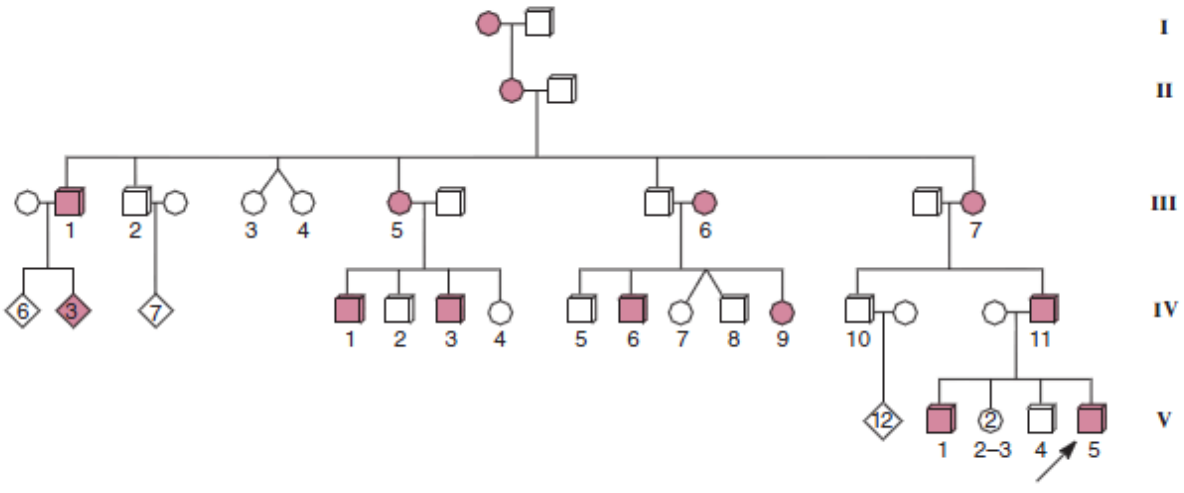


Fig: Part of a pedigree for polydactyly.

If we look at the pedigree in above figure, several points emerge. First, polydactyly occurs in every generation. Every affected child has an affected parent—no generations are skipped. This suggests dominant inheritance. Second, the trait occurs about equally in both sexes; there are seven affected males and six affected females in the pedigree. This indicates **autosomal** rather than sex-linked inheritance. Thus, so far, we would categorize polydactyly as an autosomal dominant trait. Note also that individual IV-11, a male, passed on the trait to two of his three sons. This would rule out sex linkage. (Remember that a male gives his X chromosome to all of his daughters but none of his sons. His sons receive his Y chromosome.) Consistency in many such pedigrees, has confirmed that an autosomal dominant gene causes polydactyly.