Heredity and Evolution

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CLASS: X **BIOLOGY**

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1. Define genetics.

Genetics is the branch of biology that deals with **heredity and variation**.

2. Define heredity.

Heredity is the **transmission of characters or traits** from parents to the offsprings, resulting into resemblances among individuals.

3. What is variation? What is the importance of variations?

It refers to the differences in the characters or traits among the individuals of a species.

Importance of Variations.

(i) They enable the organisms to adapt themselves in changing environment.

(ii) Variations form the basis of heredity.

(iii) They form raw materials for evolution and development of new species.

4. How do variations occur in sexual reproduction?

In sexual reproduction, two parents are involved and there is formation and fusion of gametes.

The offsprings show variations from their parents due to recombination of parental genes caused by crossing over and exchange of genes.

5. What are the two modes of reproduction in living organisms?

(i) Asexual Reproduction
(ii) Sexual Reproduction

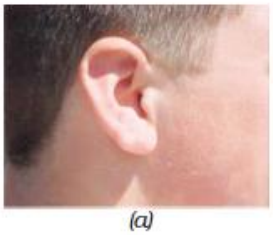
6. Where is hereditary information present in an organism? How is this information passed to the next generation?

Hereditary information is present on the **chromosome** in the form of segments of DNA called the **genes.**
This information is passed from one generation to the other through **sexual reproduction.** (Gamete formation and fertilization).

7. Name the unit of inheritance. What is its function?

The unit of inheritance is gene. It carries genetic information from one generation to another.

8. What are inherited and acquired traits? Give example.



(a)

(b)

The traits that are obtained from parents are inherited traits.

E.g. **(a) Free earlobe** **(b) attached earlobe**

The lowest part of the ear, called the earlobe, is closely attached to the side of the head in some of us, and not in others. Free and attached earlobes are two variants found in human populations.

The traits that develop during the lifetime of an individual are acquired traits. Such characteristics are **not genetically controlled** and **cannot be passed** on to the next generation.

E.g. Muscular body of a wrestler.

9. What is a monohybrid cross? Give the phenotypic and genotypic F_2 ratio.

A cross which involves a single pair of contrasting characters is called a monohybrid cross.

The F_2 phenotypic ratio of monohybrid cross is 3:1 and the genotypic ratio is 1:2:1.

10. What is a dihybrid cross? Give the F_2 dihybrid ratio.

A cross which involves two pairs of contrasting characters is called a dihybrid cross.

The F_2 ratio of dihybrid cross is 9:3:3:1

11. (a) What is genetics?
(b) Who is regarded as the 'Father of Genetics'? Name the plant on which he performed his experiments.
(c) Why did he select that specific plant for his experimental studies?
(d) Define dominant character.
(e) Give the F2 ratio of monohybrid and dihybrid crosses.

(a) Genetics is the branch of biology that deals with the study of heredity and variations.
(b) Gregor Johann Mendel, Garden pea.
(c) Garden pea plants have more visible contrasting characters / easily available / they grow in one season /fertilization was easy.
(d) The character expressed in F1 progeny is dominant character.
(e) Monohybrid ratio: 3:1 Dihybrid ratio: 9:3:3:1

12. How do Mendel's experiments show that traits may be dominant or recessive?

Cross-pollination of tall and short plants:

Mendel crossed true breeding tall (TT) and dwarf (tt) pea plants. All the plants formed in F_1 generation were **tall**.

Self-pollination of F_1 plants

Then, Mendel self-pollinated the F_1 plants and observed that all plants obtained in the F_2 generation were not tall. Instead, one-fourth of the F_2 plants were short. (3:1 ratio)

Conclusion

From this experiment, Mendel concluded that the F_1 tall plants were not true breeding. They were carrying the traits of both short and tall characters. All of them appeared tall only because the **tall trait is dominant** over the dwarf trait.

The character which appears in the F_1 is called dominant character.

The character which does not appear in the F1 or the character which is hidden is called recessive character.

Homozygous Tall	Homozygous Short		
	F1	t	t
	T	Tt	Tt
	T	Tt	Tt

F1 All the plants are tall

Heterozygous Tall	Heterozygous Tall		
	F2	T	t
	T	TT	Tt
	t	Tt	tt

F2 (3 Tall Plants 1 Short Plant)

(Phenotypic Ratio 3:1, Genotypic Ratio 1:2:1)

13. How do Mendel's experiments show that traits are inherited independently?

OR

Explain Dihybrid cross between pea plants having round green seeds with pea plants having wrinkled yellow seeds.

Mendel crossed pea plants having round green seeds (RRyy) with pea plants having wrinkled yellow seeds (rrYY). All the plants in the F_1 were Round Yellow.

Then this F_1 progeny was self-pollinated and the F_2 progeny was found to have yellow round seeds, green round seeds, yellow wrinkled seeds, and green wrinkled seeds in the ratio of 9:3:3:1.

This proves that traits are independently inherited.

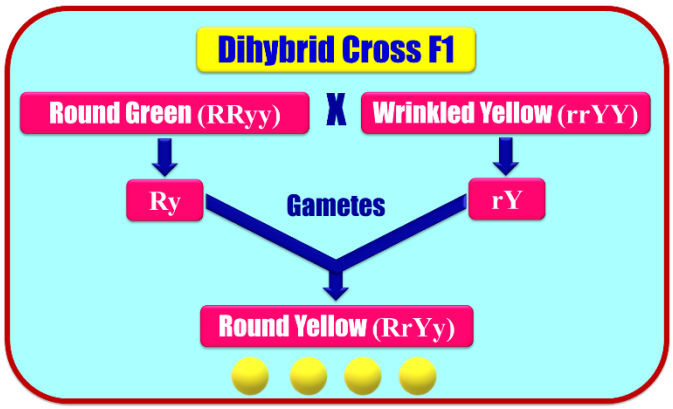
The F2 progenies produced the following traits out of 16 plants.

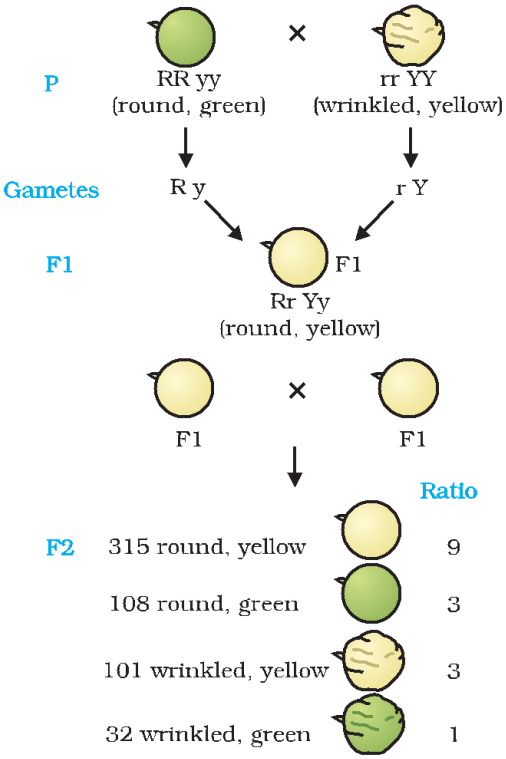
9 Round yellow seeds

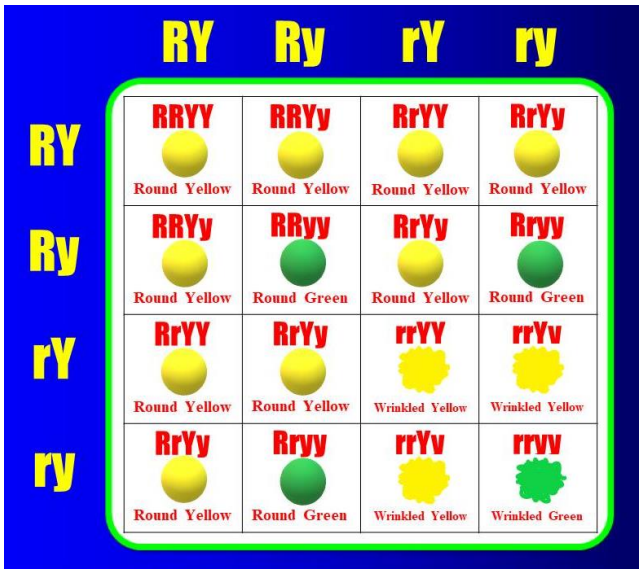
3 Round green seeds

3 Wrinkled yellow seeds

1 Wrinkled green seed **The F2 Dihybrid ratio is 9:3:3:1**







14. Study the given data and answer the following questions:

Parental plants cross fertilized & seeds collected	**F1**	**F2**
Male parent had red flowers. Female parent had white flowers.	**330 seeds** sown and observed **All 330 seeds gave red flowers**	**Out of 44 seeds** 33 seeds gave plants with **red flowers**. 11 seeds gave plants with **white flowers**

i. What is the term for this type of cross?
ii. What does the data of the column marked F_1 indicate?
iii. Express the genotype of the (a) parents (b) F1 progeny and (c) F2 progeny

i. Monohybrid cross

ii. Red flower is dominant over white flower

iii. a. Genotype of Parents – (RR) and (rr)

b. Genotype of F1 progeny – Rr

c. Genotype of F2 progeny – RR, Rr and rr

Homozygous Red	Homozygous White	
	F_1	r	r
	R	Rr	Rr
	R	Rr	Rr

F1 All flowers are Red

Heterozygous Red	Heterozygous Red	
	F_2	R	r
	R	RR	Rr
	r	Rr	rr

F2 (3 Red 1 White)

(Phenotypic Ratio 3:1, Genotypic Ratio 1:2:1)

15. In a cross between plants with pink flowers and plants with white flowers, all the offsprings of F1 generation had pink flowers.

When the F1 generation was self-crossed, it was observed in the F2 generation that out of 100, 75 flowers were pink. Make a cross and answer the following:

(a) What are the genotypes of the F1 progeny?

(b) What is the ratio of Pink: White flowers in the F2 generation?

Genotypes of F_1 progeny Pp (pink)

F_2 Phenotypic ratio 3 Pink flowers : 1 white flower.

F2 Genotypic ratio 1:2:1

PINK FLOWER	WHITE FLOWER	
	p	p
P	Pp	Pp
P	Pp	Pp

F1 All flowers are Pink

PINK FLOWER	PINK FLOWER	
	P	p
P	PP	Pp
p	Pp	pp

F2 (3 Pink: 1 White)

(Phenotypic Ratio 3:1, Genotypic Ratio 1:2:1)

16. Human males are heterogametic whereas females are homogametic. Justify.

1. Human males are heterogametic because they produce two types of gametes, one having **sperms with X chromosome** and the other having **sperms with Y chromosome**.
2. Human females are homogametic because they produce only one kind of gamete i.e., **ovum with X chromosome**.

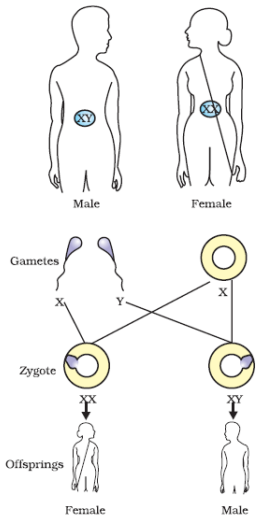
17. How is the sex of the child determined in human beings? Support your answer with a suitable illustration.

Human males are heterogametic because they produce two types of gametes, one having **sperms with X chromosome** and the other having **sperms with Y chromosome**.

Human females are homogametic because they produce only one kind of gamete i.e., **ovum with X chromosome**.

When a sperm carrying Y chromosome fuses with ovum, the zygote with XY chromosomes develops into a male baby.

When a sperm carrying X chromosome fuses with ovum, the zygote with XX chromosomes develops into a female baby.



18. The sex of the child is determined by the father not by the mother in humans. Justify.

OR

Genetic composition of the father plays a deciding role in determining the gender of the new-born child. Justify the statement.

Human males are heterogametic; produce two types of gametes, sperms with X chromosome and sperms with Y chromosome.

Half of the sperms carry X-chromosomes and the other half of the sperms carry Y-chromosomes. (50% of sperms with X chromosome and 50% of sperms with Y chromosome).

But human females produce only one type of gametes, all the ova only with X chromosome.

So, the sex of the offsprings, depend on the type of male gamete fusing with the female gamete.

When a sperm carrying Y chromosome fuses with ovum, the zygote with XY chromosomes develops into a male baby.

When a sperm carrying X chromosome fuses with ovum, the zygote with XX chromosomes develops into a female baby.

Hence it is proved that the sex of the offsprings is determined by the father and not by the mother.

19. How is the equal genetic contribution of male and female parents ensured in the progeny?

In human beings, every somatic cell of the body contains 23 pairs of chromosomes.

Out of these 23 pairs, the first 22 pairs are known as autosomes and the remaining one pair is known as sex chromosomes represented as X and Y.

Females have two X chromosomes and males have one X and one Y chromosome.

The gamete receives half of the chromosomes. Therefore, the male gametes have 22 autosomes and either X or Y chromosome.

The female gamete has 22 autosomes and X chromosome.

During reproduction, the male and female gametes fuse and thus the progeny receives 22 autosomes and one X or Y chromosome from male parent and 22 autosomes and one X chromosome from the female parent.

20. A man with blood group A marries a woman with blood group O and their daughter has blood group O. Is this information enough to tell you which of the traits - blood group A or O is dominant? Why or why not?

No. This information is not sufficient to determine which of the traits − blood group A or O is dominant. This is because we do not know about the blood group of all the progeny.

Blood group A can be genotypically AA or AO. Hence, the information is incomplete to draw any such conclusion.

21. What are genes? How do genes control the traits?

DNA is the information source for making proteins in the cell.

A segment of DNA that provides information for the synthesis of one protein is called the gene for that protein.

DNA works through enzymes. Enzymes are biocatalysts which speed up the biochemical processes.

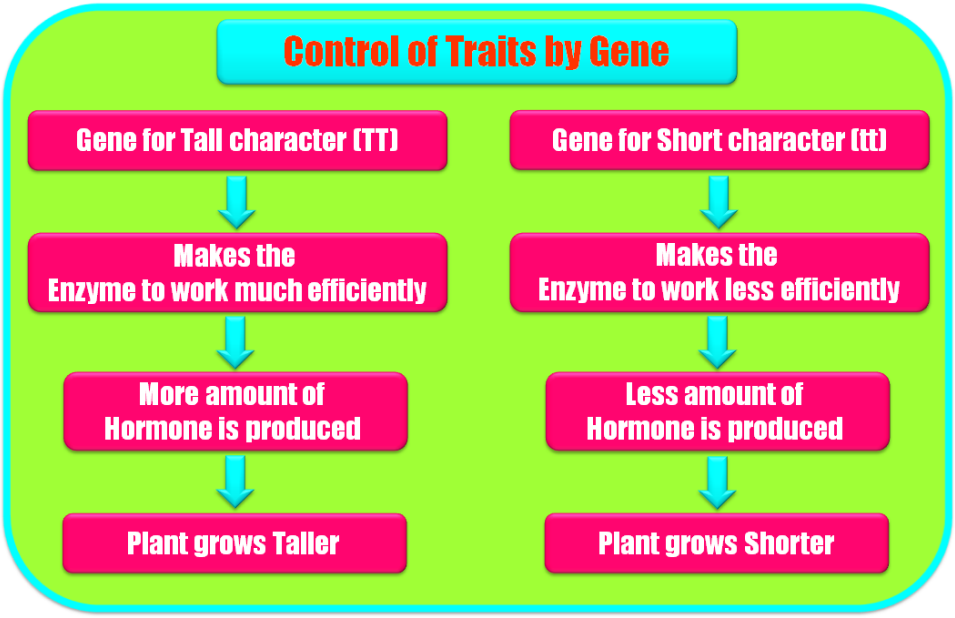
If DNA makes the enzyme to work more efficiently, a lot of hormones will be synthesized.

More amount of hormones make the plant to grow taller.

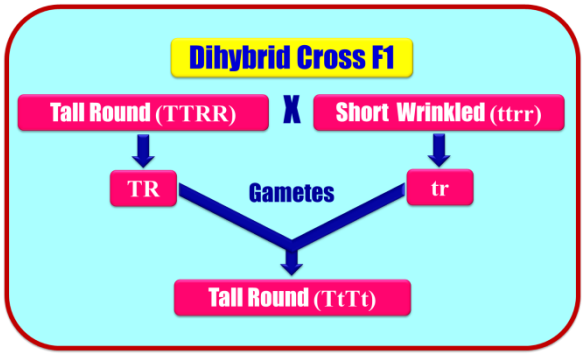
If DNA makes the enzyme to work less efficiently, less amount of hormones will be synthesized.

Less amount of hormones make the plant to grow shorter.

Thus genes control the characteristics or traits.



Dihybrid Cross between Plants of Tall Round seeds and Short Wrinkled Seeds



	TR	Tr	tR	tr
TR	TTRR Tall Round	TTRr Tall Round	TtRR Tall Round	TtRr Tall Round
Tr	TTRr Tall Round	TTrr Tall Wrinkled	TtRr Tall Round	Ttrr Tall Wrinkled
tR	TtRR Tall Round	TtRr Tall Round	ttRR Short Round	ttRr Short Round
tr	TtRr Tall Round	Ttrr Tall Wrinkled	ttRr Short Round	ttrr Short Wrinkled

Dihybrid Cross between Plants of Tall Round seeds and Short Wrinkled Seeds

The ratio and traits of F2 progenies were as follows.

9 Tall Plants with Round Seeds

3 Tall Plants with Wrinkled Seeds

3 Short Plants with Round Seeds

1 Short Plant with Wrinkled Seeds

Hence, the F2 Dihybrid ratio is 9:3:3:1

Genes:

A segment of DNA which controls a specific character is called a gene. Genes are present in chromosomes.

Alleles:

The different forms of a gene are called alleles. 'Tt', 'Rr', 'Yy'.

The genotype of Heterozygous Tall character consists of two kinds of genes, capital 'T' and small 't' (Tt). These are the alleles.

Homozygous Genotype:

When both the genes of a particular character are of the same kind, it is called homozygous genotype. Eg. 'TT' and 'tt'.

Heterozygous Genotype:

When both the genes of a particular character are of different kinds, it is called heterozygous genotype. Eg. 'Tt', 'Rr', and 'Yy'.

Phenotypic Ratio:

The ratio obtained based on the visible characters is called Phenotypic Ratio.

Genotypic Ratio:

The ratio obtained based on the genetic combination of alleles is called Genotypic Ratio.

Punnett square

Punnett square is a square diagram that is used to predict the genotypes of a particular cross breeding. It is named after the Scientist Reginald C. Punnett, who devised this approach.

Mendel proposed the three principles of inheritance of characters. They are as follows;

Principles of Inheritance

1. Law of Dominance and Recessive.
2. Law of Segregation.
3. Law of Independent Assortment.

Dihybrid Cross

A cross which involves two pairs of contrasting characters is called a dihybrid cross.

The cross between Colour of the seeds and Shape of the seeds of pea plants is a dihybrid cross.

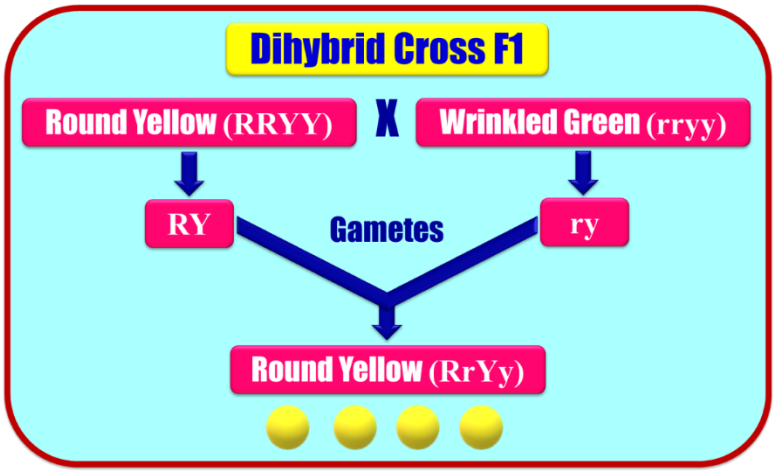
1. Colour of the seeds is a single character.

It has a pair of contrasting characters **"Yellow and Green Seeds".**

2. Shape of the seeds is a single character.

It has a pair of contrasting characters **"Round and Wrinkled Seeds".**

As these two pairs of contrasting characters are considered in a single cross, it is known as a dihybrid cross.



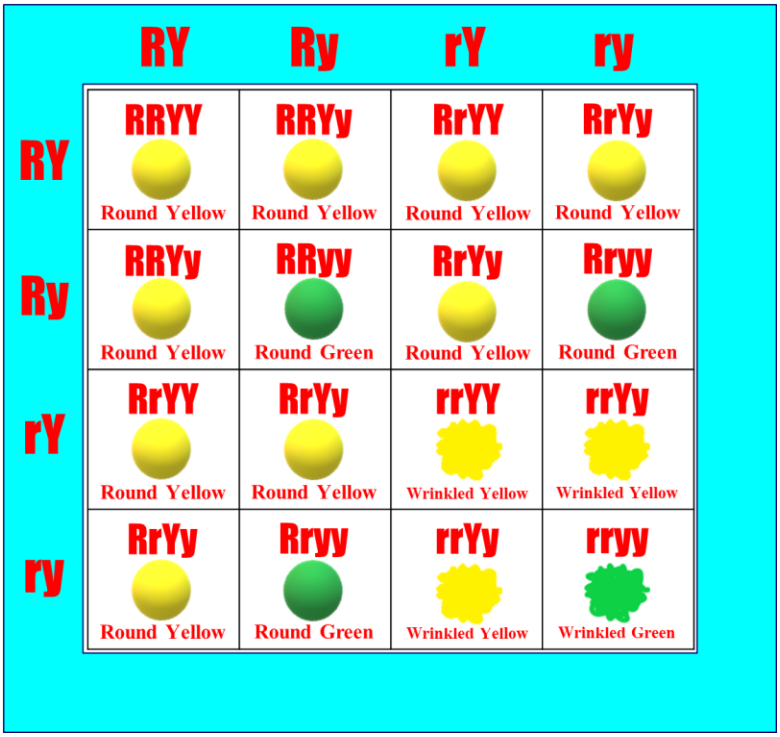
F1 Hybrids

Dihybrid Cross between

Round Yellow seeds

and

Wrinkled Green Seeds



F2 Hybrids

The traits of F2 hybrids were as follows.

9 Round yellow seeds

3 Round green seeds

3 Wrinkled yellow seeds

1 Wrinkled green seed

Hence, the F2 Dihybrid ratio is 9:3:3:1.