



Senior 4 General Science (New curriculum)

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Senior 4

Term 3

THEME: SCIENCE AND THE HUMAN BODY

TOPIC 8: HUMAN GROWTH AND DEVELOPMENT

Competency: The learner understands the various physiological changes during growth, the emotional and psychological challenges associated with each stage



Difference Between Growth and Development

Aspect	Growth	Development
Definition	Increase in size, height, weight, or mass (quantitative change).	Improvement in skills, abilities, behavior, and quality of life (qualitative change).
Measurement	Measured physically (e.g., centimeters, kilograms).	Measured by progress in knowledge, maturity, social and emotional skills.
Nature	Physical and biological.	Social, economic, intellectual, emotional.
Example	A child growing taller and heavier.	A child learning to read, becoming responsible, or gaining problem-solving skills.

Scenario Question 8.1

A village in Uganda has recently benefited from a government program. The children in the village are now healthier, with better nutrition, and the school has introduced new teaching methods that improve critical thinking and creativity.

1. Identify which changes in the village represent **growth** and which represent **development**.
2. Explain why both growth and development are important for the progress of a community.
3. Suggest one way the government can promote development apart from improving education.

Suggested Answers

1.

Growth: Children becoming healthier and physically stronger due to better nutrition.

Development: Improved teaching methods that enhance critical thinking and creativity.

2.

Growth ensures the population is physically strong and healthy, which is necessary for productivity.

Development ensures people acquire skills, knowledge, and values that improve their quality of life and enable them to contribute positively to society.

3.

The government can promote development by improving infrastructure (roads, electricity, internet), which enhances access to markets, services, and opportunities.

Importance of Mitosis

- (i) **Growth of organisms** – increases the number of cells, allowing tissues and organs to enlarge.
- (ii) **Repair of tissues** – replaces damaged or worn-out cells (e.g., healing of wounds).
- (iii) **Asexual reproduction** – produces genetically identical offspring in organisms like amoeba, yeast, and plants.
- (iv) **Maintains chromosome number** – ensures daughter cells have the same genetic material as the parent cell.
- (v) **Replacement of cells** – e.g., skin cells, blood cells, and intestinal lining cells are constantly renewed through mitosis.

Scenario Question 8.2

A boy falls and injures his knee while playing football. After a few days, the wound begins to heal.

- (i) Explain how mitosis is involved in the healing of the wound.
- (ii) Apart from healing, give two other roles of mitosis in the boy's body.
- (iii) Discuss one importance of mitosis in plants.

Suggested Answers

(i) Healing of wound:

- Mitosis produces new cells to replace the damaged ones at the site of injury.
- These new cells restore the tissue structure and function.

(ii) Other roles in the boy's body:

- Growth: mitosis increases the number of cells, enabling the boy to grow taller and stronger.
- Replacement: mitosis replaces worn-out cells such as skin and blood cells.

(iii) Importance in plants:

- Mitosis allows plants to grow by increasing cell numbers in roots, stems, and leaves.
- It also enables vegetative propagation (e.g., cuttings, runners) by producing identical cells.

Stages of Human Development

(i) Infancy (0–2 years)

Physical: Rapid growth in height and weight, development of motor skills (crawling, walking).

Cognitive: Beginning of language, recognition of people, learning through senses.

(ii) Childhood (3–12 years)

Physical: Steady growth, development of fine motor skills (writing, drawing).

Cognitive: Learning basic concepts, problem-solving, memory improvement, social skills.

(iii) Adolescence (13–19 years)

Physical: Puberty changes (voice, body shape, reproductive maturity).

Cognitive: Abstract thinking, identity formation, critical reasoning, independence.

(iv) Adulthood (20–60 years)

Physical: Peak strength and health in early adulthood, gradual decline later.

Cognitive: Advanced reasoning, career skills, emotional maturity, responsibility.

(v) Old Age (60+ years)

Physical: Decline in strength, slower reflexes, health challenges.

Cognitive: Wisdom, experience, but possible memory decline in later years.

Summary Table

Stage	Physical Development	Cognitive Development
Infancy	Rapid growth, motor skills	Language beginnings, sensory learning
Childhood	Steady growth, fine motor skills	Basic concepts, memory, social skills
Adolescence	Puberty changes, body maturity	Abstract thinking, identity formation
Adulthood	Peak health, gradual decline later	Advanced reasoning, emotional maturity
Old Age	Decline in strength, slower reflexes	Wisdom, possible memory decline

Scenario Question 8.3

A teacher in Kampala observes different behaviors among her students and their families. One child is learning to read and write, a teenager is struggling with identity and independence, while the child's grandmother is sharing wisdom from her life experiences.

1. Identify the stages of development represented by the child, the teenager, and the grandmother.
2. Explain one physical and one cognitive characteristic of each stage.
3. Discuss why understanding these stages is important for teachers and parents.

Suggested Answers

1.

Child → **Childhood**

Teenager → **Adolescence**

Grandmother → **Old Age**

2.

Childhood: Physical – steady growth; Cognitive – learning basic skills like reading.

Adolescence: Physical – puberty changes; Cognitive – abstract thinking and identity struggles.

Old Age: Physical – decline in strength; Cognitive – wisdom and life experience.

3.

Understanding stages helps teachers and parents **support learners appropriately**, recognize their needs, and guide them through challenges.

It ensures proper nurturing of physical health and cognitive abilities at each stage.

Deviant Behavior Linked to Physiological Changes

(i) Hormonal Changes

Adolescence (puberty):

- Sudden mood swings, aggression, or risk-taking behavior due to surges in testosterone and estrogen.

Menstrual cycle / menopause:

- Irritability, depression, or anxiety linked to fluctuating estrogen and progesterone.

(ii) Brain and Nervous System Changes

Brain injury or disease (e.g., tumors, epilepsy, dementia):

- Impulsive actions, violence, or socially inappropriate behavior.

Drug or alcohol effects:

- Reduced inhibition, reckless sexual activity, or criminal tendencies.

(iii) **Metabolic and Chemical Imbalances**

Diabetes (low/high blood sugar):

- Confusion, irritability, or aggression during hypoglycemia.

Thyroid disorders:

- Hyperthyroidism → restlessness, irritability.
- Hypothyroidism → lethargy, withdrawal, depression.

(iv) **Genetic and Developmental Factors**

Chromosomal abnormalities (e.g., Down syndrome, Fragile X):

- May lead to behavioral difficulties such as hyperactivity or social withdrawal.

Neurodevelopmental disorders (e.g., ADHD, autism):

- Impulsivity, repetitive behaviors, or difficulty following social norms.

(v) **Substance-Induced Physiological Changes**

Steroid abuse:

- Aggression (“roid rage”), paranoia, violent tendencies.

Diet pills / stimulants:

- Anxiety, restlessness, insomnia, sometimes leading to deviant coping behaviors.

Example Scenario Question 8.4

A 17-year-old boy in Kampala begins showing aggressive behavior, frequent mood swings, and risk-taking activities. His teachers suspect physiological changes are influencing his behavior.

Questions:

- (i) Identify the physiological changes likely responsible.
- (ii) Explain how these changes can lead to deviant behavior.
- (iii) Suggest two ways society can help adolescents cope with such changes.

Answers:

- (i) Hormonal changes during puberty (testosterone surge).
- (ii) Increased aggression, impulsivity, and risk-taking due to hormonal imbalance.
- (iii) Guidance and counselling in schools, parental support, and involvement in constructive activities (sports, clubs).

Physical, physiological and psychological (emotional) changes associated with adolescence, puberty

Here's a structured appreciation of the **physical, physiological, and psychological (emotional) changes** during adolescence and puberty, along with common myths that often mislead young people:

Physical Changes

- (i) Rapid increase in height and weight (growth spurt).
- (ii) Development of secondary sexual characteristics:
 - Boys → deeper voice, facial hair, broad shoulders.
 - Girls → breast development, wider hips, onset of menstruation.
- (iii) Acne and oily skin due to increased activity of sebaceous glands.
- (iv) Increased sweating and body odor.

Physiological Changes

- (i) Hormonal activity increases (testosterone, estrogen, progesterone).
- (ii) Onset of reproductive capability:
 - Boys → production of sperm.
 - Girls → ovulation and menstruation.
- (iii) Changes in metabolism and appetite.

- (iv) Sleep patterns may shift due to biological rhythms.

Psychological (Emotional) Changes

- (i) Mood swings due to hormonal fluctuations.
- (ii) Heightened self-awareness and concern about body image.
- (iii) Desire for independence and identity formation.
- (iv) Curiosity about relationships and sexuality.
- (v) Peer influence becomes stronger, sometimes leading to risk-taking behavior.

Common Myths About Adolescence & Puberty

Myth	Reality
Menstruation is a disease	It is a normal biological process in girls.
Wet dreams mean illness	They are a natural sign of sexual maturity in boys.
Masturbation causes infertility or madness	It does not; it is a common behavior during adolescence.
Girls should avoid sports during menstruation	Physical activity is safe and can even reduce cramps.
Acne means poor hygiene	Acne is caused mainly by hormonal changes, not dirt.
Voice breaking in boys is permanent damage	It is a normal stage of vocal cord development.

Example Scenario Question 8.5

A 15-year-old girl in Uganda begins menstruating and feels ashamed because her peers tell her it is a curse. She also experiences mood swings and acne.

Questions:

- (i) Identify the physical, physiological, and psychological changes she is experiencing.
- (ii) Explain why these changes are normal.

- (iii) Correct the myth associated with menstruation.
- (iv) Suggest two ways teachers and parents can support adolescents during puberty.

Answers:

- (i) Physical → acne, breast development; Physiological → menstruation; Psychological → mood swings, shame.
- (ii) They are natural signs of puberty and reproductive maturity.
- (iii) Menstruation is not a curse but a healthy biological process.
- (iv) Provide guidance and counselling, promote hygiene education, and encourage positive peer support.

Physical Features of Aging

- (i) Wrinkling and sagging of skin due to reduced collagen and elasticity.
- (ii) Graying and thinning of hair.
- (iii) Decline in muscle mass and strength (sarcopenia).
- (iv) Reduced bone density, leading to osteoporosis and frailty.
- (v) Diminished vision (presbyopia, cataracts) and hearing loss.
- (vi) Slower reflexes and reduced mobility.

Physiological Features of Aging

- (i) Slower metabolism and reduced energy levels.
- (ii) Decline in immune system efficiency (increased susceptibility to infections).
- (iii) Reduced cardiovascular efficiency (arteries stiffen, higher risk of hypertension).
- (iv) Decreased lung capacity and respiratory efficiency.
- (v) Slower digestion and absorption of nutrients.
- (vi) Hormonal changes (e.g., reduced estrogen/testosterone, affecting reproductive functions).
- (vii) Decline in kidney and liver function.

Psychological (Emotional & Cognitive) Features of Aging

- (i) Memory lapses and slower information processing.
- (ii) Possible cognitive decline (risk of dementia, Alzheimer's disease).

- (iii) Emotional changes: loneliness, anxiety, or depression due to retirement, loss of loved ones, or reduced social interaction.
- (iv) Greater wisdom, patience, and life experience.
- (v) Adaptation to new roles (grandparenthood, community leadership).

Common Myths About Aging

Myth	Reality
All old people become senile	Many retain sharp mental abilities well into old age.
Aging always means illness	Aging increases risk, but healthy lifestyle can prevent many diseases.
Elderly cannot learn new skills	Older adults can learn and adapt, though at a slower pace.
Sexual activity ends with aging	Desire may reduce, but many remain sexually active.
Exercise is unsafe for the elderly	Proper exercise improves strength, balance, and longevity.

Scenario Question 8.6

A 70-year-old man in Kampala complains of weak bones, poor eyesight, and loneliness after retirement.

Questions:

- (i) Identify the physical, physiological, and psychological features of aging he is experiencing.
- (ii) Explain why these changes occur naturally.
- (iii) Suggest two ways society can support the elderly.

Answers:

- (i) Physical → weak bones, poor eyesight; Physiological → reduced bone density, slower metabolism; Psychological → loneliness.
- (ii) They occur due to reduced collagen, hormonal changes, and natural decline in body systems.

- (iii) Provide community programs for social interaction, promote healthcare and exercise for the elderly.

THEME: SCIENCE OF HUMAN BODY

TOPIC 9: INHERITANCE AND EVOLUTION

Competency: The learner understands between evolution, inheritance and variation and applies them correctly in scientific enquiries.

Heritable and nonheritable traits

Here's a clear breakdown of **traits that are inherited (passed genetically from parents to offspring)** and those that are **not inheritable (acquired through environment, lifestyle, or personal effort)**:

Inherited Traits (Genetic)

- (i) **Blood group** (A, B, AB, O).
- (ii) **Eye color** (brown, blue, green).
- (iii) **Hair type** (curly, straight, wavy).
- (iv) **Skin color** (determined by melanin levels).
- (v) **Height potential** (though nutrition influences actual growth).
- (vi) **Genetic diseases** (e.g., sickle cell anemia, hemophilia, color blindness).
- (vii) **Facial features** (shape of nose, lips, ears).
- (viii) **Natural body build** (slim, broad, etc.).

Non-Inheritable Traits (Acquired)

- (i) **Language spoken** (depends on environment and culture).
- (ii) **Manners and discipline** (shaped by upbringing).
- (iii) **Knowledge and education** (schooling, training).
- (iv) **Skills** (e.g., cooking, driving, playing football).
- (v) **Religious beliefs and values** (influenced by family and society).
- (vi) **Fashion sense and preferences** (personal choice).
- (vii) **Body fitness** (exercise, diet, lifestyle).
- (viii) **Professional career** (teaching, medicine, engineering).

Quick Comparison Table

Inherited Traits	Non-Inheritable Traits
Blood group	Language spoken
Eye color	Manners & discipline
Hair type	Knowledge & education
Skin color	Skills (e.g., sports, cooking)
Genetic diseases	Religious beliefs
Height potential	Fashion preferences
Facial features	Career choice
Natural body build	Body fitness

Scenario Question 9.1

A student in Kampala has brown eyes, curly hair, and speaks Luganda fluently. He is also very disciplined and plays football well.

Questions:

- (i) Identify two inherited traits from the student.
- (ii) Identify two non-inheritable traits.
- (iii) Explain why language is not an inherited trait.

Answers:

- (i) Inherited → brown eyes, curly hair.
- (ii) Non-inheritable → speaking Luganda, discipline, football skills.
- (iii) Language is learned from the environment and culture, not passed through genes.

Variation

Variation refers to the differences or diversity in traits among individuals of the same species.

It explains why no two organisms (even twins) are exactly alike.

Variation is essential for **evolution, adaptation, and survival**.

Types of Variation

(i) Genetic Variation

Caused by differences in DNA among individuals.

Inherited from parents.

Examples: blood group, eye color, sickle cell trait.

(ii) Environmental Variation

Caused by external factors like climate, diet, lifestyle, or culture.

Not inherited.

Examples: language spoken, body fitness, tanning of skin due to sunlight.

(iii) Continuous Variation

Traits show a range of differences without clear-cut categories.

Controlled by many genes (polygenic inheritance).

Examples: height, weight, skin color.

(iv) Discontinuous Variation

Traits fall into distinct categories with no intermediate forms.

Controlled by single genes.

Examples: blood group (A, B, AB, O), ability to roll tongue.

Causes of Variation

(i) Genetic Factors:

- Mutation (sudden change in DNA).
- Sexual reproduction (mixing of genes during fertilization).

- Crossing over during meiosis.
- Independent assortment of chromosomes.
- (ii) **Environmental Factors:**
 - Climate (temperature, rainfall).
 - Diet and nutrition.
 - Lifestyle and culture.
 - Diseases and accidents.
- (iii) **Interaction of Genes and Environment:**
 - Height → depends on genes but also nutrition.
 - Intelligence → influenced by heredity and education.

Scenario Question 9.2

In a Ugandan classroom, two students are compared: one is tall and slim, while the other is short and stocky. Both speak Luganda fluently, but one has blood group O and the other blood group AB.

Questions:

1. Identify one inherited and one non-inherited trait in the students.
2. Distinguish between continuous and discontinuous variation using examples from the scenario.
3. Explain two causes of variation among the students.

Answers:

1. Inherited → blood group; Non-inherited → language spoken.
2. Continuous → height and body size; Discontinuous → blood group.
3. Causes → genetic inheritance (blood group), environmental influence (language, nutrition).

Relationship among variations, natural selection and evolution

Variation

Variation refers to differences in traits among individuals of the same species.

Examples: differences in height, skin color, blood group, or resistance to disease.

Variation arises from **genetic factors** (mutations, recombination, independent assortment) and **environmental factors** (climate, diet, lifestyle).

Natural Selection

Proposed by **Charles Darwin**.

It is process by which individuals with **favorable variations** survive, reproduce, and pass on their traits.

Those with **unfavorable variations** are less likely to survive and reproduce.

Example: Peppered moths in industrial England — darker moths survived better in polluted areas.

Evolution

Evolution is the gradual change in species over generations.

Driven by **natural selection acting on variation**.

Over time, favorable traits accumulate, leading to adaptation and sometimes the emergence of new species.

Example: Evolution of giraffes with long necks to reach tall trees.

Relationship Among Them

Variation provides the raw material → differences among individuals.

Natural selection acts on variation → selects traits that improve survival and reproduction.

Evolution results from natural selection → accumulation of favorable traits leads to species change over time.

Scenario Question 9.4

In a Ugandan savanna, some antelopes run faster than others. Lions often catch the slower ones, while the faster ones escape and reproduce.

Questions:

1. Identify the type of biological concept illustrated.
2. Explain the role of variation in this scenario.
3. Describe how natural selection leads to evolution in antelopes.

Answers:

1. Natural selection.
2. Variation → differences in running speed among antelopes.
3. Faster antelopes survive and reproduce, passing on speed traits. Over generations, the population evolves to become faster.

In short: **Variation creates differences, natural selection filters those differences, and evolution is the long-term outcome of this process.**

Inheritance



Inheritance refers to the process by which genetic information is passed from parents to offspring. It is controlled by genes, which are segments of DNA that determine traits like eye colour, height, and susceptibility to diseases.

Terminologies.

1. **A gene** : is the basic unit of hereditary and occupies a discrete position on the chromosomes that controls characteristics to be inherited. Genes controlling a particular characteristic always occur in pairs
2. **Alleles (Allelomorphs)**: are alternative forms of a gene controlling a particular characteristic. For example T and t for tall and short respectively
3. **Genotype**: is the genetic constitution of an organism i.e. the particular set alleles, leading to observable characteristics
4. **Phenotype**: is the physical characteristic of an organism determined by the genotype and the environment.
5. **Homozygous**: It is a genotype with identical or similar alleles. For example, TT for tall and tt for short.

6. **Heterozygous:** It is a genotype with two dissimilar genes. For example, Tt for tall
7. **Dominant gene:** It is a gene that expresses itself in a phenotype both in homozygous and heterozygous condition. For example TT and Tt for tall.
8. **Recessive gene:** it is a gene that expresses itself only in homozygous condition.
9. **Sex chromosome:** It is one of the two chromosomes that determine an organism's biological sex.
10. **Sex- linked gene** – it is one that is located on one of the two sex chromosomes.

Monohybrid inheritance

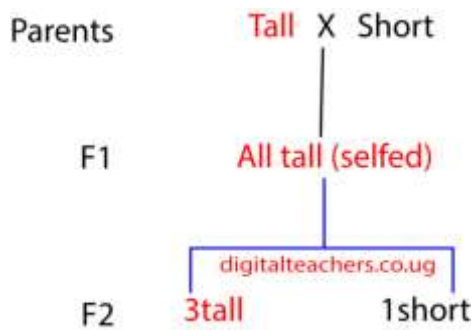
This is an inheritance that deals with a single pair of contrasting characteristics such as Tallness and shortness when concerned with height of peas.

In his investigation of a single pair of contrasting characteristics, Mendel observed that, in the first filial (F1) generation one of the characteristics never appeared only to appear in the second filial (F2) generation in small proportion compared to the one that appeared in the first filial (F1) generation.

For example; he crossed peas with long internodes, with peas of short internodes. He observed that in the F1 generation, all plants had tall internodes. When selfed to produce F2, the peas with short internodes, then appeared in small proportions.



The result of these crosses can be illustrated as follows,



It was concluded from the results that inheritance is a process in which discrete structure or particle (genes) which may or may not show themselves in the outward appearance of the organism are transmitted from parent to off spring.

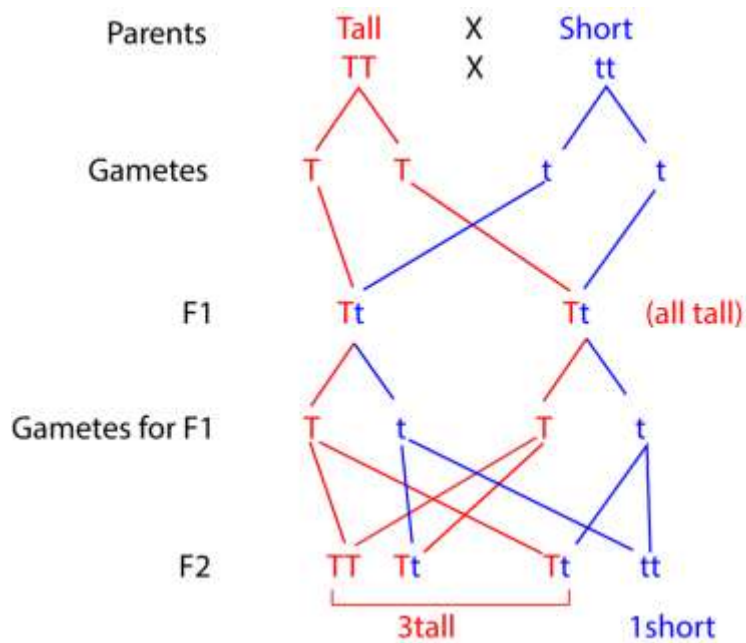
The evidence of existence of inheritable particles is got from the observation that they can be combined in one generation but separate in the next, as in witness by the recovery of the short form in F2 generation despite its absence in the F1 generation,

The characteristic that show in F1 generation (tallness in this case) is described as being **dominant** and while that which masked **F1** generation (shortness) is said to be **recessive**.

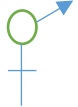
Genes and their transmission

Genes normally occur in pair each of which is obtained from each parent. The cross of a tall plant and short plant is shown diagrammatically by the two methods below.

The allele for tallness (dominant) character is represented by a capital letter **T** while the allele for shortness (recessive character) is represented by small letter **t**. It is assumed that each parent plant contains a pair of identical alleles; **TT** in case of tall plant and **tt** in case of short plant.



Pannet square to show fusion of F1 gametes

	$\frac{1}{2}$ T	$\frac{1}{2}$ t
$\frac{1}{2}$ T	$\frac{1}{4}$ TT	$\frac{1}{4}$ Tt
$\frac{1}{2}$ t	$\frac{1}{4}$ Tt	$\frac{1}{4}$ tt

In terms of probability, there are 3 chances out of four for a tall plant to appear in F2 generation; and one chance of four for a short plant to appear.

Mendel's first law of segregation states that an organism's characteristics are controlled by two genes (alleles) and only one can be carried by in a gamete.

Mendel's second law of Independent Assortment:

During the formation of gametes, alleles in a pair may combine with another allele from another pair randomly.

Scenario Question 9.5

A farmer crosses pure round-seeded pea plants with pure wrinkled-seeded pea plants. All offspring in the first generation have round seeds. When these offspring are self-crossed, the second generation shows both round and wrinkled seeds.

Questions:

1. Name the type of inheritance demonstrated.
2. Define the terms gene, allele, homozygous, and heterozygous.
3. State the phenotypic ratio of the F₂ generation.

Answers:

1. Monohybrid inheritance.
2. Gene → unit of heredity; Allele → alternative form of a gene; Homozygous → identical alleles (RR or rr); Heterozygous → different alleles (Rr).
3. 3 round : 1 wrinkled.

Breeding True

Breeding true is said to occur when an organism consistently produces offspring with the same trait after self-pollination or crossing with another of the same kind.

Example: A pure-bred pea plant with round seeds (RR) always produces round-seeded offspring.

Significance: Shows the organism is **homozygous** for that trait.

Test Cross

Test cross is the crossing an individual showing a **dominant trait** with a **homozygous recessive individual** to determine whether the dominant individual is **homozygous or heterozygous**.

Example: Round-seeded pea plant (unknown genotype) × Wrinkled-seeded pea plant (rr).

Interpretation:

- If all offspring are round → parent is **RR** (homozygous).

- If offspring are 50% round, 50% wrinkled → parent is **Rr** (heterozygous).

Back Cross

Back cross is crossing an offspring (F1 generation) back with one of its parents (or genetically similar to parent).

Types:

- With **dominant parent** → all offspring show dominant trait.
- With **recessive parent** → offspring show 1:1 ratio if F1 is heterozygous.

Use: Helps confirm genotype and stabilize desired traits.

Scenario Question 9.6

A farmer has a pea plant with round seeds but is unsure whether it is pure-bred (RR) or hybrid (Rr). He crosses it with a wrinkled-seeded plant (rr). Half of the offspring are round and half are wrinkled.

Questions:

1. What type of cross is this?
2. What is the genotype of the round-seeded parent?
3. Explain the result.

Answers:

1. Test cross.
2. Genotype is Rr (heterozygous).
3. The 1:1 ratio shows the parent carried both dominant (R) and recessive (r) alleles.

Scenario Question 9.7

A breeder crosses F1 hybrid tall pea plants (Tt) with the recessive short parent (tt). The offspring are 50% tall and 50% short.

Questions:

1. What type of cross is this?
2. State the expected ratio of tall to short plants.
3. Why is this cross useful?

Answers:

1. Back cross with recessive parent.
2. Ratio = 1 tall : 1 short.
3. It helps confirm that the F1 hybrid was heterozygous (Tt).

In short:

- **Breeding true** → shows homozygosity.
- **Test cross** → determines genotype of dominant trait.
- **Back cross** → stabilizes traits or confirms genotype.

Incomplete Dominance

Definition: A genetic situation where neither allele is completely dominant over the other.

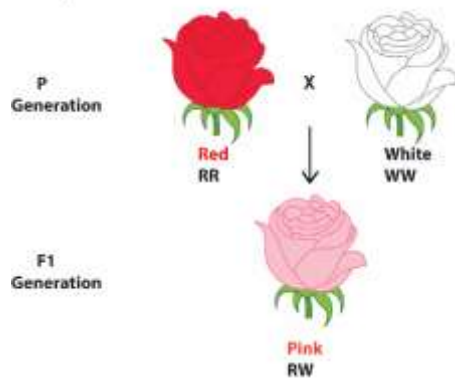
The heterozygous condition shows a **blending** of traits.

Example:

- In snapdragon flowers:
Red (RR) × White (WW) → Pink (RW).
- The heterozygote (RW) shows an intermediate phenotype.

i.e.

Incomplete dominance



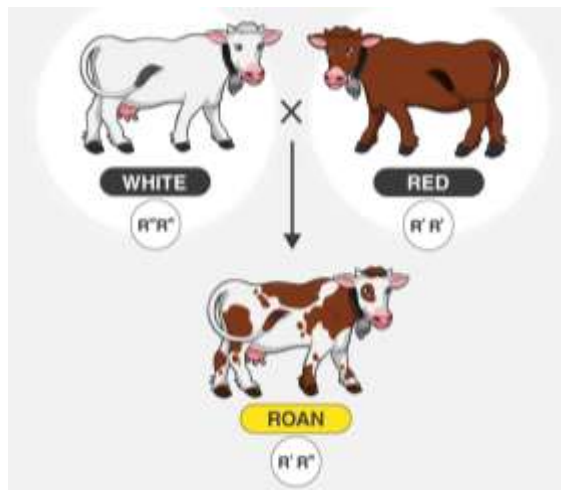
Codominance

Definition: A genetic situation where both alleles are **fully expressed** in the heterozygous condition.

The result is **side-by-side expression**, not blending.

Example:

- Human blood groups:
 - Allele A and allele B are codominant.
 - Genotype AB → blood group AB (both antigens expressed).
- In cattle:
 - Red coat (RR) × White coat (WW) → Roan coat (RW), showing both red and white hairs.



Key Difference

Feature	Incomplete Dominance	Codominance
Expression	Blending of traits	Both traits expressed equally
Example	Pink snapdragon flowers	AB blood group, roan cattle
Phenotype	Intermediate	Dual expression

Scenario Question 9.9

A gardener crosses a red-flowered snapdragon with a white-flowered snapdragon. The offspring all have pink flowers.

Questions:

1. What type of inheritance is shown?
2. Explain why the flowers are pink.
3. What would be the expected ratio if two pink flowers are crossed?

Answers:

1. Incomplete dominance.
2. Neither allele is completely dominant, so the heterozygote shows blending.
3. Ratio = 1 red : 2 pink : 1 white.

Scenario Question 9.10

A man with blood group A marries a woman with blood group B. Their child has blood group AB.

Questions:

1. What type of inheritance is shown?
2. Explain why the child has blood group AB.
3. Give another example of codominance in animals.

Answers:

1. Codominance.
2. Both alleles (A and B) are expressed equally in the heterozygote.
3. Roan coat color in cattle (red and white hairs expressed together).

✓ In short:

- **Incomplete dominance** → blending of traits.
- **Codominance** → both traits expressed side by side.

Monohybrid inheritance human

A number of human conditions are known to be associated with a single pair of alleles which are inherited in Mendelian fashion.

1. Albinism

This is a condition in human beings where the individual fail to produce skin pigments called melanin.

Albinos have;

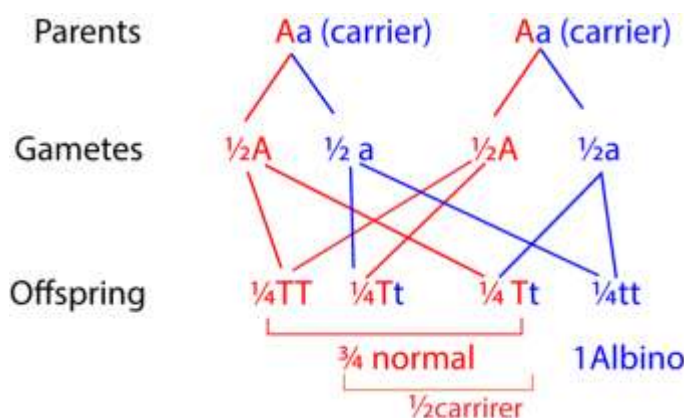
- ✓ Light skin
- ✓ White hair
- ✓ Pink eyes
- ✓ They are sensitive to bright light



Albino

The allele for albinism is caused by recessive [a] and so only exert its effect in the homozygous state [aa]. The allele for melanin production [A] is dominant.

Suppose a couple each with normal pigmentation have an albino child. For this to happen the child must have [aa]. Therefore, unless for rare mutation, the parents must both be heterozygous [Aa] so each produces A and a gametes in about equal number. Therefore, randomly to produce three types of genotype AA, Aa, aa.



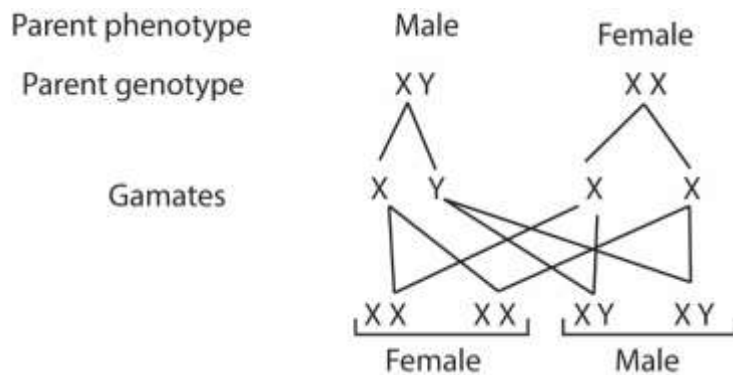
1. Congenital disease such as cystic fibrosis in which the connective tissue develops in glands of the body.
2. Chondrodystrophic dwarfs are characterized by shortened and deformed legs and arms. It is caused by a dominant gene and hence affects in homozygous and heterozygous state.

Sex determination.

The medium size chromosome in *Drosophila melanogaster* determines the individual's sex for which reason they are called the **sex chromosome**. In the female, the two sex-chromosomes, both rod-shaped in appearance, are identical and are known as **X-chromosomes**. In the male, however, the two sex-chromosomes differ from each other; one is rod-shaped X-chromosome, the other is hook-shaped and is called **Y-chromosome**.

The sex chromosomes are an exception to the rule that homologous chromosomes are identical in appearance. Being different, they are described as **heterosomes**; all the other chromosomes, which are identical in appearance, are called **autosomes**.

Despite this difference, the sex chromosomes are transmitted in a normal Mendelian manner as shown below.



Generally, a female produces only one kind of gamete as the chromosomes are concerned; all her eggs contain an X chromosome. For this reason, in human and many other species, the female is said to be homogametic (same gametes). A male on the other produces two kinds of gametes as far as chromosome are concerned: half of the sperm contain an X chromosome, the other half a Y. The male is therefore heterogametic (different gametes) on fusing randomly, approximately half the zygotes receive two X chromosome and develop into female, the rest receive Y chromosomes and give rise to males. In some insects, females are XX and male XO

Sex linkage

Sex linked characters are those whose genes that are carried on sex chromosomes usually X-chromosomes and is inherited along with sex for examples: red-green colour blindness and haemophilia

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