

Chapter 4

Human Skeleto-muscular System

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NCEA Level 1 Biology material covered in this chapter includes:

- The skeleton.
- Bones.
- Joints and cartilage.
- Muscles.

Introduction

The skeleto-muscular system includes **bones**, **cartilage**, **joints** and **muscles**. The bones, cartilage and joints form the skeleton, which is like scaffolding. The joints and muscles work like levers to move the bones.

Ligaments and **tendons** are important in this movement. The bones are held together with ligaments; muscles are attached to the bones via tendons.

Functions of the skeleton

The skeleton offers *support* and shape, and *protection* of vital organs:

- The brain is protected by the skull.
- The spinal cord is protected by the back bone.
- The heart, lungs, liver, kidneys and spleen are protected by the ribcage.

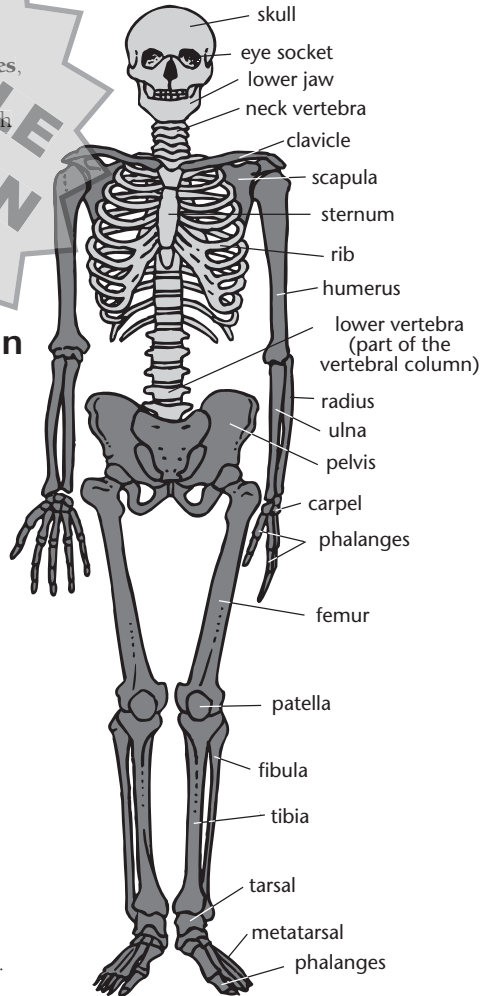
Movement of the skeleton occurs through a system of levers; *storage* of minerals (calcium) occurs in the bones

Blood cell formation occurs in the skeleton – red cells and some of the white cells (phagocytes) and platelets are made in the bone marrow.

Structure of the skeleton

The skeleton can be divided into two parts:

- The **axial skeleton** is made up of the skull, **vertebral column** and rib cage. This forms the main axis of the body.
- The **appendicular skeleton** is the name given to the remaining parts – ie the shoulder girdle, pelvic girdle, arms and legs.



- Axial skeleton: skull, vertebral column, ribcage
- Appendicular skeleton: shoulder girdle, pelvic girdle and limbs

Fig. 4.1: The human skeleton.

Activity 12B: Applied genetics

1. In guinea pigs, wavy-hair (W) is dominant to smooth hair (w).
- How would you determine the genotype of a wavy-haired guinea pig?
 - Following are a series of matings.

- A.** $WW \times ww$ **B.** $WW \times WW$ **C.** $Ww \times ww$
D. $Ww \times Ww$ **E.** $ww \times ww$ **F.** $Ww \times Ww$

Which of the matings **A–F** would produce offspring consisting of:

- 1 : 1 ratio of phenotypes.
 - 3 : 1 ratio of phenotypes.
 - 1 : 1 ratio of genotypes, but only one phenotype.
 - 1 : 2 : 1 ratio of genotypes.
 - All the same genotype.
2. The garden pea shows a number of pairs of contrasting traits, as shown in the table:

| | Dominant trait | Genotype | Recessive trait | Genotype |
|---------------|----------------|----------|-----------------|----------|
| Seed colour | yellow | Y | green | y |
| Seed shape | round | R | wrinkled | r |
| Flower colour | red | C^* | white | c^* |
| Stem height | tall | T | short | t |

* C and c had to be used to avoid confusion with the R and r of seed shape.

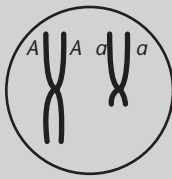
- Write the genotype of:
 - A plant heterozygous for stem height.
 - A white-flowered plant.
 - A true-breeding plant grown from a yellow seed.
 - As far as the alleles for flower colour are concerned, how many kinds of gamete could a white-flowered plant produce?
 - What *phenotype* would be shown by each of the following genotypes?
 - $TTYy$
 - $Ttyrr$
 - Which of the following is/are capable of producing only one kind of gamete, so far as the alleles for seed colour, stem height and flower colour are concerned?

A. $TTYyrr$ **B.** $ttyRR$ **C.** $TtYyrr$
5. True or false?
- If a plant shows a recessive trait, then we know its genotype.
 - A gamete carries one gene for each character.
 - In a mating between two mice, each of which has the genotype Bb , four kinds of fertilisation are possible.
 - If both parents are heterozygous for tongue-rolling, then the probability that their first two children will be tongue-rolling boys will be $\frac{9}{64}$ (tongue-rolling is dominant).

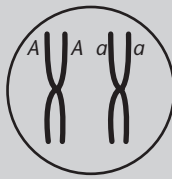
6. A person has the genotype Aa . Which of the diagrams **A–D** below could correctly show the arrangement of genes on the chromosomes in a dividing skin cell of this person?



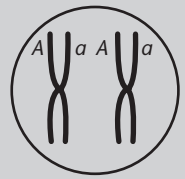
A.



B.

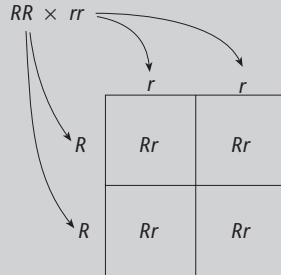


C.

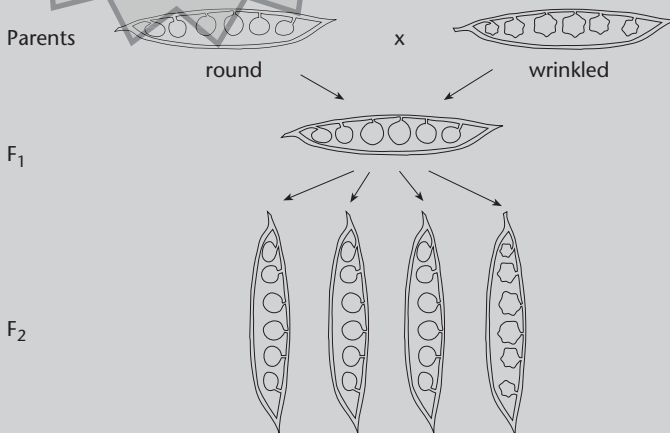


D.

7. What's wrong with a Punnett square that shows the results of a cross between two true-breeding parents, as shown?



8. What's wrong with the diagram below, showing a cross between round and a wrinkled pea varieties, in which round is dominant?



| | Independent variable | Dependent variable | Controlled variables |
|----|---|--|--|
| c. | Whether fertiliser is added to the soil or not. | Growth rate – this could be in terms of height of plants, number of leaves, number of beans produced in a certain period of time, wet and dry mass of the plants (how much the plants weigh at the end of the experiment – dry mass is the weight after the plant has been dried in an oven to remove all moisture). | <ul style="list-style-type: none"> • Type of bean seeds / plants. • Density of plants – how many plants there are in a set area. • Number of plants used in each condition. • Volume of soil in each condition. • Type of soil used must be the same before fertiliser is added to one group. • Site that the plants are grown in. • Watering of the plants. • Time that the measurements are made for each set of plants. |

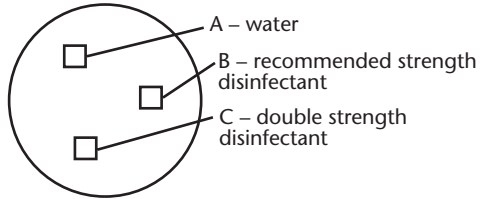
Activity 2B: Planning an Investigation

1. a.

| | |
|--|---|
| Aim: To investigate the effect of disinfectant concentration on the rate of growth of sub-cultured bacteria on agar plates. | |
| Variables: | |
| Independent variable | Concentration of disinfectant. Range of independent variable: <ul style="list-style-type: none"> • No disinfectant – water only. • Recommended strength disinfectant. • Double strength disinfectant. |
| Dependent variable | Size of clear area around the filter paper (measured in mm). |
| Controlled variables | <ul style="list-style-type: none"> • Agar plates used – all the same as supplied by the teacher. • Bacteria used for sub-culturing – all the same as supplied by the teacher. • Size and type of filter paper used – use the same type of filter paper to cut the squares and make all the squares 5 mm × 5 mm. • Type of disinfectant used will be the same. • Incubation – all the plates will be incubated in the same place (the school incubator) set at 25°C. • Time for incubation – all the plates will be left for the same time (eg from period 3 on Wednesday to period 5 on Friday). <p>You need to make sure you explain exactly how you will control each variable – even if it seems very obvious (like ‘use the same type of filter paper’) – make sure that you write it down.</p> <p>Also be honest with your timing – it will depend on when in the day you have your Human Biology/Biology lessons.</p> |

b. Plan

- Collect three Petri dish agar plates that have been sub-cultured with bacteria by the teacher.
- Cut 9 squares of filter paper, 5 mm × 5 mm.
- Soak 3 of the squares of filter paper in water, 3 in the recommended concentration of disinfectant, and 3 in double the recommended concentration of disinfectant, all for 1 minute each.
- Take the filter paper out of the disinfectant or water with tweezers and let the excess fluid drip off.
- Place one of each of the filter paper discs on each plate, labelling on the outside of the Petri dish with a marker pen as in the diagram shown.
- Seal the Petri dish plates with masking tape around their edges.
- Place the Petri dish plates *upside down* in an incubator set at 25°C for approximately 48 hours – they will be looked at in our Human Biology/Biology class in 2 days' time.
- Remove the Petri dish plates and measure the diameter of the clear space around each paper square.
- Record the results in the table below and calculate the average for each set of results.



| Petri dish plate | Clear space around the paper square – distance across (mm) | | |
|------------------|--|------------------------------|------------------------------|
| | Water | Normal strength disinfectant | Double strength disinfectant |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| Average | | | |

Activity 2C: Gathering, processing and interpreting data, and reporting
1. a.

| Type of exercise carried out by Katrina | Average | |
|---|----------------------------------|--|
| | Initial heart rate at rest (bpm) | Heart rate after 3 minutes of exercise (bpm) |
| Skipping | 68 | 130.7 |
| Step-ups | 68 | 129.3 |
| Star jumps | 68 | 145.3 |
| Walking | 68 | 85.0 |



- abiotic (242):** non-living environmental factor, such as light intensity, temperature.
- absorption (52):** taking in the proteins of digestion.
- acrosome (120):** tiny compartment at the tip of a sperm, containing enzymes that enable the sperm to enter the egg.
- active transport (9, 58):** movement of a substance across a membrane from a lower to a higher concentration, using energy in the process.
- adipose tissue (115):** fat storage tissue, present especially under the skin.
- adrenal gland (116):** ductless gland above the kidney, secreting adrenaline and other hormones.
- adrenaline (71, 116):** hormone secreted by the inner part (medulla) of the adrenal gland.
- aerobic (169):** in the presence of oxygen.
- aerobic respiration (46):** the use of oxygen to release energy from food.
- afferent arteriole (106):** tiny blood vessel supplying one of the million or so microscopic filters in the kidney.
- agar (175):** jelly derived from seaweed and used to grow bacteria and fungi.
- alimentary canal (51):** tube connecting mouth and anus, in which digestion and absorption of food occur.
- allele (156):** one of two or more alternative forms a gene controlling a particular characteristic can take.
- allergen (99):** normally harmless chemical that provokes a strong immune response, such as inflammation and/or mucus secretion.
- alveoli (singular alveolus) (92):** minute sacs that form the ends of the air tubes in the lungs.
- amino acids (53, 142):** chemical building blocks from which proteins are made.
- amnion (132):** membrane containing protective fluid that surrounds the foetus in the womb.
- amniotic fluid (132):** protective fluid surrounding the developing foetus.
- anaerobic (88, 169):** without oxygen.
- anaerobic respiration (46, 169):** respiration (release of energy) in the absence of oxygen.
- androecium (211):** male part of a flower, consisting of the stamens.
- angina (82):** pain caused by impaired blood flow to the heart muscle.
- annuals (209):** plants that complete their life cycle in one year or less.
- antagonistic pair (45):** pair of muscles that work together to produce movement, eg biceps and triceps.
- anterior pituitary gland (124):** front part of the pituitary gland; produces growth hormone and hormones controlling the ovaries, testes and certain other endocrine glands.
- anther (211):** part of a stamen that produces the pollen grains.
- antibody (67, 194):** protein that helps to protect the body against invading organisms.
- anti-diuretic hormone (ADH) (111):** hormone produced by the posterior pituitary gland; promotes retention of water by the kidney.
- antigen (194):** a substance, usually foreign to the body, that stimulates the production of an antibody.
- antitoxin (194):** an antibody that neutralizes a poisonous antigen.
- apical meristem (203):** growing tip of a stem or root, consisting of rapidly dividing cells.
- appendicular skeleton (29):** the pelvic girdle, legs and arms.
- artery (65):** vessel that carries blood away from the heart.
- arteriole (72):** tiny artery.
- articular cartilage (37):** cartilage that protects the joint surfaces of bones.
- aseptic (185):** the absence of micro-organisms.
- assimilation (52):** absorption of nutrients by cells and their conversion into the constituents of the cells.