How an arm works

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Educator notes

Learning objectives

- Identifying the position of different levers in the body
- Explaining what an antagonistic muscle is
- Understanding how muscles work with the skeleton to create movement in the body

Equipment needed

- Split pins (one per group of four)
- Balls of string (one per group of four)
- Straws (two per group of four)
- Balloons (two per group of four)
- Card (one sheet per group of four)

Curriculum links

- Science (Biology)
  - Biomechanics
  - The interaction between skeleton and muscles
  - The function of muscles and examples of antagonistic muscles
  - Working scientifically

Resources required

- How an arm works presentation slides
- Build an arm model student sheet

Time needed: 60 minutes

Contents	Page

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Slide 2
What is movement?

- Ask the students how they think movement is created in the human body. Take ideas from the class

Slide 3
Movement

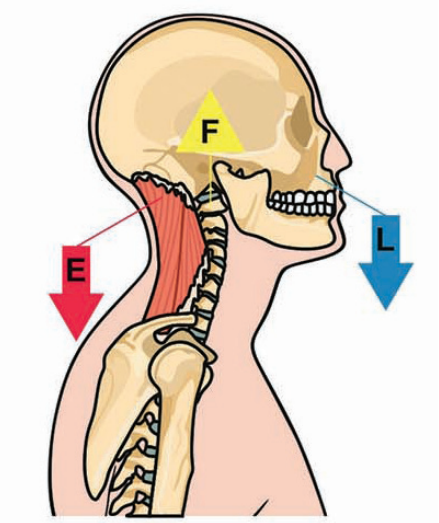
- Explain to students that the skeletal and muscular systems in the human body work together to create movement, and that movement happens at joints (a place where two or more bones join together)
- Ask the students what it would be like if we didn't have any joints. Take some ideas from the class
- Ask the students to try:
  - Acting out eating a meal without bending their elbows
  - Walking around the room without bending their knees

Slide 4
Levers

- Explain to students that some of our body parts can be thought of as simple levers. A lever is a bar that turns on an unmoving point called a fulcrum. The pressure that is created when you push or pull on one end of the bar is called the force. The object that is lifted on the other end is called the load
- Explain to students that there are three parts to all levers:
  - Fulcrum – the point at which the lever rotates
  - Input force (also called the effort) – the force applied to the lever
  - Output force (also called the load) – the force applied by the lever to move the load
- Then go on to explain to students that there are three types of levers: first class, second class and third class. The difference between the three classes depends on where the force is, where the fulcrum is and where the load is:
  - In a first-class lever, the fulcrum is located between the input force and output force
  - In a second-class lever, the output force is between the fulcrum and the input force
  - In a third-class lever, the input force is between the fulcrum and the output force

Slide 5 and 6
Quick quiz

- In pairs, ask the students to discuss which type of levers the following joints are:
  - Elbow
  - Toe
  - Neck
- Reveal the answers on the next slide:
  - Elbow – Class 3
  - Toe – Class 2
  - Neck – Class 1



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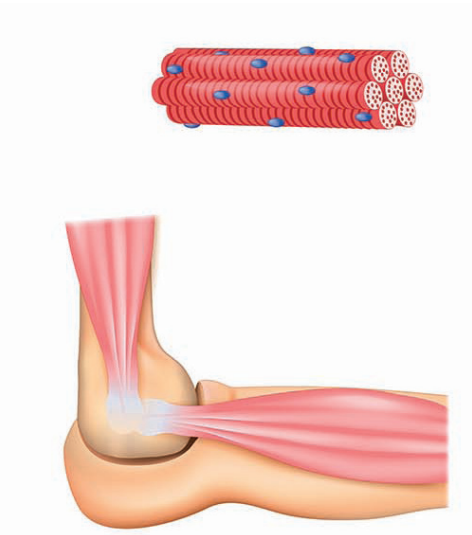
Slide 7
Muscles

- Explain to students that our joints could not move without muscles, as they make the skeleton flexible. Further explain that muscles can only contract and pull bones – they never push them
- Introduce the three types of muscles in the human body:
  - Cardiac – the only muscle of this type is the heart
  - Smooth, or involuntary, muscle is found inside our organs and other body parts. We cannot consciously control these
  - Skeletal, or voluntary, muscles are attached to our bones by tendons and these are what cause movement



Slide 8
Antagonistic muscle pairs

- Share the definition of antagonistic: actively opposing (or showing unfriendliness) towards something (or someone)
- Explain to students that muscles work by getting shorter or contracting. Muscles are attached to bones by strong tendons. When a muscle contracts, it pulls on the bone, and the bone can move, if it is part of a joint
- Some muscles move bones in opposing ways, antagonising each other, and are therefore called antagonistic muscle pairs
- Share the example of an arm; when you move your arm, the bicep contracts while the triceps muscle relaxes. The bicep pulls the bones together, bending the arm. The reverse happens when the arm straightens
- Reiterate the point that muscles can only pull and cannot push. If we only had one muscle on a joint, then we wouldn't be able to move our joint back into its relaxed position after contracting, so skeletal muscles work in pairs to move the body

Slide 9
Build an arm model activity

- Split the class into small groups (3 or 4). Hand out the materials and **Build an arm model student sheet** and move around the room to provide support as the students build their arm models. The student instructions are here for your reference. They are accompanied by helpful step-by-step photos in the student sheet

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Activity
Build an arm model instructions

20-30 mins

Detailed step-by-step diagrams can be found on the Build an arm model student sheet.

1. Cut out two circles and two pairs of long strips of cardboard in two lengths as per the picture – refer to diagrams 1 and 2 on student sheet
2. Punch holes in the circles, and at the ends of one of the shorter cardboard strips – refer to diagram 3
3. Sellotape each of the balloons to a straw, making sure the balloon can still be blown up – refer to diagram 4. Make sure only one student blows up the balloons throughout
4. Slot the straws through the holes in the shorter cardboard strip, and then the circles – refer to diagram 5
5. Tape the other longer cardboard strips in place as shown in diagram 6. This section of the model will form the upper arm
6. Punch a hole at the end of the top, flat piece of cardboard, and at one end of the last remaining shorter cardboard strip and draw a hand on the other end of it – refer to diagram 7. These holes will form the 'elbow' joint
7. Use a split pin through the two holes you made in the previous step to create an elbow joint – refer to diagram 8
8. Cut out 14 pieces of string, making sure that at least two of them will reach from the top to the bottom of the model – refer to diagram 9
9. Secure two long pieces of string from the top of the arm to the bottom, where you drew the hand – refer to diagram 10
10. Secure two pieces of string to the cardboard circles at one end and just below the elbow joint at the other – refer to diagram 11. These four strings represent tendons which connect the muscles to the bones
11. Connect six more strings to a cardboard circle, and secure them with the existing two strings using tape, underneath the balloon – refer to diagram 12
12. Now tie another one around all the existing strings, lined up with the balloon, to create an enclosure around it – refer to diagram 13
13. Repeat for the other side (see diagram 14) and the model is complete.

Ask students to consider what happens when each of the balloons, which represent the triceps and bicep muscles, are blown up? Make sure only one student blows up the balloons throughout

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Slides 10 and 11

Recap quiz

- After the groups have finished building their models and tidied up, recap key learning by asking students if they can answer the quiz questions, which are to the right
- Reveal the answers on **Slide 11**

Try next: Look at how an artificial arm from 1904 compares to your model using this online interactive from the Science Museum. This is a virtual reconstruction, with discussion questions, of an object from the museum's medicine gallery.

Q: How many types of lever are there?
A: 3

Q: What type of lever is the neck?
A: First-class lever

Q: Name the three types of muscle in the human body.
A: Cardiac, skeletal and smooth

Q: What is the name given to pairs of muscles?
A: Antagonistic

Q: How do muscles cause bones to move?
A: By contracting

Q: How are muscles connected to bones?
A: With tendons