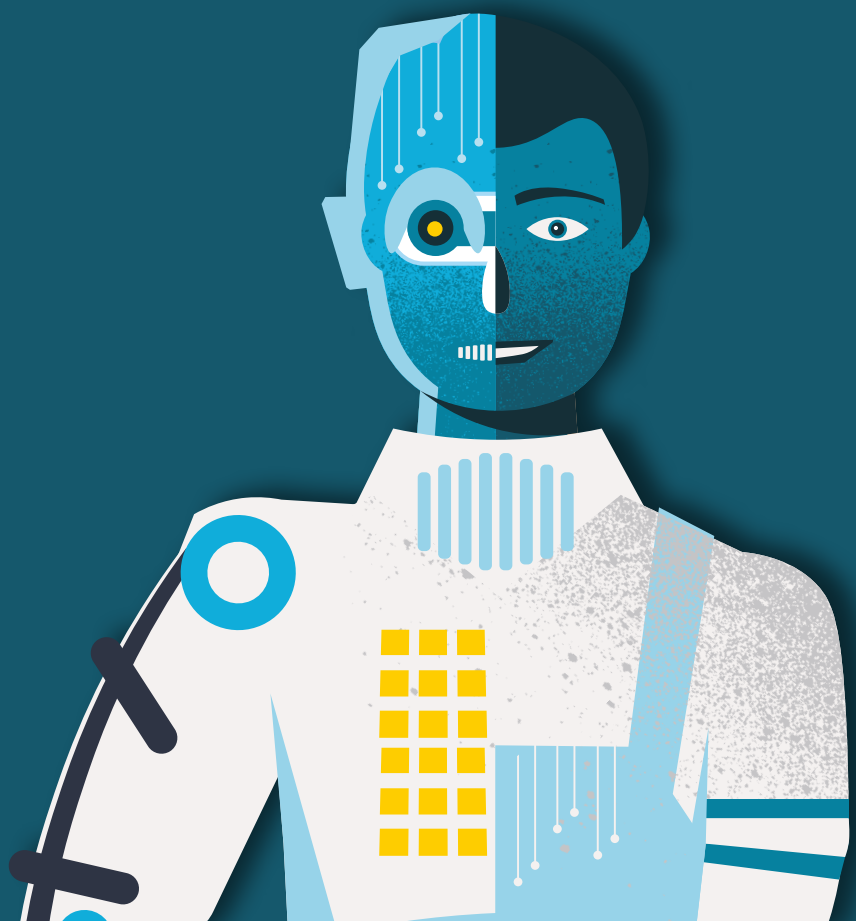
STEM CLUBS

NUMBER 1 FOR STEM

A STEM FUTURE: SUITABLE FOR STUDENTS AGED 11-14

How could we augment ourselves?

STEM Learning activity resources



SUBJECT LINKS:

Biology, chemistry, design and technology, maths and essential employability skills.

A STEM FUTURE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

STEM Learning activity resources

Introduction

This programme has been created by STEM Learning, the largest provider of STEM education and careers support in the UK. It has been developed in partnership with Club leaders and supports essential employability skills and the Gatsby Careers Benchmarks..

This programme is part of A STEM Future, a suite of themed activity resources exploring how science, technology, engineering and maths will enhance our future.

How could we augment ourselves?

The human body is an amazing piece of engineering. For thousands of years it has kept us running, thinking and, best of all, staying alive! But are there scientific innovations that we can use to make our bodies even better?

This programme investigates how you can use science to augment ourselves – from using nutrition to improve brain functionality, to exploring magnetic finger implants.

Key information

AGE RANGE: 11-14

SUBJECT LINKS: biology, chemistry, design and technology, maths and essential employability skills.

DURATION: a range of activities from 30 to 60 minutes – 6-8 hours in total.

FLEXIBILITY: complete the whole programme over a half term or choose individual activities to suit the needs of your club.

RESOURCES: each activity includes a list of the resources required and a comprehensive set of club leader and student notes.

ESSENTIAL SKILLS: Each activity identifies essential employability skills as recognised by the Skills Builder Framework

IMPACT MEASUREMENT: each set of resources is designed to help evaluate and assess the progress of club based learning on club members. A useful set of assessment tools are available at https://www.stem.org.uk/enrichment/stem-clubs

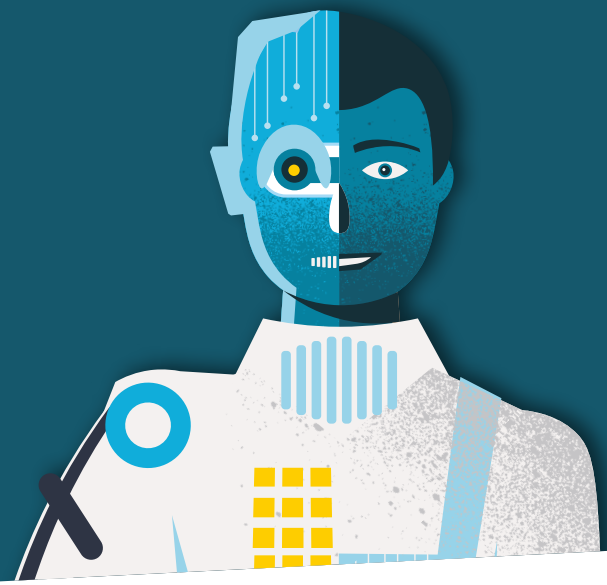
ACHIEVEMENT: students that successfully complete a complete set of activities can be rewarded with the downloadable STEM Clubs Certificate of Achievement. Students may be able to use these resources to work towards a CREST Discovery Award.

APPROPRIATE VENUES: Club leaders can run most activities in general spaces e.g. classrooms, halls, and outdoor areas. Some activities need to be conducted in labs and workshops – these are marked clearly in the Club leader guide and in the table below.

SAFETY: each activity includes details about significant health and safety considerations, such as appropriate eye protection, gloves, etc. Club leaders should ensure that all equipment is handled with care, particularly sharp instruments. Advice and guidelines are available from CLEAPSS and SSERC, or see the STEM Clubs handbook (page 20). We recommend that practical activities are risk assessed before commencing and Club leaders must follow their employer or organisations policies.

OTHER ACTIVITIES: visit www.stem.org.uk/resources/stem-clubs/ for a wealth of ideas for STEM-related clubs.

FURTHER SUPPORT: the STEM Clubs Best Practice handbook can be found at www.stem.org.uk/stem-clubs/getting-started A selection of careers information, resources, programmes and guidance can be found at www.stem.org.uk/stem-careers



Activities

1	**GRIPPING STUFF!:** students make a simple 'bionic' hand out of cardboard to mimic the role of tendons and muscles in controlling finger movement.	60 minutes	Page 4
2	**SPRUNG SOLES:** students create a rapid prototype of a 'bionic' shoe that can augment how a person walks or runs, explaining how their design works with the wearer's own bones and muscles.	60 minutes	Page 8
3	**CLEAR HEADS:** students explore whether a simple 10 minute guided meditation / relaxation session can affect their pulse, blood pressure and subjective feelings and consider how we might monitor our stress levels and suggest helpful actions to improve wellbeing and focus.	60 minutes	Page 12
4	**BRAIN BOOSTERS:** students explore the nutrition which helps brain function. Then create a brain-boosting diet for a day.	30 minutes	Page 15
5	**SHOULD WE 'GO SUPER'?:** students generate and share ideas about how STEM could give them superpowers or animal abilities, and whether it's right or wrong for this to be possible.	30 minutes	Page 18
6	**20/20:** students consider an amazing example of how science and technology can help restore sight before trying out three simple eye tests. They share ideas for an optical superpower they would like to have.	60 minutes	Page 21
7	**GREEN HUMANS:** students use simplified information to estimate how much of an adult's energy needs they might meet if they could photosynthesise.	30 minutes	Page 24
8	**HOW COULD WE FLY?:** students research bird anatomy and follow a template to design a wing for a human, thinking about the bones and muscles they would need to create.	60 minutes	Page 27
9	**HEADS-UP DISPLAYS:** students generate ideas for a wearable heads-up display and present their design sketches.	30 minutes	Page 30
10	**GET CREST DISCOVERY AWARDS:** By completing activities in this resource pack, your STEM Club members can get a CREST Discovery Award.		Page 33
11	**SKILLS BUILDER FRAMEWORK:** Introduction to the Framework that uses essential employability skills to develop student learning across four key domains: interpersonal, self-management, creative problem-solving and communication skills.		Page 34

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

1 Gripping stuff!

Objective

Students make a simple 'bionic' hand out of cardboard to mimic the role of tendons and muscles in controlling finger movement.

TOPIC LINKS

- Biology: skeleton, muscles, tendons
- Design and technology: mechanisms

ESSENTIAL SKILLS SUPPORTED

Problem solving, leadership, teamwork

TIME

60 minutes

RESOURCES AND PREPARATION

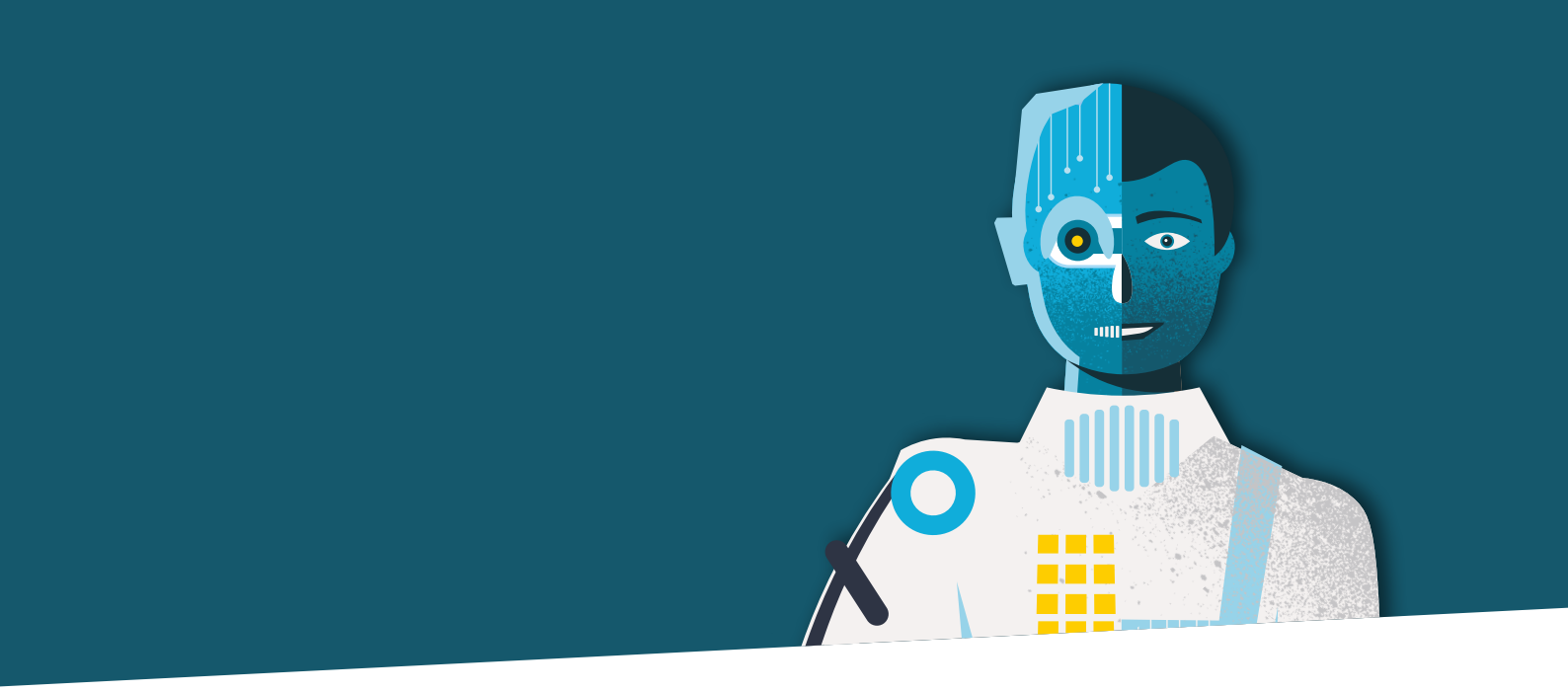
- thick corrugated card
- pens
- straws
- tape
- string
- scissors
- sharp point (e.g. compasses) to poke holes through card
- rubber bands
- stapler
- light items to pick up e.g. empty can, plastic drinks bottle, clean washing-up sponge etc.

HEALTH AND SAFETY:

A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

DELIVERY

1. Introduce the scenario: many people are born without some or all of their lower arm. Other people lose part or all of their arm in accidents or in war. How can engineers use our understanding of anatomy to build prosthetic limbs and help these people?
2. Watch the 'Prosthetic arms from a garden shed' video clip about Team UnLimbited (03:47).
3. Discuss what STEM roles might help create prosthetic limbs like these: surgeon, designer, anatomist, materials specialist, mechanical engineer, electrical engineer, programmer, nurse, 3D printing specialist etc. Students can take on these roles if they wish.
4. Explain that students are going to make a very simple version of a prosthetic arm that illustrates some of the principles used to build them.
5. Discuss how our fingers are controlled by our lower arm muscles, which pull or relax the long tendons that control our fingers (students can grab their lower arm just below the elbow and flex their fingers, to feel the muscles contract and relax and see their finger tendons moving).
6. Guide students as they follow the instructions on the student guide.
7. Can teams pick anything up with their bionic hand? Test their creations using empty drinks bottles, cans or clean washing-up sponges.



TIPS

- students should create creases at the 'joints' on their hands but take care not to cut through any layers of cardboard
- if straws are too long, fingers won't bend
- wrap tape right round each finger section to hold straws in place

EXTENSION IDEAS

1. Test different materials to add as grippy finger pads
2. Students make improved designs thinking in terms of how they can better mimic bones, joints and tendons for greater strength and control
3. Make the prosthetic from other, more permanent materials
4. Can students modify the design to control their hand and make it tighten / relax by bending / straightening their own elbow, like in the video
5. Design and 3D print finger and hand sections with holes for string and mounting points for rubber bands, then design or identify suitable materials for joints eg flexible strips

DIFFERENTIATION IDEAS

Support: students make large individual fingers out of 3cm x 15cm sections of card and if time permits can join to a rectangular 'hand'.

Challenge: challenge students to use extra straws and string to articulate the thumb as well. Students can staple rubber band sections to the tip and hand on the opposite side of each finger, to provide opposing tension to re-open (do first, so staples don't interfere with straws and string).

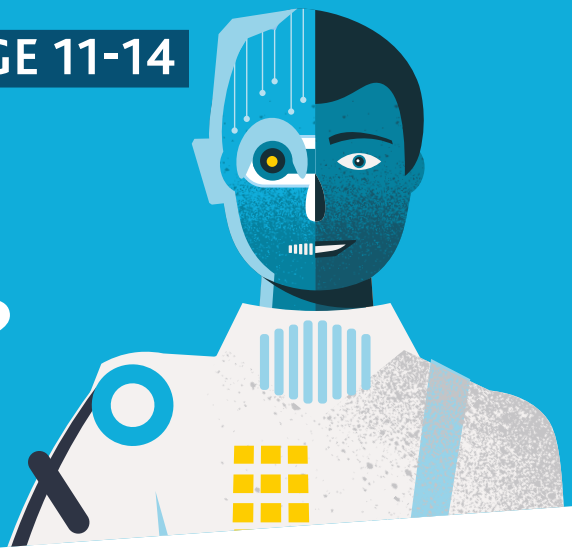
USEFUL LINKS

- Prosthetic arms from a garden shed (scroll for video clip)
  https://www.youtube.com/watch?v=k6KfSXKshQM
- Team unLimbited website
  http://www.teamunlimbited.org
- Do an online image search for 'cardboard robot hand' to find examples.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

1 Gripping stuff!



Briefing

Every year, thousands of babies are born without one or more of their limbs. Countless more people lose a limb each year due to accidents. Because of this, there are a lot of people in need of prosthetic legs, feet, arms and hands. Simple bionic hands that mimic our muscles and tendons are helping many children and adults around the world to live normal lives. Today, we are going to look into how these amazing devices are made!

YOUR TASK **Build a bionic hand and see what you can pick up!**

WHAT YOU NEED TO DO

1. Get into groups of three or four.
2. One person should trace around their hand or draw a simple hand, like the one in the diagram. Carefully cut out your hand.
3. While someone does this, another person should cut 12 sections of straw, each about 1cm long, and four pieces of string each about 50cm long.
4. Crease the cardboard along the red lines to make 'joints'. Make sure not to cut it.
5. Poke holes at the red dots.
6. Carefully tape the straws as shown. Press the tape onto the cardboard either side of the straw. Wrap the tape right round each joint.
7. Bend the thumb up so it's at 90o to the hand. Tape it in place.
8. Feed each string 'tendon' through a hole. Tie a knot to stop it escaping.
9. Feed each 'tendon' through three straws.
10. Pull on the 'tendons' to move each finger! What can you pick up?

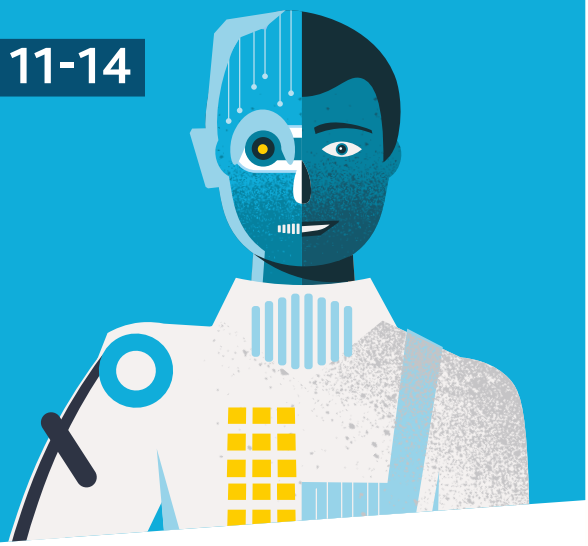
FUN FACTS

1. your hand contains 29 bones, 34 muscles and 48 main nerves. There are 9 muscles that just control your thumb
2. there are no muscles in your fingers - the muscles that control them are all in your forearm
3. human language may have begun as hand gestures

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

1 Gripping stuff!



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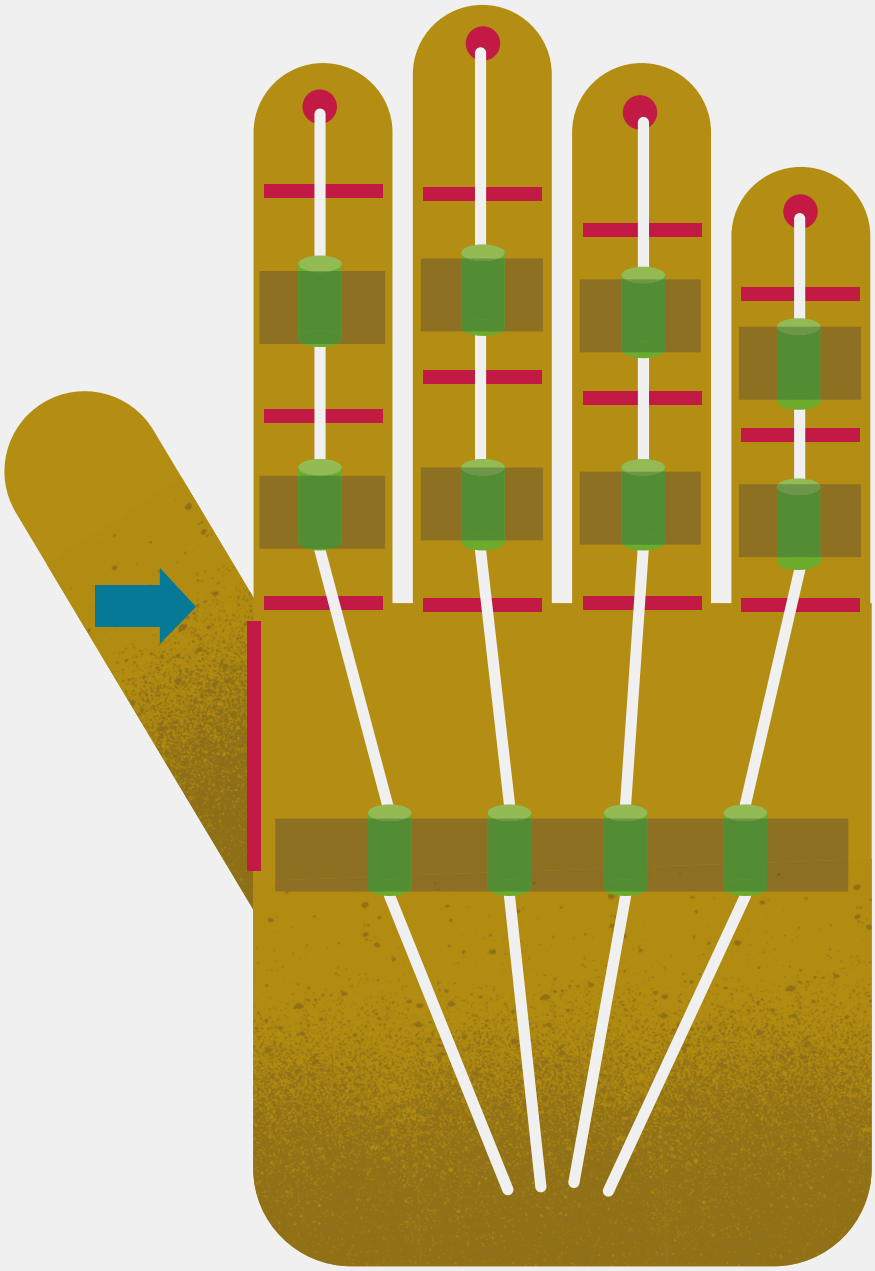


STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

2 Sprung soles

Objective

Students create a rapid prototype of a 'bionic' shoe that can augment how a person walks or runs, explaining how their design works with the wearer's own bones and muscles.

TOPIC LINKS

- Biology: Muscles and bones
- Design and technology: Properties of materials; Mechanisms

ESSENTIAL SKILLS SUPPORTED

Listening, presenting, aiming high

TIME

60 minutes

RESOURCES AND PREPARATION

You can deliver this activity with a wide range of possible materials - students can use what's available to represent their ideal material choices.

- students should bring in old training shoes that they no longer need
- thin plastic sheet
- high density foam sheet eg Plastazote
- corrugated and thin cardboard
- ribbons or grosgrain
- rubber bands or elastic
- packing peanuts
- dowel rods
- scissors and knives
- double-sided and ordinary tape
- quick-drying glue (e.g. hot glue gun)
- internet access (optional) for research

HEALTH AND SAFETY:

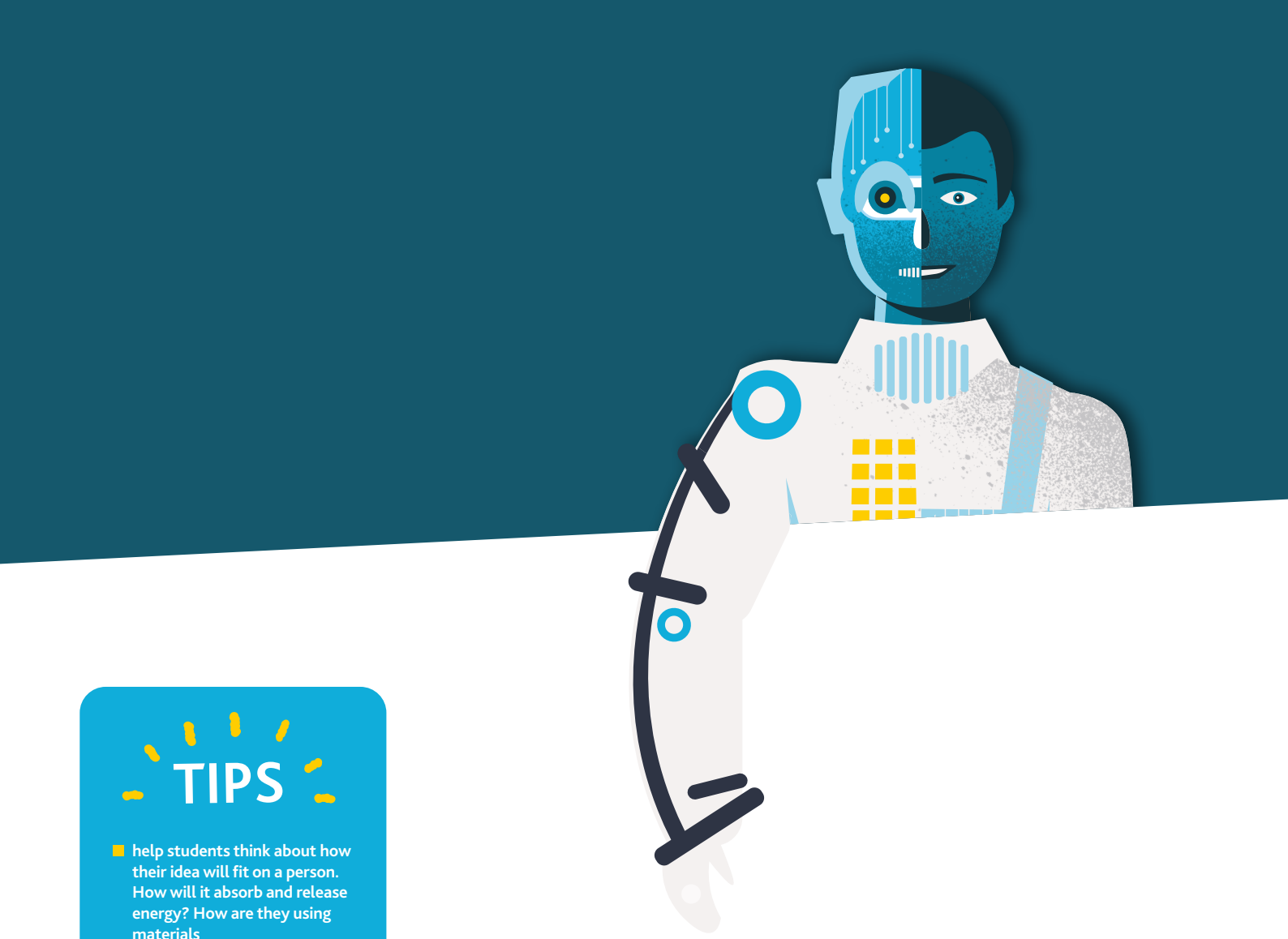
A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

Be sure to explain to the pupils the dangers associated with using a hot glue gun. All children using the hot glue gun should be carefully supervised. You may want to seek the assistance of other adults for this activity.

Advise pupils to be careful when testing their designs and to avoid running or jumping in case of injury.

DELIVERY

1. Introduce the concept: STEM helps design mechanical aids that are helping people to regain their ability to walk once more, combining exoskeletons with efficient batteries, motors and artificial muscles, and intelligent sensors and controls. But we can also think of designs to give anyone additional abilities. Show the Re-Walk video (skip to 0:55) and some of the Bionic Boots promo video.
2. Discuss which STEM roles might help to develop technologies like this, for example: materials scientist, mechanical, electrical and electronic engineers, programmers, industrial designer, sensor designers, podiatrists and biomechanical specialists etc. Students can take on these roles if they wish.
3. Students consider their feet and create quick sketches of a bionic shoe idea. Optionally, students can briefly research on the internet using the suggested search terms for stimulus ideas provided below.
4. Students create a rapid prototype of their design from available materials. Reinforce that this is a quick process to bring their idea to life so they can explain it to others, and not a detailed attempt to create a finished example.
5. Students share their ideas. Use questioning to help them link their design to the muscles and bones in the foot or lower leg, their ideas about absorbing and releasing energy during walking or running, or to how they are using rods and levers to transfer or multiply forces.



TIPS

- help students think about how their idea will fit on a person. How will it absorb and release energy? How are they using materials
- help students work quickly to create a simple mock-up
- if students wish to take their training shoes home, then their design should not fix permanently to the shoe - use straps to attach them instead

EXTENSION IDEAS

1. Students can use the slow-motion video option on their smartphones to film a volunteer running barefoot and in trainers on a treadmill, from the front, side and rear, to explore how the foot lands, flexes and pushes off
2. Students can design and print simple 3D parts for a shoe design, including sole unit and any moving parts or parts used to join to the foot or leg

DIFFERENTIATION IDEAS

Support: show images from the internet search ideas below. Briefly discuss each one as a class, then select one idea as a starting point for students' own ideas. Foam or sponge-based sole ideas will be quicker to mock up than those including curved springy sheets, rods or levers.

Challenge: students could consider a lever-based design like the bionic boot. Ask for a more detailed explanation of the underlying science behind students' design ideas.

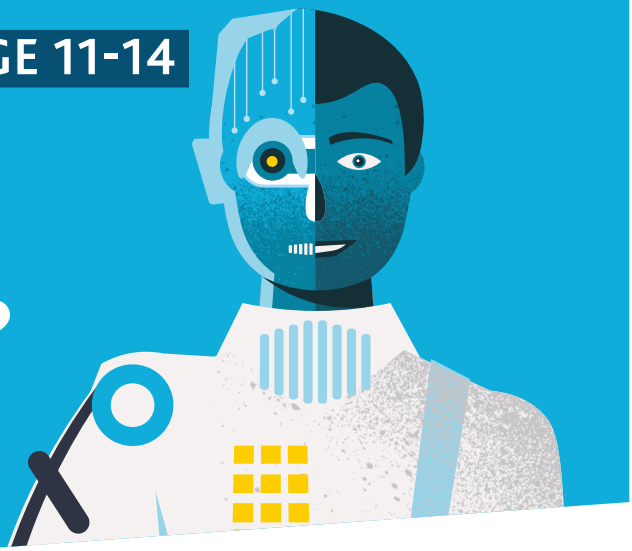
USEFUL LINKS

- ReWalk (skip to 0:55)
  https://www.youtube.com/watch?v=2Xd27c-pz4Y
- Bionic boots promo
  https://www.youtube.com/watch?v=VCnT-qWTE84
- Search terms: these all link to interesting and unusual designs: bionic boots, jump boots, moon shoes, enko shoes, hoka one one, on cloud, reebok atv, adidas bounce.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

2 Sprung soles



Briefing

'Exo wear' are mechanical devices that replace or boost our own skeleton and muscles. This amazing technology is already being used to help people walk and lift heavy loads. In what ways could shoes or boots use wearable technology to help their wearers walk more easily or run faster? What design features would such shoes or boots need to have? Today, you're going to explore the topic of wearable technology and 'exo wear'; and make a prototype for a shoe or boot.

YOUR TASK **Design and prototype some bionic shoes that increase your ability to walk or run.**

WHAT YOU NEED TO DO

1. Think about how your foot works when you walk or run. Taking your shoes and socks off and looking at your foot might help! Note: be careful not to tread on anything sharp while your shoes are off!

a. What bones help you land, move forward and step off the ground with each step?

b. What muscles and ligaments help absorb shock when running and push you off the ground?

2. Think of how footwear could change the way you walk or run for the better. Think about the videos you watched at the beginning of this session to give you some ideas. You could use rods to help add an extra spring to your step, soft foam to help soften the impact as you run, stretchy material that helps the shoe to spring off the ground, or anything else you can think of! Sketch your ideas for your bionic shoe.

3. Create a 'rapid prototype' of your design: shape and add materials to an old training shoe to bring your ideas to life.

a. What will be the sole, and how will this connect to the training shoe?

b. How will you provide any extra 'bounce' or strength, if at all?

c. How will you soften the impact when running, if at all?

d. Will your design need to attach to the person's leg as well as their shoe?

4. Share your idea with the class. Explain how it works with the wearer's own bones and muscles to give them new abilities! After sharing your idea and seeing others' ideas, think about how you could improve your idea and add to your design.

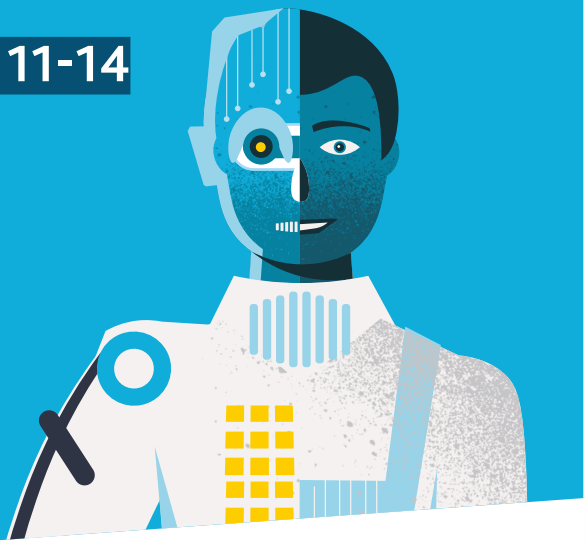
FUN FACTS

1. The human foot contains 26 bones, 33 joints, 107 ligaments, and 19 muscles
2. UK foot measurements are based on the barleycorn, a Mediaeval unit of measure that's one third of an inch, or about 8.5mm
3. Usain Bolt's fastest recorded speed is an amazing 44.72 km/h (27.8 mph), reached during the final 100 meters sprint at the 2009 World Championships

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

2 Sprung soles



Notes

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

3 Clear heads

Objective

Students explore whether a simple 10-minute guided meditation / relaxation session can affect their pulse, blood pressure and subjective feelings. Use this to consider how we might monitor our stress levels and suggest helpful actions to improve wellbeing and focus.

TOPIC LINKS

Biology: cardiovascular system; responses to stress

ESSENTIAL SKILLS SUPPORTED

Staying Positive

TIME

60 minutes

RESOURCES AND PREPARATION

- students will need to listen to the 10-minute guided meditation video below (audio only) or to a ~10-minute beginner's guided meditation of your choice
- stopwatches etc. to time 30 seconds to measure pulse and breathing rate
- blood pressure monitor(s) (helpful but not essential)
- pens for rating levels of relaxation

HEALTH AND SAFETY:

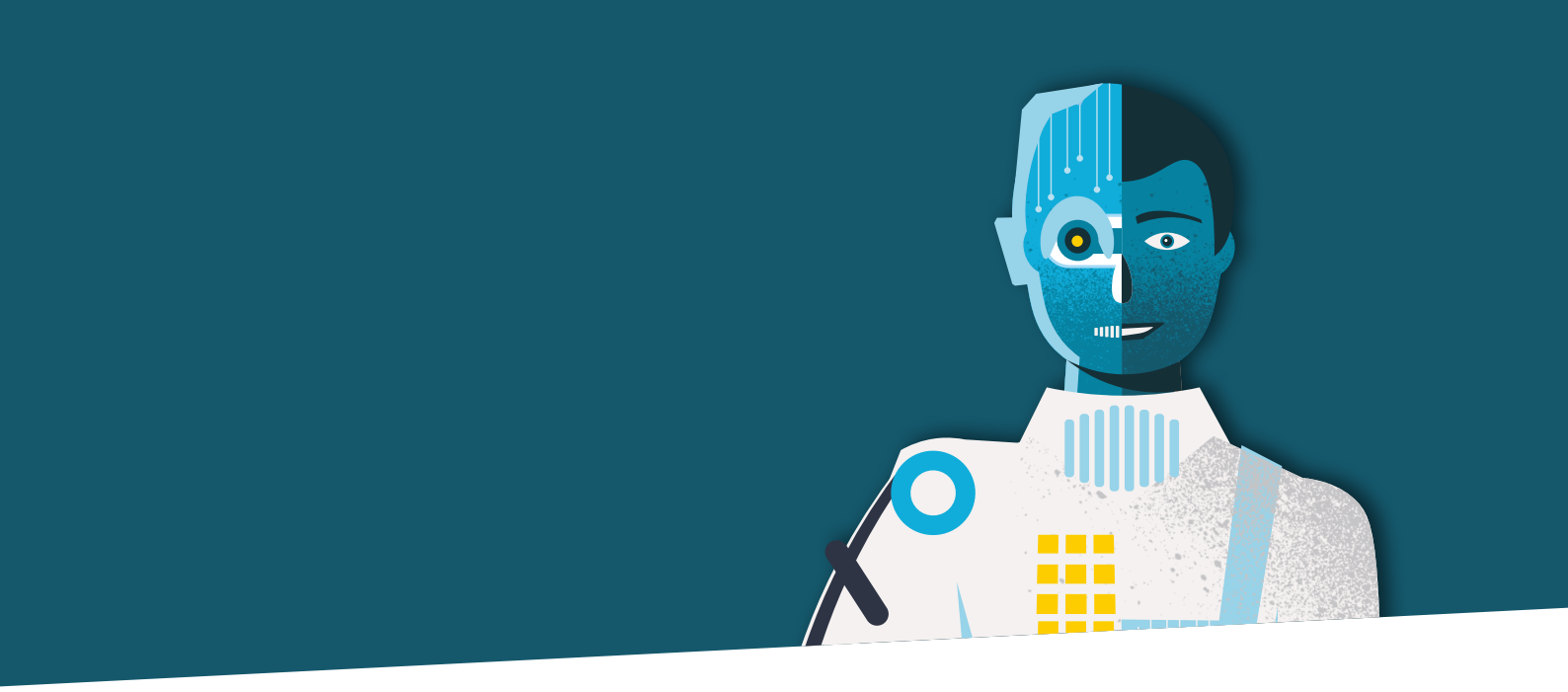
A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

Be aware of the mental health and stress levels of the pupils before starting this activity. Make it known how students with serious mental health issues can find help, either by going through the NHS, an in-school pastoral system or by talking with their parents/guardians. Impress upon the students the importance of seeking help and the lack of judgement they would face.

The use of non-medical grade pulse/blood pressure monitors may cause anomalies in results. Please advise pupils to seek medical advice should they be concerned.

DELIVERY

1. Introduce the idea that as well as using technology to augment ourselves to improve our physical performance, there are other things that complement mental health, wellness and non-physical abilities. Share ideas and include the idea of meditation (specifically in its non-religious use), which has been shown to help calm the 'noise' and clutter in our minds.
2. Students discuss and share some reasons why they might have a busy mind or feel stressed. Get them to suggest some words that describe these feelings. They can then share some words that describe how they would like their minds to be.
3. Discuss some STEM roles that might play a part in researching the benefits of meditation, for example: neuroscientist, health practitioner, teacher, health researcher, therapist etc.
4. Explain that students will follow a short, guided meditation to see if it affects how they feel. Discuss what you could measure to get objective data (physical variables, i.e. pulse, blood pressure and breathing rate) and subjective data (descriptions of how students feel). Explain that I many cases, certain physical variables can be used to indicate stress, i.e. when someone's pulse increases despite not doing physical exercise, it is often because they are stressed or worried.
5. Measure students' pulses and, if possible, the blood pressure of one or two volunteers. Also, students can measure their breathing rate. Optionally, students can rate their subjective level of relaxation on the line on their student guides.



6. Play the guided meditation audio. Students should sit comfortably in a relaxed position.
7. Gently return to the session. Using slow, gentle movements, students again measure their pulse / blood pressure and rate their subjective level of relaxation. Discuss any differences, noting that this is a brief, one-off taster. Explain that many people do this daily to get the most effect.
8. Watch 'The science of meditation' video (2'59")
9. What sensors could we use to track how meditation helps mental health and wellbeing? Discuss students' ideas for how they could get real-time feedback on their level of stress and prompts to take action, for example through smartwatches / smartphones linked to stick-on sensor pads etc. (The Apple watch has sensors to measure pulse, for example.

EXTENSION IDEAS

1. Watch the TED video if time does not permit during the session
2. Students research health sensors and apps and present what they discover
3. Students practise meditation for 10 minute a day for a fortnight, recording their stress levels in a number of ways, and report back
4. Discuss or research other practices that are proven to improve wellbeing (diet, exercise, social contact etc)

DIFFERENTIATION IDEAS

Support: model how to take a pulse from the wrist or side of neck under the chin (or use the pulse meter on a blood pressure monitor). Time 30 seconds for the group and help students double their count.

Challenge: discuss how sensors might 'learn' how to identify and ignore brief or short-term high readings of stress indicators. Explore how to measure sleep quality (health wristbands and some smartphone apps can do this).

TIPS

- it's best to do this in a warm room
- there is no need for darkness
- students can relax in their own way during the guided meditation but should be quiet and not disturb others
- if appropriate, link to your school's pastoral system and support for students experiencing stress

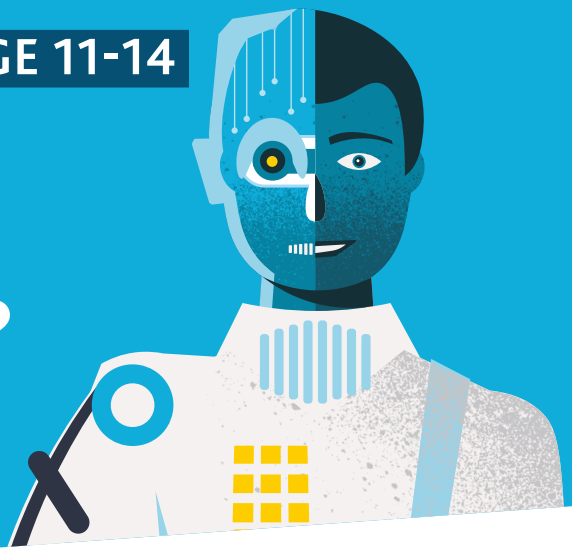
USEFUL LINKS

- **The science of meditation**
  https://www.youtube.com/watch?v=Aw71zanwMnY
- **Andy Puddicombe (from Headspace) TED talk on meditation**
  https://www.youtube.com/watch?v=qzR62JJCMBQ
- **Research on meditation**
  https://en.wikipedia.org/wiki/Research_on_meditation

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

3 Clear heads



Briefing

Bionic body parts and brain-boosting microchips sound exciting, but there are things you can do right now to improve your mental health and wellbeing. Meditation is one of them - it's proven to calm busy minds. And you don't need a team of engineers and programmers to help you!

YOUR TASK **Meditate for ten minutes and see what happens.**

WHAT YOU NEED TO DO

1. Measure your pulse, breathing rate and, if you can, your blood pressure:

Pulse: _____ bpm Blood pressure: ____ / ____

Breathing rate: _____ Breaths per minute

2. Mark a point on this line to rate how relaxed you feel right now:

Really wound up — **Really relaxed**

3. Relax, sit comfortably and follow the gentle instructions in the ten-minute guided meditation. Stay quiet and don't disturb your neighbours.

4. Open your eyes and gently measure your pulse, breathing rate and blood pressure again:

Pulse: _____ bpm Blood pressure: ____ / ____

Breathing rate: _____ Breaths per minute

5. Mark a point on this line to rate how relaxed you now feel:

Really wound up — **Really relaxed**

6. What difference did meditation make? Imagine doing this for ten minutes once or twice every day. When could you fit this in? How might it improve your mental health and wellbeing?

FUN FACTS

1. The parts of our brain that are associated with our emotions are together called the limbic system. Some researchers believe that these are some of the 'oldest' parts of our brain from an evolutionary point of view, though this isn't certain
2. Right at the centre of this is our amygdala, made up of two little lobes about the size of almonds. Among other things, this helps us store memories associated with emotions, guiding how we react to future events
3. Many people, like Professor Steve Peters, believe it's possible to overcome the problems this can cause. His approach, known as 'managing your chimp' can help train your brain not to overreact to situations

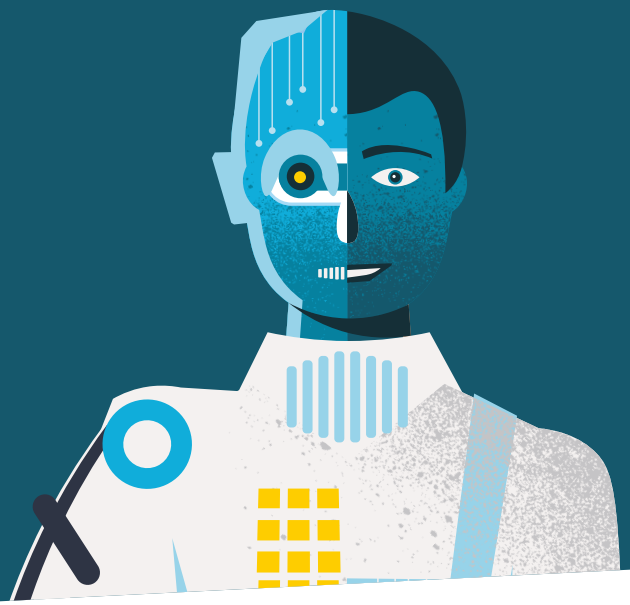
STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

4 Brain boosters



Objective

Students explore how nutrition can help to increase brain function. After validating evidence on the topic, the students will then create a brain-boosting diet for a day of the week. The session will end with the opportunity for students to share their feedback on their peers' diets.

TOPIC LINKS

- Biology: nutrition and health
- Design and technology: principles of nutrition and health

ESSENTIAL SKILLS SUPPORTED

Problem solving, creativity, teamwork

TIME

30 minutes

RESOURCES AND PREPARATION

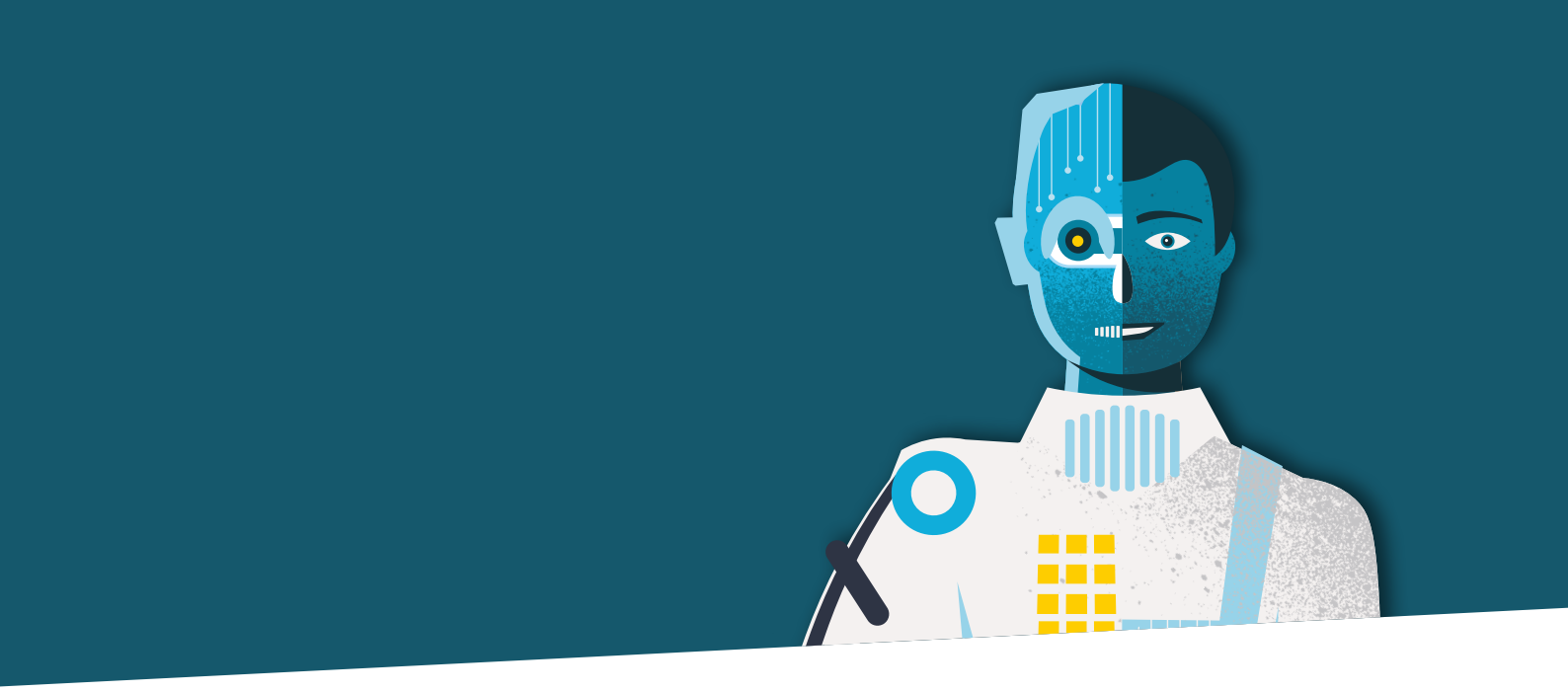
- students can circle the food choices on their student guide, but for a more active approach provide photos or samples of each food choice
- paper and pens to write menu ideas
- internet access for research

HEALTH AND SAFETY:

A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

DELIVERY

1. Introduce the issue: many scientists believe that our diet can have short term effects on our ability to focus, which is really important for study. And in the long term, the wrong diet choices can affect how well we can retain our mental abilities as we grow older.
2. Use the internet and the suggested search words below to explore these ideas and to find scientific evidence for their truth.
3. Discuss which STEM roles are involved with understanding which foods are best for us (or worst) and to develop ways to help everyone improve their diet. Examples include: nutritionist, neurologist, food product developer, agricultural scientist, horticulturist, food scientist, etc. Students can take on these roles if they wish.
4. Review the student guide. Students choose their top nine foods by reviewing samples, photos or choosing from the list. Share ideas. Identify that these foods are rich in nutrients that are best for our brain health (see Tips for list)
5. Students spend a few minutes thinking of some menu ideas they could build around these foods. This doesn't need to be detailed - just outline ideas.
6. Students share their ideas. Vote on which menu suggestions are most popular.
7. Highlight that STEM - including our own knowledge as well as that of 'experts' - can improve our lives and abilities by helping us make the right choices, as well as by creating new technologies. Identify the foods that students should eat less of, like fried foods, energy drinks, sweets and pastries.
8. Ask each student to suggest one or more easy changes they could make to their diet to include more brain boosters. Go around the room and share ideas.



TIPS

- the MIND diet recommends whole grains, green leafy vegetables, other vegetables, fish and seafood, poultry, nuts, berries, beans and pulses, olive oil
- students choose nine foods rather than ten because the tenth recommended food in the MIND diet is wine in moderation
- remind students that it's important to include more healthy foods AND eat fewer unhealthy foods, and of the importance of staying well hydrated

EXTENSION IDEAS

1. Students can find out more about the MIND and Mediterranean diets and find examples of dishes that could form part of a healthy or brain boosting diet
2. Students organise a STEM club dinner to cook and share MIND diet-friendly meals and could invite parents, the elderly or other adults to share their food

DIFFERENTIATION IDEAS

Support: show photos or samples and identify nine brain-boosting foods as a class. You could do this by counting votes for each choice and finding the top nine. Ask students to think of just one or two menu ideas.

Challenge: ask students to identify more detailed choices from some groups, for example listing green leafy vegetables, other vegetables, sources of whole grains and healthy ways to enjoy more seafood. Ask students to think of a breakfast, lunch, dinner and two snack ideas.

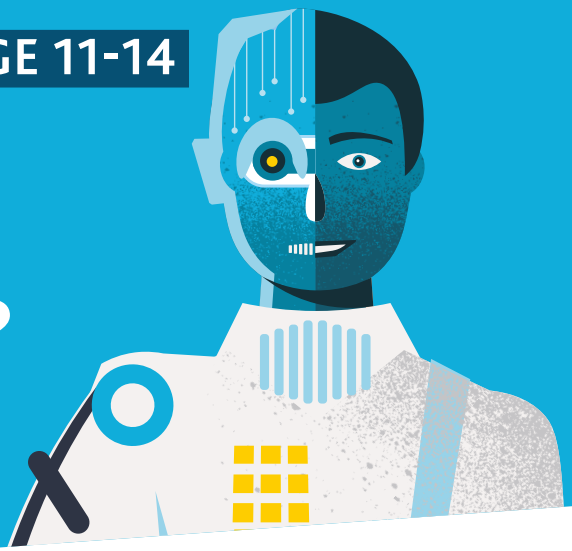
USEFUL LINKS

- The MIND diet slows mental decline
  https://www.nhs.uk/news/food-and-diet/new-brain-diet-slows-mental-decline/
- What is a Mediterranean diet?
  https://www.nhs.uk/Livewell/Goodfood/Pages/what-is-a-Mediterranean-diet.aspx
- How the food you eat affects your brain
  https://www.youtube.com/watch?v=xyQY8a-ng6g
- Suggested search terms: nutrition, psychiatry, nutritional psychiatry, food science, brain foods, brain function, diet, brain diets, etc.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

4 Brain boosters



Briefing

Augmenting ourselves isn't just about using STEM skills to invent new technologies to replace or improve our abilities. It can also mean using STEM to help us make better decisions – for example, about what we eat. The right diet is one that is rich in nutrients, which help our brains to perform at their best. Eating the right diet can improve your focus, make studying easier and help your brain to stay healthy for a long time.

YOUR TASK **Choose the foods you think are best for your brain - then think of a brain-boosting diet for a day.**

WHAT YOU NEED TO DO

1. Choose or circle nine foods you think might be best for your brain.

Whole grain	**energy drinks**	**red meat**	**poultry**
fish	**nuts**	**beans and pulses**	**sugary foods**
Margarin	**fried food**	**green leafy veg**	**other veg**
	Berries	**olive oil**	**pastries**

2. Share your nine brain-boosters. Which foods were the most popular choices?
3. Use these foods to create a day's worth of brain-boosting meals and snacks. You can add other things from your store cupboard, like herbs and spices.
4. Share your meal and snack ideas. Whose menu would you most like to eat for a day?
5. Some foods are not so good for your long-term brain health. Some of these unhealthy foods are in the list above. Identify these foods and think of others you should avoid or eat in moderation.
6. Think of three changes you could make to include more brain-boosters in your diet. Share your ideas!

FUN FACTS

1. The 'Mediterranean diet' includes traditional eating choices from countries like Italy, Greece and Spain. Lots of scientific studies have linked diets like this to being healthier and living longer
2. You should aim to have no more than 30g of sugar (about 7 teaspoons) a day. A single canned drink can contain more than that
3. Dark chocolate can also form part of a healthy diet. But it needs to be dark chocolate - and not too much - just a square or two a day

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

5 Should we 'go super'?

Objective

Students generate and share ideas about how STEM could give them superpowers or animal-like abilities, such as super strength (robotic/prosthetic limbs), super healing abilities (nanomedicine), super linguistic abilities (instant translators) or flight (Richard Browning's jet suit). Then, they should discuss whether it would be right or wrong to use science and technology in this way.

TOPIC LINKS

- Biology: genetics and evolution
- Engineering: mechanics and robotics

ESSENTIAL SKILLS SUPPORTED

Presenting, creativity, teamwork

TIME

30 minutes

RESOURCES AND PREPARATION

- you may wish to display the question and sample perspectives on the student guide, as well as some of the suggested videos below, on a large screen
- arrange the furniture to suit the discussion style below, or your preferred approach

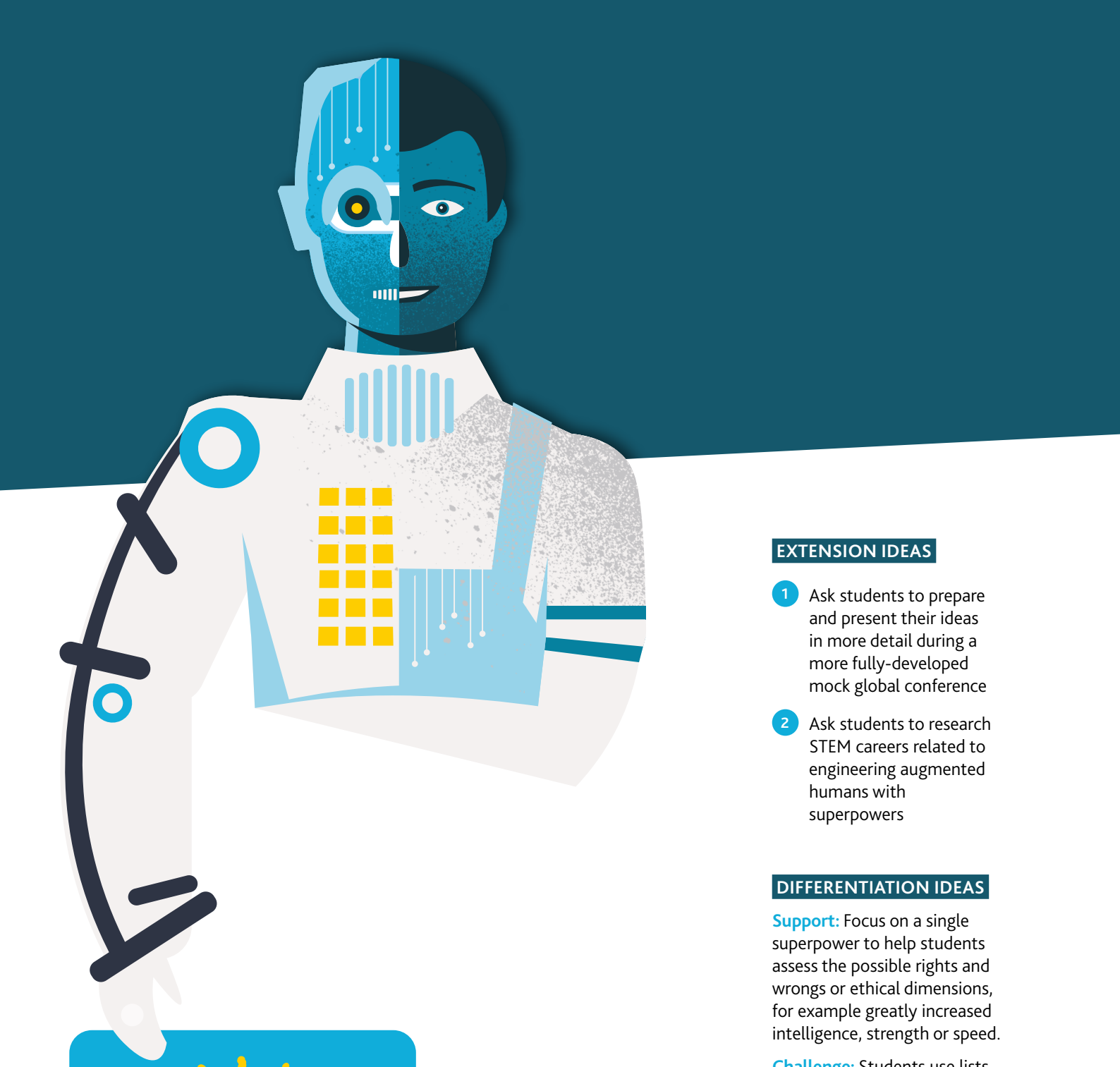
HEALTH AND SAFETY:

A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

DELIVERY

1. Introduce the questions and background to students. Explain that they are going to use their STEM knowledge and imagination to explore the issues and possibilities and decide what they think the answer might be.
2. Students reflect on the perspectives.
3. Deliver this activity using the think-pair-share and 30-second circuit approach below, or using your preferred approach.

- students think individually to generate ideas, then get into pairs
- pairs share ideas together, adding suggestions to build on each other's ideas
- finally, pairs form a large circle. Set the scene as a global conference in which students are taking part. Students take turns to spend 30 seconds each to explain their ideas to the group
- list some key ideas and interesting points, to discuss once every pair has shared their suggestions
- as time permits, discuss together whether students' ideas leave them feeling hopeful or concerned about future possibilities for enhancing human abilities. What reasons do they have to feel hopeful or pessimistic



EXTENSION IDEAS

1. Ask students to prepare and present their ideas in more detail during a more fully-developed mock global conference
2. Ask students to research STEM careers related to engineering augmented humans with superpowers

DIFFERENTIATION IDEAS

Support: Focus on a single superpower to help students assess the possible rights and wrongs or ethical dimensions, for example greatly increased intelligence, strength or speed.

Challenge: Students use lists or 'diamond 9s' to organise their superpowers, for example from least to most radical, interesting or worrying, justifying their choices.

TIPS

- pay attention to timings while students think and discuss in pairs. Useful questions:
- what superpowers or animal-like abilities would you want, and why
- what do you want to do that you can't do right now
- would it be ok if everyone had the same superpowers or extra abilities as you
- what if people you know could obtain these abilities, but you could not
- what if you or someone else used their superpowers to cause hurt or harm

USEFUL LINKS

Exoskeleton for lifting heavy objects
https://www.youtube.com/watch?v=lWmFEoDjUc4

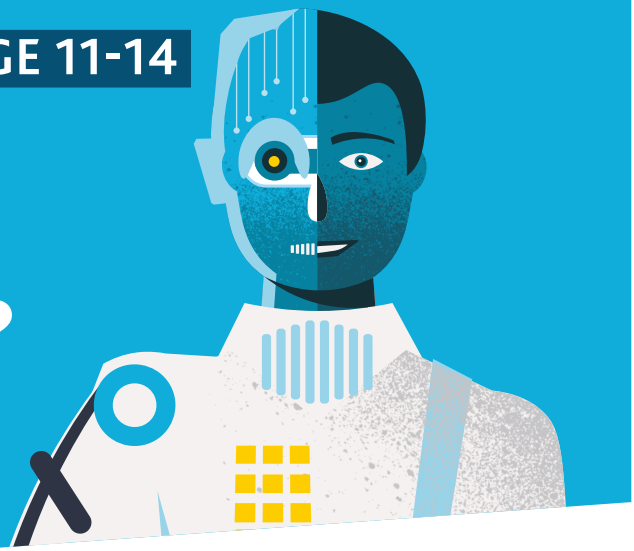
Language translator device
https://www.youtube.com/watch?v=WeByuOD8k1c

Richard Browning's jet suit
https://www.ted.com/talks/richard_browning_how_i_built_a_jet_suit

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

5 Should we 'go super'?



Briefing

STEM could one day - perhaps soon - give us superpowers, like enhanced vision, speed or strength, better brains and even new animal abilities like breathing underwater or flying. What powers/abilities would you want, and why? And do you think it is right for people to enhance themselves in these ways? Should everyone be allowed to enhance themselves in whatever ways they like?

YOUR TASK **Discuss your ideas and share whether you think it's right to enhance human abilities.**

WHAT YOU NEED TO DO

Think up some great ideas, share them with a partner to help you develop them, and then present your ideas to the group in just 30 seconds!

Here are some perspectives to kick-start your thinking:

- STEM can help humans take over from evolution. It's time for us to become whoever - or whatever - we can imagine we can be.
- STEM should help people living with an injury or disability, but it could be dangerous to give some people extra powers.
- If they have the money and the wish, it's OK for people to buy whatever extra powers or abilities they can afford.
- It's not fair that some people should be allowed to have extra abilities, but not others.

FUN FACTS

1. Rob Spence has fitted a tiny camera into his prosthetic eye, allowing him to record and share what he sees
2. Artist Neil Harbisson can only see in black and white, but he has fitted himself with an insect-like antenna that, he claims, allows him to 'hear' colours
3. Kevin Warwick, Professor of cybernetics at the University of Reading, has attached electrodes to nerves in his arm, which allow him to control electronic devices and also 'feel' sensations from senses humans can't normally experience, like ultrasound
4. Richard Browning, an English inventor, has made his own jet engine flying suit

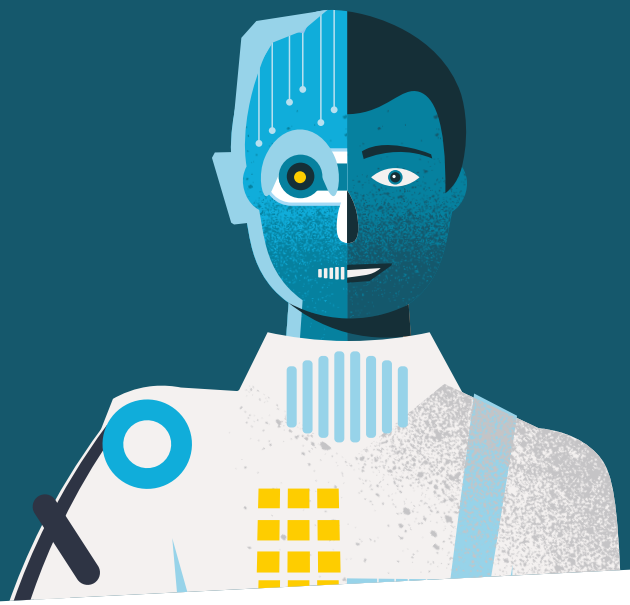
STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

6 20/20



Objective

Students consider an amazing example of how science and technology can help restore eyesight before trying out three simple eye tests. They share ideas for an optical superpower they would like to have.

TOPIC LINKS

Biology: eyesight

ESSENTIAL SKILLS SUPPORTED

Listening, presenting, problem solving

TIME

60 minutes

RESOURCES AND PREPARATION

Choose how many of the three eye tests you will include.

- download and print the Snellen eye chart PDF. Students should stand 3m from this
- ask students to cut a semicircle out of corrugated card, radius 50cm or more, for example using a pin, string and marker pen
- measuring tape
- three coloured pens or pencils with yellow, red, and bright green bodies
- students will need a smartphone with torch function, or a small single LED torch
- A4 black card or black ring binder
- it's best if students can go to a darkened area to view their retinas

HEALTH AND SAFETY:

A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

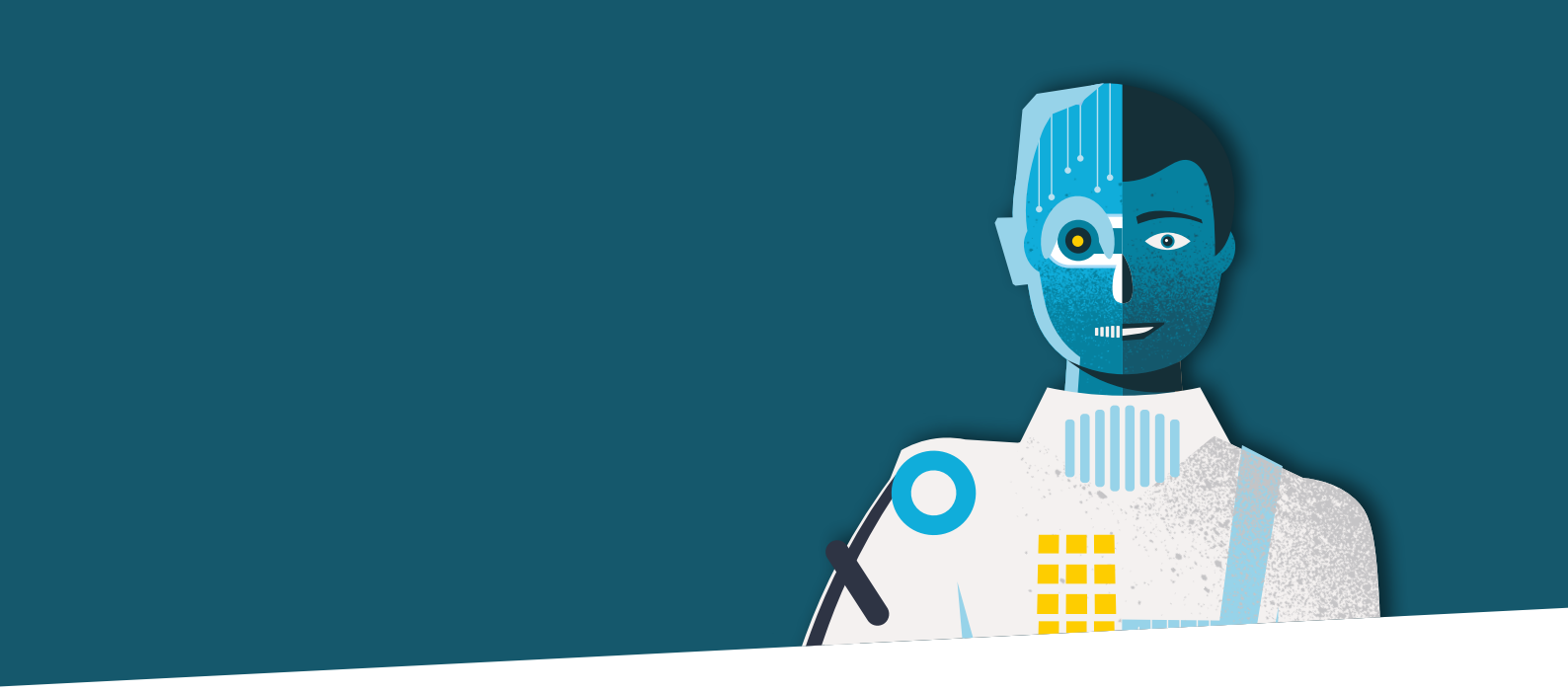
Ensure that the students understand the risks of light damage to their eyes. Closely supervise the students as they undergo the eye tests to make sure that they act responsibly throughout.

DELIVERY

1. Introduce the idea: STEM is helping to restore sight in the most amazing ways and could one day enable us to augment our vision.
2. Show the video clip: surgeons have developed a way to implant a lens in a section of tooth, which they implant in a patient's cheek tissue to grow new blood vessels and then graft onto their eye, restoring their sight (the video is an animation and doesn't include surgery or the finished graft).
3. Discuss what STEM roles can help restore sight - and might one day help to augment it: surgeon, optician, optical physicist, designer, optical engineer, neuroscientist etc.
4. In pairs, students complete the three eye tests as a circus of tasks. Emphasise that these are for fun only. Ensure students don't shine a bright LED light directly into their eyes.
5. Discuss what students discovered:

- how good was their visual acuity
- could they detect different colours at the same point in their peripheral vision, or were some colours harder to detect than others
- what was it like seeing the network of blood vessels on their retinas

6. Students share their superpower ideas. Help students link their ideas back to how STEM is already helping those with limited or no sight.



TIPS

- ask students to take care if stepping backwards when taking the Snellen test, and to ensure they don't shine a bright light directly in their eye - turn smartphone 'torches' down to minimum
- move each coloured pen or pencil slowly during the peripheral vision test
- students don't need to test both sides, but can if there's time

EXTENSION IDEAS

1. Make large 3D model eyes using cheap white plastic footballs cut in half
2. Students research and make models of cone and rod cells
3. Do a practical to find students' blind spots and ask them to explain why these exist
4. Research how best to look after your eyes if you use a screen a lot - like some students may do so at home
5. Research how the brain interprets the signals it receives from the eyes

DIFFERENTIATION IDEAS

Support: Demonstrate each test. Ask a more able student to supervise each eye test or partner more able students with less able students.

Challenge: Ask students to explain why it's harder to detect colours at the edges of our peripheral vision (the colour-receptive cones are less dense in the parts of the retina where peripheral sight is focused).

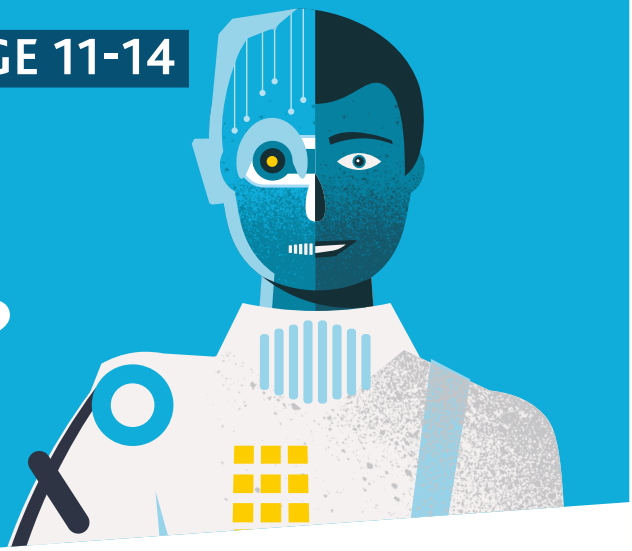
USEFUL LINKS

- 'Tooth lens' implanted into eye to restore vision
  https://www.youtube.com/watch?v=InQjRGo9Bi8
- A4 Snellen eye chart PDF
  https://www.allaboutvision.com/eye-test/snellen-chart.pdf
- Seeing your retina
  https://www.exploratorium.edu/snacks/seeing-your-retina
- Put your peripheral vision to the test
  https://www.scientificamerican.com/article/put-your-peripheral-vision-to-the-test/
- Amazing eyes in nature
  https://www.nationalgeographic.com/science/phenomena/2014/07/03/natures-most-amazing-eyes-just-got-a-bit-weirder/

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

6 20/20



Briefing

How can STEM help people whose sight is limited or gone? What extra powers could you add to your eyesight? Some of the answers to these questions might amaze you! The starting point for answering any of these questions is to understand how we can test our vision.

YOUR TASK **Carefully test your vision, then think about what optical superpower you'd like to have!**

WHAT YOU NEED TO DO

1. Visual acuity: how well can you focus? Stand 3m away from the letter chart. Have a partner stand next to the chart. If you wear glasses, keep them on. Gently cover one eye and start reading each line on the chart. What line can you get to, before you can only correctly read 4 of the letters on that line? If you can read them all, how far do you need to be from the chart before you can't read the bottom line?
2. Peripheral vision: how well can you see things at the edge of your vision? Crouch down so the bridge your nose touches the centre of the flat edge of the cardboard semicircle. Look straight forward. Have your partner hold one coloured pen/pencil vertically at one end of the flat edge of the cardboard, then slowly move it round the curved edge towards the centre. Let them know when you can detect what colour it is. Mark these points on the edge with your name and the colour. Repeat for other colours and for other people.
3. Retinal image: what does the back of your eyeball look like? Go to a darkened area of a room. Hold the black card about 20cm from your eyes. Turn on your phone's LED torch function. If you can, turn this to its lowest setting. Hold the phone flat, so the screen faces down and the LED points up. Move the phone around by your cheek so the LED moves close under your eye but not so close that your phone touches your cheek. Take great care and do not shine the light directly into your eye. The pattern you see is the network of blood vessels on the inside of your retina!
4. Superpower: think about what optical superpower you'd like to have. Share your ideas. Explain your ideas and suggest what future technology might make them a reality.

FUN FACTS

1. The term '20/20' vision comes from letter charts like the one you used. It means that what you can read at 20 feet from the chart is the same as what most people can read at 20 feet from the chart. If you had 20/40 vision, it would mean that you can see at 20 feet what most other people can see from 40 feet, meaning that you have bad eyesight. 20/20 vision doesn't mean perfect sight and many people have eyesight that is better than 20/20
2. Geckos have night vision that's 350 x better than a human's. They don't have eyelids, so they lick their eyeballs to keep them clean
3. An ostrich's eye is bigger than its brain. At 5cm in diameter, it's the largest eye of any land animal. But a colossal squid's eye can be as much as 27cm across

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

7 Green humans

Objective

Students use simplified information to estimate how much energy an adult could create if he/she could photosynthesise, and whether this would be enough to fulfil their daily energy needs.

TOPIC LINKS

- Biology: nutrition and energy needs; photosynthesis
- Chemistry: rates of reaction
- Maths: working with numbers; rounding; estimation

ESSENTIAL SKILLS SUPPORTED

Listening, presenting, problem solving,

TIME

30 minutes

RESOURCES AND PREPARATION

- students will need calculators.
- measuring tapes and / or A4 paper.

HEALTH AND SAFETY:

A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

DELIVERY

1. Introduce the concept: one great way to augment humans might be to enable us to create our own energy sources, like how plants use photosynthesis to create glucose. Review the photosynthesis reaction.
2. Share ideas on what humans might be able to do if they didn't need to find food, or how this might change everyday lives. How would this work? Would we use symbiotic cyanobacteria that could photosynthesise for us? Would we have to wear some form of external suit that could photosynthesise and would be linked to our digestive system or blood?
3. Discuss what STEM roles might make such an ability possible, for example: nutritionist, plant biologist, human biologist, genetic scientist etc.
4. What information do we need to calculate whether a person could survive on just they energy made through photosynthesis? After all, humans require a lot more energy than plants to survive. Brainstorm ideas and see if students can generate a list of data they need.
5. Students use tapes and A4 paper to estimate their own surface area by thinking of each part of their body (torso, head, legs etc.) as a simple cylinder.
6. Review the list of data and prompts on the student guide.
7. Identify each step in the calculation together.
8. Students complete their calculations using the sample data.
9. Share students' conclusions. They should find that we could make roughly 5% of our energy requirements using photosynthesis - just 1/20th! (This may vary if some students have used their own surface area estimate, for example.)

TIPS

- you may wish to omit estimating real surface areas to avoid sensitivities, or use just one volunteer
- the data provided is based on a female's average daily energy needs (male is 2,500 calories)
- the average female human will need 8,400,000 joules per day - 97.2 joules per second (round this up to 100). They could create 5.4 joules per second if all their surface area could photosynthesise (round down to 5). Hence we would need approximately 20 x our surface area to meet all our energy needs based on this simplified approach
- problems include:
  - we wear clothes for social reasons and to regulate our temperature, covering our bodies. This would stop us from using all of our skin for photosynthesis
  - not all surface area will ever be in direct sunlight
  - there is much less sunlight in winter
  - photosynthesis wouldn't give us essential vitamins, minerals, fats etc
  - what would happen to our digestive systems

10 Discuss some of the many problems with this (see tips). How could students perhaps increase the rate of reaction, so the process is more efficient and creates more energy? (E.g. dense chlorophyll, use in stronger sunlight.)

11 Share ideas for other ways humans might be modified to free us from our everyday needs, such as food, sleep, water and breathing air.

EXTENSION IDEAS

1. Use the link below to find more accurate insolation values for your region, to replace the simplified and rounded-up average value for London. Use these to calculate minimum and maximum estimates for your region
2. Find insolation values for other regions on Earth and compare how much energy a person could create in each one
3. Students design a 'photosynthesis suit' an explorer could use to create glucose during an expedition. This could use bat wing, fin or other designs to dramatically increase surface area
4. Students should research Euglena and identify its properties exploring how these unique features benefit the organism

DIFFERENTIATION IDEAS

Support: complete as a whole-group activity, asking groups of students to take on each step. Check answers at each stage before moving on.

Challenge: don't share the student guides at first and ask students to identify key data they would need. Students share their estimates of daily calories needs. Hide the hints on the student guide. Using the student guide, students complete on their own and share final answers. Ask students to identify the flaws and limitations in this exercise.

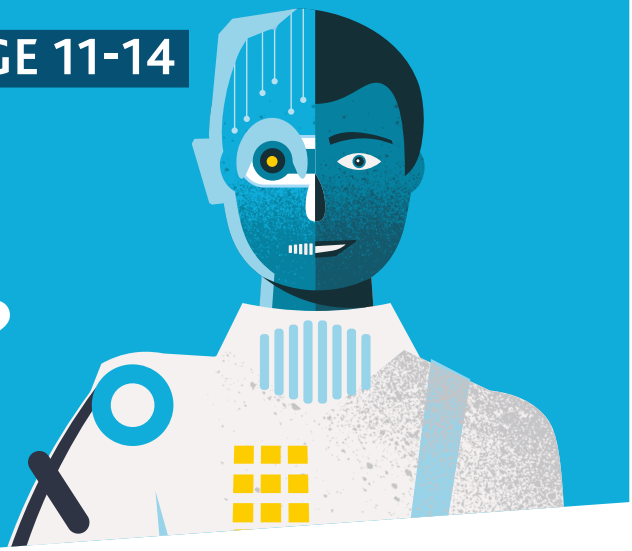
USEFUL LINKS

Solar insolation values for the UK
https://www.theecoexperts.co.uk/freebook/appendix-solar-insolation-values-uk

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

7 Green humans



Briefing

Plants produce their own energy through photosynthesis. What if humans could do that as well? We'd be free - or partially free - from the need for food, which might allow us to do new, amazing things!

YOUR TASK **Estimate how much energy a human could photosynthesise!**

WHAT YOU NEED TO DO

Use the information and hints below to estimate how much energy a human could create through photosynthesis.

1. Share your ideas about how this might happen: might we implant photosynthesising bacteria in our skin, or use some sort of external covering?
2. Calculate how many joules of energy a person needs each second to stay alive. Round this to the nearest multiple of 10.
3. Calculate how many joules of energy a person could create each second, based on the amount of sunlight falling on their skin.
4. Use your two answers to calculate the percentage of a person's daily energy could be created using photosynthesise.
5. How many times bigger would a person's surface area need to be to meet all their energy needs through photosynthesis?

The average person needs 2000 calories per day.
Hint: how many calories do they need per second?

One calorie = 4,200 joules of energy.
Hint: how many joules per second does a person need?

The Sun provides the UK with roughly 3 watts of energy per second per m2 on average.
Hint: 1 watt = 1 joule per second

The average adult has a surface area of about 2m2.

6. What flaws or limitations to this plan can you think of? There are lots!

FUN FACTS

1. About 60 - 70% of our energy needs is due to our Basal Metabolic Rate (BMR) - the energy we need at rest to keep our heart beating, our lungs breathing and our body at the right temperature. Just 30 - 40% of our energy is used for moving about and doing stuff
2. Cyanobacteria (bacteria that can photosynthesise) are estimated to produce about 20-30% of all the photosynthesis on Earth
3. In total, photosynthesis on Earth produces an estimated 1500 to 2250 TW (1 TW = a trillion watts!) of energy per year. That's roughly 100 times more energy than human's use! (This is based on statistics from 2013)

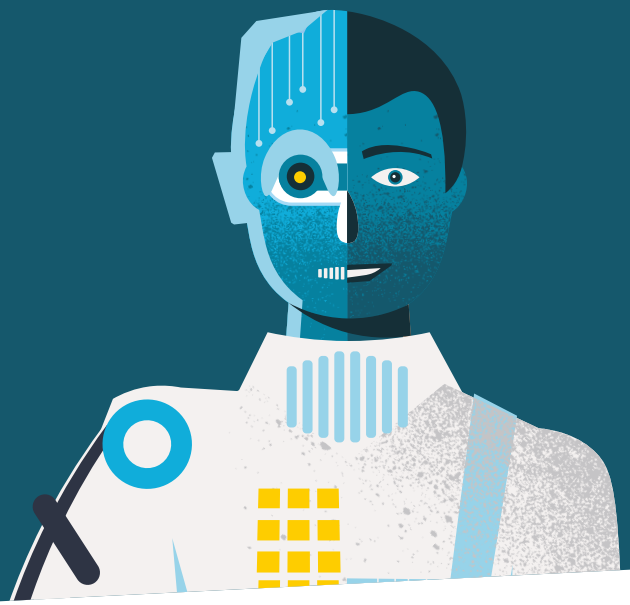
STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

8 How could we fly?



Objective

Students research bird anatomy and follow a template to design a wing for a human, thinking about the bones and muscles they would need to create for it.

HEALTH AND SAFETY:
A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

TOPIC LINKS

- Biology: skeletons and muscles; animal anatomy
- Design and technology: mechanisms

ESSENTIAL SKILLS SUPPORTED

Presenting, problem solving, creativity

TIME

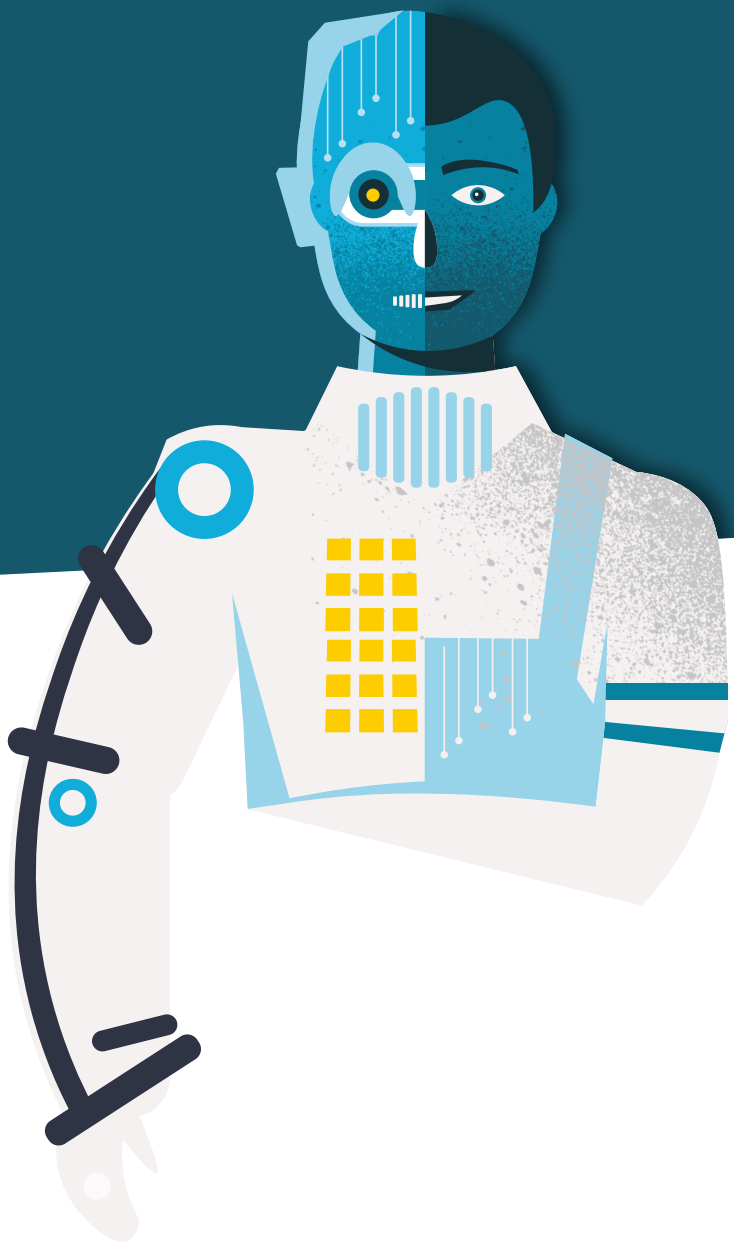
60 minutes

RESOURCES AND PREPARATION

- long and short lolly sticks, marker pens, brass paper fasteners, tape, craft knives, OR
- construction kit components, e.g. Lego technic beams (all lengths) and pin connectors
- rubber bands of various lengths (optional)
- internet access for research (optional)

DELIVERY

1. Introduce the scenario: what if humans had wings that allowed us to fly? What kind of wings would we have – bird wings, bat wings or insect wings? How would we need to augment or change our bodies to make these wings work? Discuss whether students think we could grow living tissue and structures, or whether we should do this using mechanical exoskeletons.
2. Discuss some STEM roles that might play a part in making this a reality, for example: animal biologist, human biologist, mechanical engineer, materials scientist, electronic engineer, designer, programmer, surgeon, aeronautical engineers etc. Students can take on these roles if they wish.
3. Review the student guide together.
4. Optionally, students research bird, bat and insect wing anatomy.
5. Students follow the template to make a simple mechanism for folding wings. They vary the 'bone' lengths and pivot points to see how this changes the shape and motion of the wing. Then, choose the best configuration.
6. Students share and justify their ideas.
7. Discuss how life might change if people were to gain the ability to fly like birds. What could we do? What benefits would this bring – or problems?



TIPS

- start with suggested lengths and pivots
- change only one length or pivot location at a time and see how the motion of the mechanism changes

DIFFERENTIATION IDEAS

Support: make one or two mechanisms, ready for students to copy or alter. Cut coloured lolly sticks to equal lengths, to match the template.

Challenge: students add rubber bands to represent muscles, to unfurl and furl their wings (join these to 'bones' using paper fasteners or additional pin connectors).

EXTENSION IDEAS

1. Students can design and 3D print the 'bones' for their wings, creating simple pivot joints from pins and holes, to create a more 'biological' looking model of their idea
2. Students research materials to cover their mechanism, for example fabrics used for wing suits, wing kites etc. Should these have some 'stretch'
3. Make life sized wing mechanisms out of thick corrugated card and design a harness to hold it on a person's torso
4. If using a construction kit, students can add gears to create a flapping motion from circular motion
5. Students research and build simple ornithopters

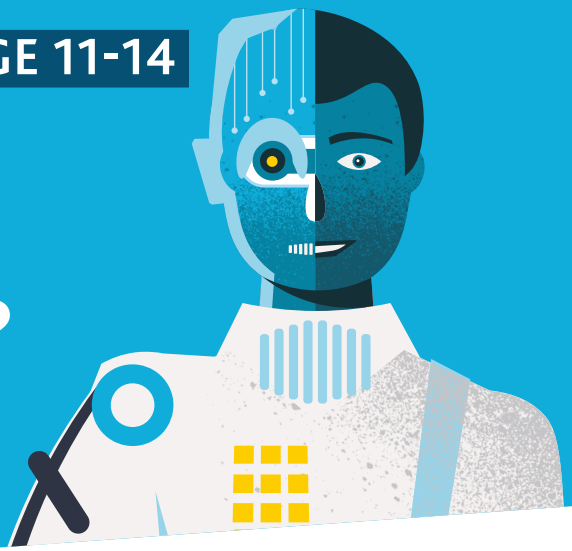
USEFUL LINKS

Commercial wingsuit designs
http://www.wingsuitfly.com/wingsuits/4572051374

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

8 How could we fly?



Briefing

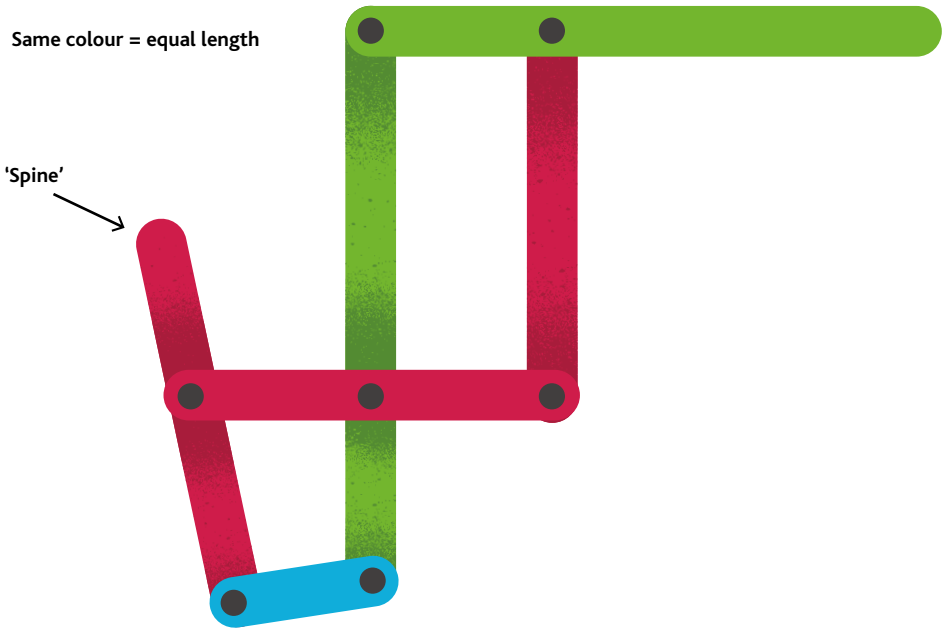
What would you do if you could fly? Where would you go, using your new augmented ability?

YOUR TASK

Create and improve a wing mechanism that could help you take to the skies!

WHAT YOU NEED TO DO

1. Follow the template below to create a wing mechanism out of lolly sticks or construction kit components. Join the lolly sticks using a paper fastener or pin connector.



2. See what happens when you change the length of one bone, or the location of one pivot. Change one at a time until you think you have the best mechanism.
3. Create another identical wing on the other side of your 'spine'.
4. Test the movement of the wings, checking that the wing structure neatly folds and opens, like a birds.

FUN FACTS

1. Wings are really a bird's front legs or arms, which have become adapted for flight.
2. One reason birds can fly is that their bones are much lighter than human bones. This makes it much easier for them to push their bodies off the ground and into the air.
3. Many of the bones in a bat's wing are its greatly elongated finger bones!

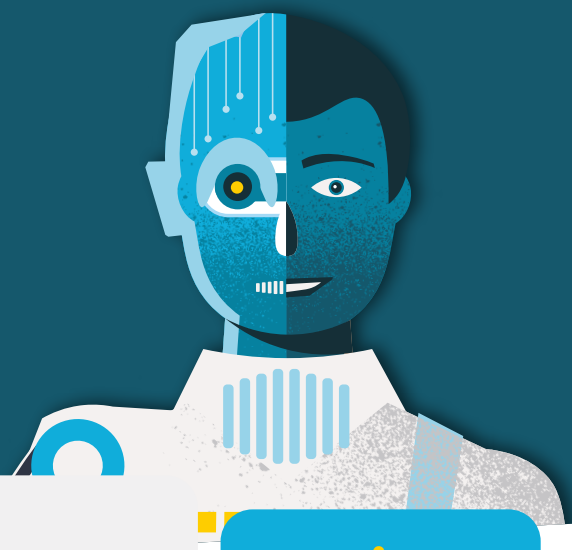
STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

9 Heads-up displays



Objective

Students generate ideas for a wearable heads-up display and present their design sketches.

TOPIC LINKS

- Biology: vision
- Design and technology: design specifications; create appealing products
- Physics: light

ESSENTIAL SKILLS SUPPORTED

Creativity, leadership, teamwork

TIME

30 minutes

RESOURCES AND PREPARATION

- corrugated and thin card
- pipe cleaners
- thin, clear plastic sheet (can be cut with scissors)
- tape, glue, scissors, craft knives
- paper and pens

HEALTH AND SAFETY:

A suitable risk assessment must be carried out by the activity leader and any significant findings recorded: if carried out in schools, guidance from CLEAPSS or SSERC must be used where appropriate.

TIPS

- students should focus on specific user groups and how a display can meet this group's needs.

DELIVERY

1. Introduce and explore the concept of heads-up displays as a way to augment our abilities. Share ideas about how a heads-up display could help anyone, or could specifically help people with certain jobs or interests.
2. Discuss what STEM roles might be involved in creating a heads-up display, for example: designer, optical engineer, electronic engineer, programmer etc. Students can take on these roles if they wish.
3. Students form pairs or threes. They discuss who they would create their display for and what information this group of people would benefit from having. Teams sketch how their display would show this information.
4. If time permits, or by splitting tasks within groups, students can sketch or create a 'rapid prototype' of the headset itself (or they might have chosen a more radical idea, like a contact lens or projector chip inserted into the eye itself!)
5. Teams briefly share ideas.
6. Discuss some objections, especially if the displays include cameras that could record everything that the wearer sees. Why do students think wearable displays are not widely in use yet? Might we skip this technology entirely and adopt something more advanced, like contact lens displays, instead?

DIFFERENTIATION IDEAS

Support: watch the 'getting started with Google Glass video', which will give students ideas. Focus on sketching/ rapid prototyping the display only.

Challenge: students sketch or rapid prototype their headset design as well. They discuss what extra sensors or controls their design might include. Discuss ethical or legal issues in using heads-up displays.

EXTENSION IDEAS

1. Students could experiment with creating a simple heads-up display using some two-way mirror material (acrylic sheet is available in small sizes cheaply from online auction sites) and a smartphone, projector or mini projector. (Search for 'smartphone heads up display' for ideas) increase surface area

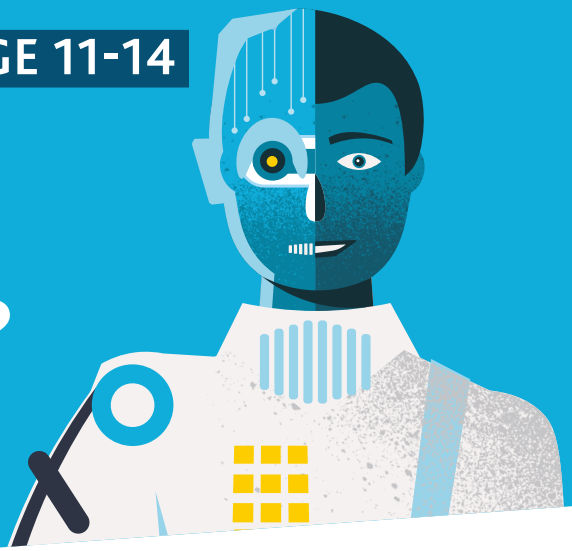
USEFUL LINKS

- **Google Glass 2 is being used in factories and other businesses**
  https://www.wired.com/story/google-glass-is-backnow-with-artificial-intelligence/
- **Getting started with Google Glass**
  https://www.youtube.com/watch?v=4EvNxWhskf8

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

9 Heads-up displays



Briefing

Imagine having all the information you need, right in front of your eyes, as and when you need it. What would you want to know? How could this make your life easier? Can you think of any times or places where this technology might not be OK to wear?

YOUR TASK **Design an amazing heads-up display, then present your ideas.**

WHAT YOU NEED TO DO

1. You may be able to make a quick prototype to show how your display will fit on a user's head. If so, you will need to answer the following questions.

a. How will it fit so it's comfortable to wear?

b. What other sensors or devices might you include?

c. How will users interact with it or control it?

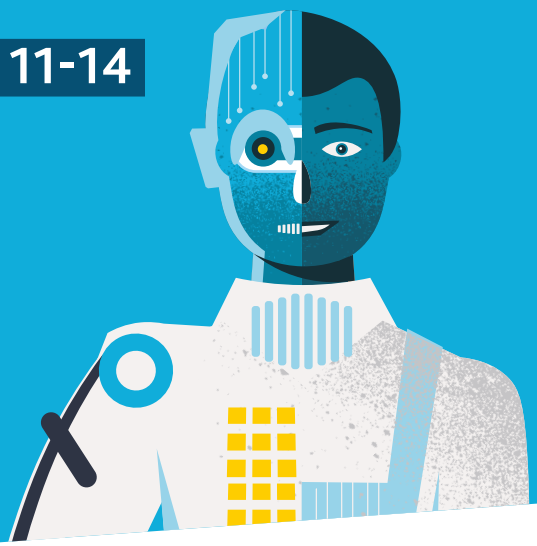
2. Sketch and label what the user will see in your display.

3. Present and explain your ideas. Which display idea seems most interesting, useful or likely to be used by lots of people?

FUN FACTS

1. Google Glass uses a partially reflecting mirror to display information from a tiny LED display. This lets light through so the user can see, while also creating a surface from which the information reflects into the user's eye

2. Many military pilots use helmet-mounted heads-up displays to show vital information no matter where they look. These can even track the pilot's eye movement so the aircraft computer knows what they are looking at



How could we augment ourselves?

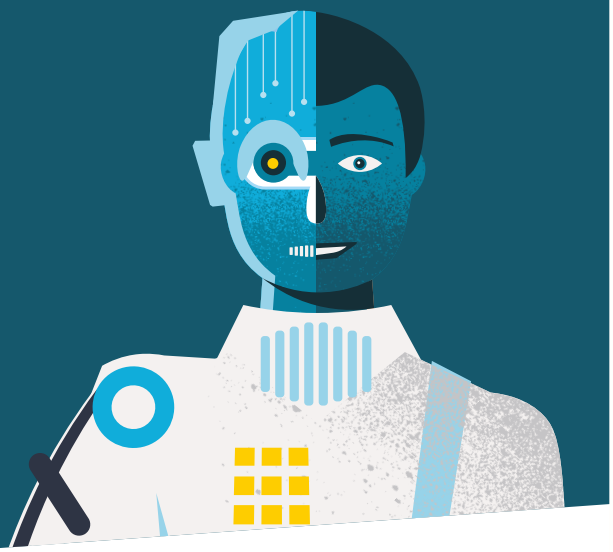
9 Heads-up displays

Sketch and label what the user will see in your display

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

10 Get CREST Discovery Awards



By completing activities in this resource pack, your STEM Club members could get a CREST Discovery Award.

ABOUT CREST

CREST is a scheme that inspires young people to think and behave like scientists and engineers. It is student-led, flexible and trusted. CREST helps young people become independent and reflective learners. With no set timetable, projects can start whenever you want, and take as long as you need.

HOW TO GET YOUR CREST DISCOVERY AWARDS

You can use the activities in this pack to undertake a CREST Discovery Award.

1. Learn more about CREST Awards by visiting www.crestawards.org or contact the CREST team on crest@britishscienceassociation.org for advice and support.
2. Sign-up for a free account - https://my.crestawards.org/
3. Select one or two activities that have open investigation potential and encourage extended research and scientific investigation. Projects should be made suitable for CREST Discovery Days. The CREST Discovery Getting Started guide has all the details! Download it from: https://discoverylibrary.crestawards.org/getting-started-guide-discovery/62140325
4. We suggest using the other activities to introduce and develop chosen topics.
5. Have each student complete a CREST Awards Discovery Passport.
6. Log in to your CREST account to submit the student project, pay the entry fee and request certificates. These will be posted to your delivery address.

TAKING THEIR WORK FURTHER

If members want to take activities further, they can work towards a CREST Bronze or Silver Award.

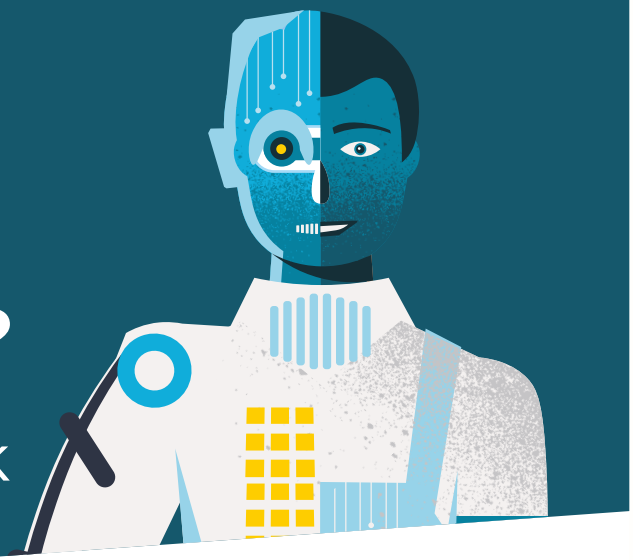
CREST Bronze Awards require around ten hours of enquiry, project-based work, and Silver Awards require thirty hours of work at GCSE or equivalent standard. Using one of the activities for inspiration, they choose a question or topic to investigate.

Guidance on how to run CREST Bronze and Silver Award projects is available on the CREST Awards website www.crestawards.org

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

11 The Skills Builder Framework



Skills Builder FRAMEWORK

The Activities and Employability Skills

Each activity within this resource pack has identified the essential employability skills it supports and develops in students. These skills have been mapped to the essential skills identified by the Skills Builder Framework, which breaks down eight essential skills into 16 teachable and measurable steps. Club leaders and teachers can use the activities to promote good practice and enhance each student's individual learning curve. Helping to promote transferable skills key to their education and future employment.

ABOUT THE SKILLS BUILDER PARTNERSHIP

The Skills Builder Partnership brings together educators, employers and skills-building organisations around a common approach to building eight essential skills. Their programmes include training and resources, supporting schools and colleges to embed a rigorous approach to building skills and achieve the Gatsby Benchmarks. As an individual teacher or Club leader, you can freely access a suite of online teaching tools and resources, designed by their team of teachers to build essential skills. The suite includes learning activities, supporting videos, classroom resources, assessment tools and the Skills Builder Framework, which you can use in STEM clubs and classroom teaching.

THE SKILLS BUILDER FRAMEWORK

The Skills Builder Framework breaks down eight essential skills into 16 teachable and measurable steps, providing a common set of expectations and a roadmap for progression. Step 0 is for the least experienced learners and Step 15 represents a highly skilled adult. The Framework can be used by teachers and Club leaders to talk to students about their skill strengths and areas for development and is a useful tool for framing conversations about careers and employability. Focusing student learning through the Framework, enables students to recognise their own essential skill levels and work to master them over time. The Framework can provide a language for students to articulate this progress to helping to develop employability skills and prepare students for future careers.

Skills Builder also provide multiple online assessment tools, including a student self-assessment, student-by-student teacher assessment and class-level formative assessment through the Skills Builder Hub. This means that programmes can be differentiated and focused to meet individual needs.

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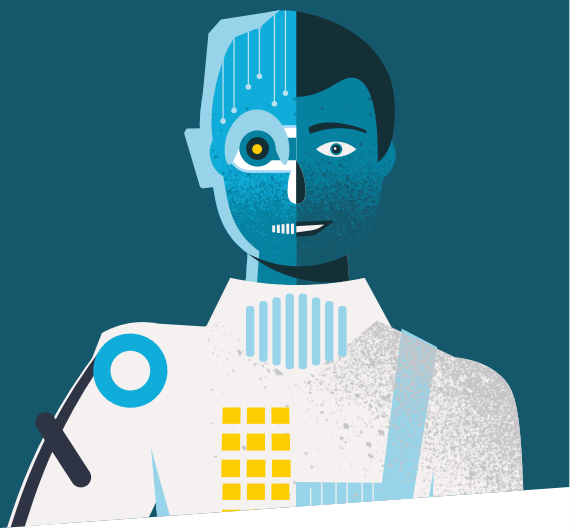

EIGHT ESSENTIAL SKILLS

The eight essential skills broadly break down into four domains we know both teachers and employers value.

Communication

1. Listening – ability to listen and understand information
2. Presenting – vocal communication of information or ideas

Creative Problem solving

3. Problem Solving – ability to find a solution to a complex situation or challenge
4. Creativity – use of imagination and the generation of new ideas

Self-Management

5. Staying Positive – ability to use tactics to overcome setbacks and achieve goals
6. Aiming High – ability to set clear, tangible goals and devise a robust route to achieving them

Inter-personal

7. Leadership – supporting, encouraging and motivating others to achieve a shared goal
8. Teamwork – working cooperatively with others towards achieving a shared goal

You can find out more about essential skills and the Framework on the Skills Builder website, https://www.skillsbuilder.org/framework and you can access resources on the Skills Builder Hub https://www.skillsbuilder.org/hub

You can find additional support and information on careers and employability skills on the STEM Learning Careers pages, https://www.stem.org.uk/stem-careers. You can also download the free Skills Builder toolkit from the STEM Learning website https://www.stem.org.uk/rxfum6

STEM CLUBS

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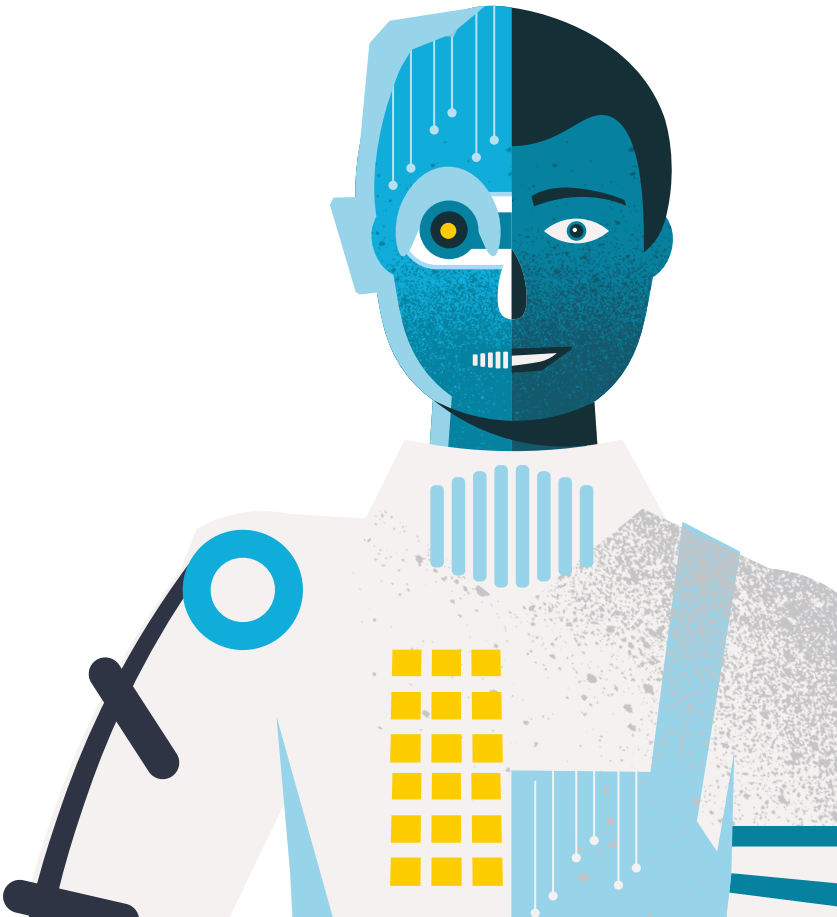
STEM Clubs Programme, led by STEM Learning

Achieving world-leading STEM education for all young people across the UK.



For more information on the programmes and publications available from STEM Learning, visit our website www.stem.org.uk