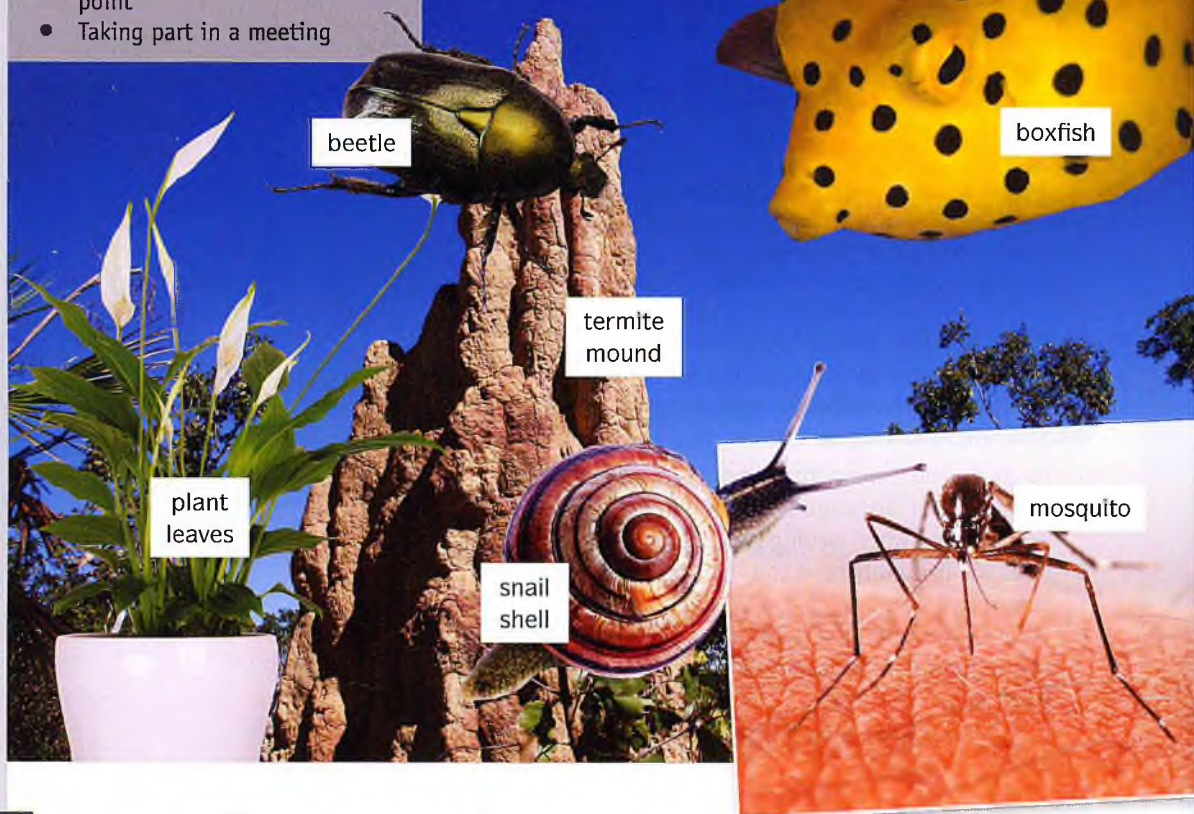


UNIT 3

Finding a direction for your research

- Doing a literature review
- Using evidence in arguing a point
- Taking part in a meeting

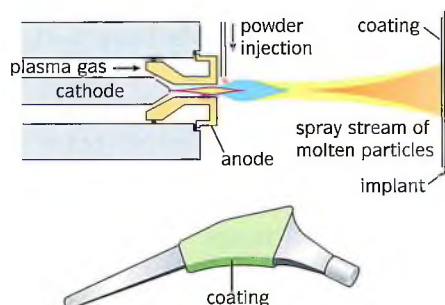


Doing a literature review

Biomimetics, or bionics, involves designing processes, substances, devices, or systems that imitate nature.

- 1 a Which natural phenomenon in the pictures above do you think inspired each of the following inventions?
 - 1 air-conditioned buildings
 - 2 body armour
 - 3 super-aerodynamic car
 - 4 painless hypodermic needle
 - 5 harvesting water from fog
 - 6 solar cells that follow the sun
- b In pairs, discuss the following questions.
 - 1 Can you think of any other biomimetic inventions?
 - 2 Biomimetics groups are often multi-disciplinary, that is, they involve people from a number of different subject areas. What disciplines do you think might be included in a biomimetics group?

- 2 a Pia is a materials scientist. She would like to find a more efficient way of coating metallic bone implants with hydroxyapatite (HA), a bioactive calcium phosphate (CaP). Look at the diagram on the right. It shows a plasma-spray process for coating metallic bone implants with calcium phosphate. Use a dictionary to check the meaning of the words in the diagram.



- b Pia has noticed a problem with the process shown in Exercise 2a, but she thinks that a biomimetic solution might be possible. In pairs, look at the diagram carefully and answer the following questions.

- 1 What do you think the problem might be?
- 2 Can you think of a biomimetic way to coat the implants with CaP? (Clue: think about how crystals grow naturally)

- 3 a Pia has decided to read up on the topic to help her plan her research to find a more efficient coating method. In pairs, discuss the following questions.

- 1 Why is it a good idea to review the literature before planning your experiment?
- 2 How can you find research papers which will be relevant to your area?
- 3 What might Pia's next step be after she has read some of the literature?

- b Look at the extracts from the literature which Pia has found. Which extract(s) describe:

- 1 why CaP is used on metallic bone implants
- 2 the advantages of CaP-coated implants
- 3 the disadvantages of using plasma-spraying to CaP-coat metal

A All coatings were found to undergo significant plasma-spraying-induced changes. Specifically, hydroxyapatite (HA) partly decomposed to α -TCP and tetra calcium phosphate. (Radin, S.R. and Ducheyne, P., 1992)

B Uncemented HA-coated implants had better survival rates than the uncoated, cemented ones. (Havelin, L.I., Engesaeter, L.B., Espehaug, B., Furnes, O., Lie, S.A. and Vollset, S.E., 2000)

C Plasma-sprayed coatings have an irregular surface, and always contain some holes throughout their thickness. (Pilliar, R.M., 2005)

D Surface engineering of biomaterials is aimed at modifying the biological responses while still maintaining the mechanical properties of the implant. Therefore, there has been research to develop CaP-based surface coatings on various metals for implant applications. (Paital, S.R. and Dahotre, N.B., 2009)

E Since 1985, it has been reported that HA coatings on metallic implants can successfully enhance clinical success, and a less than 2% failure rate was reported during a mean follow-up study of 10 years. (Yang, Y., Kim, K-H. and Ong, J.L., 2005)

C Match the definitions (1–8) to the underlined words and phrases in Exercise 3b.

- 1 a further investigation into sth which happened before
- 2 a way in which sth can be used for a particular purpose
- 3 having parts of different forms, shapes or sizes
- 4 to cause sth to happen
- 5 to change
- 6 to continue to be sth or have sth
- 7 to decay or to break down into smaller parts
- 8 to improve the quality, amount or strength of sth

d Explain to a partner in your own words:

- 1 why CaP is used on metallic bone implants
- 2 two advantages of CaP-coated implants
- 3 two problems there are of using plasma-spraying to CaP-coat metal

e Pia has written a review of the literature she has found. Read the summary of her review below and then answer the questions.

- 1 Does Pia's summary include key information on why CaP coating is used on implants? Does it describe advantages and disadvantages of the process?
- 2 Has she used the same words as the original authors did in extracts A–E?
- 3 How does she refer to the work of other scientists?
- 4 What does *et al.* mean in 'Yang *et al.*, 2005'?

(1) The surface of metallic bone implants is often sprayed with calcium phosphates (CaPs) to improve the biological response (Yang *et al.*, 2005; Paital and Dahotre, 2009). (2) Studies have found better survival rates for coated implants (Havelin *et al.*, 2000). (3) However, the usual plasma-spray technique cannot coat all surfaces evenly (Pilliar, 2005). (4) In addition, the plasma-spraying process causes CaP input powders to break down into other compounds such as tetra calcium phosphate (Radin and Ducheyne, 1992).

f In a literature review, it is important to combine information from different sources and show how different pieces of information relate to each other. Look at Pia's summary again and answer the following question.

What word or phrase does Pia use to show that:

- a there is a contrast between the information in Pilliar (2005) and Havelin *et al.* (2000)?
- b Radin and Ducheyne's (1992) research shows another problem with spraying, different from Pilliar (2005)?

g Complete extracts 1–5 with the words in the box. There may be more than one possible answer.

As a result In contrast Moreover On the other hand Therefore

- 1 Kurella *et al.* (2006) used a continuous-wave Nd:YAG laser system to melt a CaP precursor on Ti–6Al–4V substrate. _____, Paital *et al.* (2009) used a pulsed Nd:YAG laser system.
- 2 Coating crystallinity was observed to increase at higher temperatures. _____, sputtered coatings heat-treated in the presence of water vapour at 450 °C resulted in a significant increase.
- 3 Thiriau *et al.* (2008) showed that the procedure results in more light-weight implants. _____, Amrani & Guyton (2011) reported that surface damage in the CaP coating can also be observed.
- 4 A surface with a greater texture enhances cell interaction with complex tissue such as bone. _____, creating three-dimensional features or textures on the surface of a biomaterial is becoming a reality.
- 5 Sliding and/or vibratory motions resulted in adhesion and cohesion at the interface of the two surfaces. _____, adhesive damage caused bound particles to transfer from one surface to the other.

h The linking words in Exercises 3f and 3g show a relationship between two different sentences. We can also describe a similar relationship in a single sentence using the correct word *and* or *but*. Look at Pia's summary in Exercise 3e and:

- combine sentences (2) and (3) by replacing *However*, with *and* or *but*.
- combine sentences (3) and (4) by replacing *In addition*, with *and* or *but*.

i We can describe the relationships between sentences (2), (3) and (4) in Pia's summary in different ways. In pairs, look at the four ways below of organising the sentences and then decide which way (a–d) is best. Think about the style and the effect on the reader as well as the meaning of the sentences.

- a (Sentence 2). However, (Sentence 3). In addition, (Sentence 4).
- b (Sentence 2). However, (Sentence 3) and (Sentence 4).
- c (Sentence 2) but (Sentence 3). In addition, (Sentence 4).
- d (Sentence 2) but (Sentence 3) and (Sentence 4).

j Look at another extract from Pia's literature review. Complete the gaps with the linking words in the box. There is one word you do not need.

and but first however in addition so

Biomimicry has been used to develop alternative coating techniques.

(1) _____, the metal is treated with strong base or acid (Kim *et al.*, 1996). This treatment transforms the surface into an alkali salt or hydrated oxide. These show negative surface charges, (2) _____ they can attract Ca^{2+} and cause CaP to grow on the implant. (3) _____, a disadvantage of this method is that it can cause surface problems, (4) _____ these can affect the survival of the implants. (5) _____, these methods cannot be used to coat stainless steel because its alkali salts and oxides do not show negative surface charges (Miyazaki *et al.*, 2000).

Using evidence in arguing a point

- 4 a Read the information about fog. In pairs, can you think of a way the properties of water can be used to capture water from fog?

What is fog?

Fog develops in almost the same way as a cloud. However, fog actually touches the ground rather than being above it like a cloud. Fog is made up of tiny water droplets, which are usually around 10 μm in diameter. Fog forms when the air cools to a point where it can no longer hold all of the water vapour it contains (the dew point). The water vapour therefore condenses into tiny liquid water droplets, on surfaces such as the ground, roofs or around microscopic particles such as dust and pollutants in the air. The water droplets are hydrophilic, that is they attract other water droplets, and so once the process has begun, larger drops of water can form.

- b Rayna is doing a PhD in environmental science. She has been investigating water-harvesting mechanisms. She is writing to Bryn, her PhD supervisor. Read an extract from her email and then answer the questions below.

... wondering if I could arrange a meeting with you some time next week? I'd like to discuss an idea for a possible new direction to take our research in.

Basically, I've been doing some reading on the Namib Desert Beetle and think that there might be a way to design some kind of water-harvesting material based on its wings.

They are covered in hydrophilic bumps which attract water droplets in the fog. The drops get larger, and when they become too heavy to stay on the bump they roll off. The bumps are surrounded by hydrophobic channels so the water rolls down into the beetle's mouth.

I really think it might be possible to develop a superhydrophobic material which has a surface covered in superhydrophilic bumps to trap water droplets in fog and this is what I'd like to ...

- 1 What is the difference between *(super-)hydrophilic* and *(super-)hydrophobic*?
- 2 What does Rayna hope to design?
- 3 What is the biological inspiration for her design?
- 4 How does she plan to use this inspiration in her design?

- c In pairs, draw a diagram of the design described in Rayna's email. Compare your diagram with the one in the key on page 106.

- d ► 3.1 Listen to Rayna and Bryn's meeting. Is Bryn interested in Rayna's idea? Why / why not?

- e ► 3.1 Listen again and answer the questions.

- 1 Why does Bryn think Rayna's idea is more complicated than the lotus-inspired design?
- 2 Why does Rayna think her material would be more efficient than the lotus-inspired design?
- 3 Why does Rayna think her material would be more effective than fog-catching nets?
- 4 What two uses does Rayna suggest for her material?
- 5 Which use is Bryn most interested in?



5

a When we are arguing with someone, we need to use evidence to support our point of view. We can use 'because' or 'because of' to give a reason or 'so' to show a result of a situation. Look at the following examples and then complete sentences 1–5 below using *because*, *because of* or *so*.

- I think nets must be less efficient **because** they have holes in them.
- I think nets must be less efficient **because of** the holes in them.
- They have holes in them, **so** I think nets must be less efficient.

- 1 _____ the wave of depolarisation running along the cell, a series of new action potentials is triggered.
- 2 _____ the magnitude of the energy loss is greater for phosphorescence than for fluorescence, phosphorescence occurs at longer wavelengths than fluorescence.
- 3 The internal dynamics of the proton are complicated _____ they are determined by the quarks exchanging gluons.
- 4 Root gravitropism influences the plant more than root hydrotropism, _____ hydrotropism is difficult to observe *in vivo*.
- 5 The remaining subjects were excluded from the analysis _____ missing data.

b ▶ 3.2 Listen to this extract from Rayna and Bryn's conversation and circle the phrase in bold that the speakers actually use. Check your answers in Audioscript 3.2 on page 93.

Rayna: I think we could / We can create a material which will / could be used **to** harvest water from fog.

Bryn: Yes, that might be possible / we can, but it wouldn't be / I don't **believe it would be** any better than the lotus-inspired surfaces Meera and Zein are working on.

Rayna: That's true, but it seems to me that / but this would be more efficient.

c Look at the alternatives in the sentences in Exercise 5b. The meanings are the same. Which version of the conversation is more polite? Why?

d Make the sentences below more polite by using the less certain and less direct kind of language in Exercise 5b.

- 1 I think that biomimetic solar panels which move with the sun can be created by using alternative materials and designs.
- 2 They will be useful in developing areas, where motor-based sun-tracking panels are not affordable.
- 3 Also, solar cells that track the sun are probably more efficient at generating power than those in a fixed position.

6

Think of an issue which people in your field often argue about. Then in pairs, argue for or against the point. Remember to use evidence to support your view and phrases to sound polite, as in Exercises 5a and 5b.

Taking part in a meeting

7 a In pairs, discuss the following questions.

- 1 Have you ever taken part in a meeting in English? If so, who was the meeting with and how was it?
- 2 What might be difficult about having a meeting in English, apart from the language difficulties you might have?

b ▶ 3.3 Listen to four scientists talking and take notes about problems they have had in meetings in English.

- 1 Sahal: _____
- 2 Hitomi: _____
- 3 Sam: _____
- 4 Radek: _____

c Have you ever had a problem like those described by the speakers?

8 a Sarah, Deepak and Ali work together as part of a team developing biomimetic adhesives by mimicking the way geckos stick to surfaces. Read the information below. Then in pairs, answer the following questions.

- 1 How does the physical structure of the gecko's foot help it to stick to surfaces?
- 2 How does the way the gecko places its foot help it to stick?
- 3 How do gecko toes become 'unstuck'?
- 4 Why does dirt not collect on the gecko's foot?

Geckos can easily run up a wall or across a ceiling because of their remarkable toes, which are made up of a hierarchy of structures that act together as a smart adhesive.

The pad of a gecko toe is crossed by many ridges or *scansors*, which are covered with small hair-like stalks called *setae*. Each foot can have up to about 2 million *setae* which cluster in diamond-shaped groups of 4. Each *seta* branches into hundreds of tiny endings with flattened tips. These tips are known as *spatulae*.



Many people have investigated just how geckos are able to stick and they have found that it is due to Van der Waals forces. These are attractive forces between molecules in the gecko feet and in the surface they stick to. To maximise the area available to create these forces, it is important that the *setae* are oriented correctly, as they are when the animal walks.

In their resting state, the *setae* bend proximally like a claw. When the gecko places its foot, the *setae* extend so that their tips point away from the body. The *spatulae* sit flat against the surface which sets up strong adhesive forces. The gecko also slides the foot very slightly creating a shear force. The ability of the gecko to stick is therefore not just because of the structure of the foot, but because of the whole locomotor system.

However, it is not only this sticking power which interests scientists. Because geckos can run up walls and across ceilings, they must be able to rapidly switch between sticking and detaching. They do this by changing the shape of the *setae* to increase the angle between *seta* and surface to more than 30 degrees, allowing the foot to be peeled away.

Gecko *spatulae* are also self-cleaning. Van der Waals forces form between the *spatulae* and pieces of dirt. However, because only a few *spatulae* can adhere to a single piece of dirt, when the dirt comes close to the surface the gecko is walking on, stronger forces pull the particle off the gecko's foot, which therefore becomes clean.



b ▶ 3.4 Sarah, Deepak and Ali are holding their monthly research meeting. Sarah is the team leader, Deepak is a senior research assistant and Ali is a junior research assistant. Listen to the beginning of the meeting and answer the questions.

- 1 What has Deepak been doing differently in his recent study?
- 2 What does Ali ask him about at the end of the conversation?

c In your opinion, is Ali's question at the end of this extract relevant or irrelevant to the discussion? Why?

d ▶ 3.5 Listen to the next part of the meeting. Is Ali satisfied with Deepak's answer to the question? How do you know?

e ▶ 3.6 Now listen to the final part of the meeting.

- 1 Is your answer to the questions in Exercise 8c still the same, or have you changed your mind?
- 2 Does Deepak think Ali's question was relevant? Why?

9 a During the meeting, Ali interrupts both Sarah and Deepak several times. Do you think it is appropriate for a junior scientist to interrupt and/or be critical of a senior colleague's ideas? Why / why not?

b When you want to interrupt someone, it is important to sound polite. Three ways you can do this are to use:

- *could* or *can* to make the interruption into a question.
- *sorry* to show the listener might not like what you're going to do.
- *just* to show that you are not going to talk for too long.

Look at Audioscripts 3.4–3.6 on pages 93–94. Which phrases does Ali use to interrupt?

10 a ▶ 3.7 Listen to five extracts from the conversation between Sarah, Deepak and Ali. Write one word or phrase in each space.

- 1 _____, for a while, people thought it could be capillary, but now it seems it's mainly ...
- 2 _____ you're clear on the adhesion mechanism now, Ali?
- 3 That's OK. _____, so as I was saying, what I've been looking at (*fade out*) is the effect of the geometric ...
- 4 _____, because we now know that they are curved, we've ...
- 5 _____, could I jump in and ...

b What is the function of these words and phrases? Can you find other examples of words with this function in Audioscripts 3.4–3.6 on pages 93–4?

11 Work in groups of three. Imagine you all work in the same department and are holding your regular meeting in which you all discuss your recent work. Role play the meeting. Take turns to present your current research, interrupting to ask questions where necessary.