Lesson 4

INTRODUCTION

The Introduction is the statement of the problem that you investigated. It should give readers enough information to appreciate your specific objectives within a larger theoretical framework. After placing your work in a broader context, you should state the specific question(s) to be answered. This section may also include background information about the problem such as a summary of any research that has been done on the problem in the past and how the present experiment will help to clarify or expand the knowledge in this general area. All background information gathered from other sources must, of course, be appropriately cited.

A helpful strategy in this section is to go from the general, theoretical framework to your specific question. However, do not make the Introduction *too* broad. Remember that you are writing for people who have knowledge similar to yours. Present only the most relevant ideas and get quickly to the point of the paper.

1. Find the English equivalents:

Постановка завдання (задачі), оцінити конкретні цілі, в рамках теоретичної бази, зазначити конкретні питання, уточнити, розширити знання, бути відповідним чином процитовані, доречні ідеї.

2. Translate the following words and word-combinations:

Introduction, to investigate, broader context, to include background information, the point of the paper.

3. Answer the following questions:

1. What is Introduction?
2. What should Introduction give readers?
3. What may this section also include?
4. What is a helpful strategy in this section?

Completing a Material Transfer Agreement

(from Cambridge English for Scientists by Tamzen Armer)

4. Read the beginning of the email sent to members of a laboratory. Then in pairs, answer the questions below.

Dear all,

Sooner or later, issues of Technology Transfer (sharing and using discoveries, inventions, materials, data etc.) will become important in your research career. Protecting your work from competitors and, where appropriate, making it attractive to the commercial sector will be important during your career as a professional scientist. What are the key issues that you must think about?

1. What is the purpose of the email?

2. What kind of discoveries, inventions, materials and data might you share with other scientists in your field?
3. What do you think are the key issues of technology transfer?

5. **The next part of the email identifies some key issues and offers advice on them. Match the headings (A-E) to the extracts (1 -5).**

A Huh??? What do I do now??
B Always read the small print!
C Look out! There may be a thief about!
D Your research is valuable - to others!
E Who, me?

1 _____
Sooner or later someone in your field is going to ask you for some materials. Never send out any material without first checking if a Material Transfer Agreement (MTA) is needed.
2 _____
Don't leave sensitive information, notebooks, etc. open on your desk or in unlocked rooms at the end of the day. You never know who might be in the building ...
3 _____
If you request materials from another lab, you will probably be asked for an MTA to sign. Not all MTAs are the same (some say 'we claim ownership of everything developed in your lab') so read carefully before signing and always ask if you're not sure.
4 _____
Yes, you! Your research may have a commercial application. Always talk possible applications over with your supervisor or division head/director before you publish.
5 _____
If you are still none the wiser, or unsure about any of the issues in this email, please talk to your group leader or contact me (Liam Sands) at the Technology Transfer Office.

6. In pairs, discuss the following questions.

1 Does your place of work or study have similar rules to those in the email?
2 What kind of materials require an MTA?
3 What kind of information would you expect to be asked for in an MTA?

7. **Binh, a biochemist, is completing an MTA to receive some samples from a tissue bank in the UK. Read the MTA form. Does this MTA ask for the kind of information you discussed in your answer to question 3 in Exercise 6?**

MATERIAL TRANSFER FORM
SECTION A

*(to be completed when **sending** or **receiving** material):*
Recipient Researcher: Dr Alina. Piotrowska_____

Recipient Institution & Address: School of Biological Sciences, University of the South, CFO Box 2010
Provider Researcher: Liverpool Tissue Bank
Material Name:Breast tissue microarrays – paraffin wax embedded tissue
Is this work involved with existing commercial arrangements? *(1) Yes / No*
Does the work involving the material have commercial potential? *(2) Yes / No*
Is this material hazardous? *(3) Yes / No*
Is BioSafety Committee Approval required? *(4) Yes / No*
Is Ethics Committee Approval required? *(5) Yes / No*
If required, has Ethics and/or BioSafety Approval been received? *(6) Yes / No*
Who will own the IP in any modifications to, or data collected on the material? *(7) University /Other / Joint*
Will any University of the South students be involved in using the material? *(8) Yes / No*

8. Binh's supervisor Alina is helping him to complete the MTA. Listen and complete Section A by circling the correct option (1-8).

Binh: *... Yes, I have that. OK, so recipient researcher? I assume that is you, rather than me.*
Alina: *Yes, so Dr Alina Piotrowska is fine.*
Binh: *And is the address OK too?*
Alina: *Yes, that's fine. So, the material is coming from the Liverpool Tissue Bank, good, and you're asking for breast tissue microarrays, that's fine as well, and paraffin wax embedded, dobrze, very good.*
Binh: *OK, so the rest of the form.*
Alina: *Well, this work is not through any industrial partners.*
Binh: *So that's a 'no' here? In the part about existing arrangements?*
Alina: *That's right... and it doesn't have commercial potential, or you're not going to make money from it at least. They ask about that again, just here, so put no in now.*
Binh: *Right. Next, so, is this material hazardous? No.*
Alina: *Yes, yes, it is. Any human tissue is classed as hazardous.*
Binh: *Even when it's fixed?*
Alina: *Even when it's fixed.*
Binh: *So then does it require BioSafety Committee Approval?*
Alina: *Yes. But not Ethics Committee. That's only for live subjects.*
Binh: *Right. So yes for biosafety and no for ethics.*
Alina*: And we already have the BioSafety Approval ... so yes for that question.*
Binh: *Oh ... I don't even know what the next question means.*
Alina: *Oh, rig h t... well, one of th reasons we fill in these MTAs is so it's clear who the material and the findings belong to. In some cases, even though you do the work, as the tissue is from the Liverpool bank, they still have certain rights regarding the data.*

Binh: *Ah, yes, I meant to ask about that. The forms for the provider say that I have to give them my raw data when I've finished the project. Is that normal?*
Alina: *Yes - so the IP will be held by both us and them together.*
Binh*: IP?*
Alina: *Intellectual Property. In this case, who owns the findings in other words.*
Binh: *OK.*
Alina: *And because you are doing the work but the tissue bank wants copies of your data, we have to arrange to have a talk about what that means for you. That's why they want to know if university students are involved ... so, you can say yes here to the last question.*
Binh: *OK, thank you so much. Erm, Part B…*

9. Binh has to write a brief lay summary of what the material will be used for in Section B of the MTA. In pairs, discuss the following questions.

1. What do you think a *lay summary* is?
2. What kind of language should Binh use or avoid when writing it?
3. Who will probably read the summary?
4. Why do you think the MTA asks for the summary to be written in this way?

10. Complete Binh's lay summary using the phrases in the box.

different types of *material is samples of*
The aim of the research is to investigate
will be stained to show

SECTION B

(to be completed when **receiving** material):
Brief lay summary of what the material is and what it will be used for:
The (1) _____human breast tissue**,** both normal and from (2) _____ tumour. The tissue (3) _____ expression of the Nek-2 protein, a protein that has been shown to be overexpressed in one class of tumours. (4) _____ Nek-2 expression in various tumour types and grades.

EXTRA READING

11. Read a story about early studies of the nature of colour. Read for the first time and say who contributed to the study of colours.

12. Read the text for the second time and answer the following questions:

a) How many colours did Aristotle identify?
b) What elements did he correspond them to?
c) Who was the first to suggest hierarchy of colours?
d) What colour did philosophers view as the absence of colour according to Leonardo da Vinci?
e) When did the detailed understanding of colour begin?
f) Who was the first to use the word spectrum for the array of colours produced by a glass prism?

g) How many colours did Newton assign to the spectrum?

***

Early studies of the nature of colour

In Ancient Greece, Aristotle developed the first known theory of colour. He postulated that God sent down colour from the heavens as celestial rays. He identified four colours corresponding to the four elements: earth, fire, wind, and water.

Leonardo da Vinci was the first to suggest an alternative hierarchy of colour. In his Treatise on Painting, he said that while philosophers viewed white as the "cause, or the receiver" of colours and black as the absence of colour, both were essential to the painter, with white representing light, and black, darkness. He listed his six colours in the following order: white, yellow (earth), green (water), blue (air), red (fire), and black.

The detailed understanding of the science of colour began in 1666, when Isaac Newton, using two prisms, observed that white light was composed of all the colours of the rainbow, and could be identified and ordered. Newton first used the word "spectrum" for the array of colours produced by a glass prism. He recognized that the colours comprising white light are "refracted" (bent) by different amounts and he also understood that there is no "coloured" light, the colour being in the eye of the beholder. Instead, there is merely a range of energies - or the proportional frequencies and the inverse wavelengths. Newton assigned seven colours to the spectrum in an analogy to the musical scale.

WRITING

Write a paragraph about the role of physics in the development of other sciences, industries, and modern technologies. Use the following phrases to present your opinion:

In my opinion…; I strongly believe that…; Personally, I think that…; As far as I'm concerned…; To my mind…; It seems to me that….

Grammar

13. Translate the sentences keeping in mind:

1) The verbs using with the Subjective Infinitive Construction in Passive form: a) ***to believe, to consider, to hold, to think, to suppose (вважати, думати); b) to expect (очікувати), to estimate (оцінювати), to say (говорити), to report (повідомляти).***

2) The verbs using with the Subjective Infinitive Construction in Active form:

to seem, to appear (здаватися), to prove, to turn out (виявлятися), to happen (траплятися, виявлятися).

3) The expressions using with the Subjective Infinitive Construction: ***to be likely (ймовірно), to be sure, to be certain (напевно), to be unlikely (навряд).***

1. Його знали як дуже чутливого до будь-якої критики. 2. Вважають, що атомна енергія стане головним джерелом постачання енергії. 3. Кажуть,

що наша лабораторія отримала нові прилади. 4. Відомо, що напівпровідники знайдуть різноманітне застосування в майбутньому. 5. Вважається, що водень складає половину поверхні землі, води та повітря. 6. Очікується, що він поновить випробування на наступному тижні. 7. Ймовірно, ці вчені опублікують результати своїх досліджень. 8. Навряд чи він візьме участь у дискусії. 9. Напевно, він представить свою доповідь наприкінці конгресу. 10. Виявилося, що він усвідомлює всі наслідки експерименту.

14. Transform the following sentences, using the Subjective Infinitive Construction and the verb in brackets according to the model:

History repeats itself. – History is known to repeat itself.

1. Leonardo da Vinci discovered and laid down immortal principles in the theory of art (to know). 2. Leonardo da Vinci designed the first parachute (to suppose). 3. Leonardo denied himself meat out of an aversion to the killing of animals (to say). 4. Applied science will produce a vast increase in entirely new synthetic products of all kinds (to expect). 5. Rapid expansion of industrialization leads to an exhaustion of natural resources (to believe). 6. Close cooperation between scientists and scientific institutions all over the world is one of the most striking characteristics of modern science (to consider). 7. Charles Spencer Chaplin made more people laugh than any other human being in the history of the world (to know).

15. Translate the following sentences into Ukrainian:

1. Leonardo da Vinci is considered to be a pioneer in physiology and botany. 2. The Earth is said to have been part of the Sun. 3. The delegation is reported to have arrived in the capital already. 4. Moral perfection is considered to be one of the ideals of mankind. 5. Leonardo da Vinci is known to have studied optics. 6. His painting and sculpture are supposed to have opened up few fields of enquiry. 7. He is known to have studied the structure of the bones and muscles of the human body.

16. Translate the following sentences into English:

1. Відомо, що наука значно змінила умови життя сучасної людини. 2. Вважається, що Леонардо да Вінчі сконструював перший ліфт. 3. Кажуть, що цей політичний діяч досяг великих успіхів. 4. Очікується, що протиріччя між цими країнами будуть залагоджені. 5. Відомо, що Леонардо да Вінчі створив проект реконструкції Мілана. 6. Кажуть, що він достатньо розумний, щоб правильно оцінити ситуацію. 7. Очікується, що вони поновлять випробування наступного тижня. 8. Повідомляють, що президент вже прибув до столиці.

17. Translate the sentences paying attention to the Object and Subjective Infinitive Constructions:

1. We consider radioactive atoms to be very valuable in all sorts of ways. 2. An atom is known has been proved to hold a tremendous force, hidden in its tiny

body. 3. Everything around us is known to be composed of atoms. 4. The common articles in the laboratory are known to be made of plastics. 5. In general, plastics are known to be classified into groups according to their behaviour when they are heated. 6. The plastics have proved to be satisfactory alternatives to many other materials. 7. The 19th century is often considered to be the century of steam and electricity. 8. We know the molecules of substances to be in continual motion.

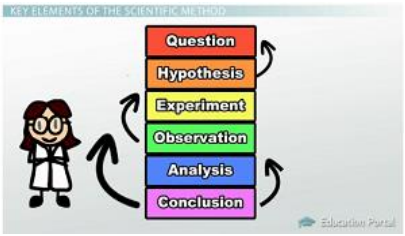
18. Translate the sentences paying attention to the Object and Subjective Infinitive Construction:

1. Відомо, що атомній енергії належить майбутнє. 2. Кажуть, що наша лабораторія отримала нові прилади. 3. Відомо, що розчин – це однорідна суміш двох або декількох речовин. 4. Ми виявили, що ці експерименти відповідали раніше прийнятим нормам. 5. Учні очікували, що магніт притягне цей предмет. 6. Відомо, що біля полюсів магніту магнітне поле сильніше.

Unit III Scientific Method

Lesson 1

Key Elements of the Scientific Method



The scientific method is a set of procedures that scientists follow in order to gain knowledge about the world.

However, the steps involved in the scientific method vary widely among the different scientific disciplines. Chemists follow the method a bit differently than psychologists. Geologists and botanists have their own unique methods. So, is there really one scientific method that encompasses all of science? To find out, we'll need to learn more about the scientific process.

There are six key steps that tend to characterize the scientific method. The first step is the question. This is the part where a scientist proposes the problem that he or she wants to solve. A well-conceived question usually leads to a hypothesis, a potential answer to the question at hand. Sometimes, hypotheses look more like predictions. The scientist predicts what the outcome will be when he or she tests the hypothesis. The scientist's test is also called the experiment. Experiments are ordered investigations that are intended to prove or disprove a hypothesis. Important data comes from performing an experiment.

The scientist has to make observations of the results that he or she gets from the experiment. An observation is a statement of knowledge gained through the senses or through the use of scientific equipment. Observations are crucial for collecting data. Once the results are in, the scientist must begin the analysis. Data analysis involves comparing the results of the experiment to the prediction posed by the hypothesis. Based on the observations the scientist made, he has to determine whether the hypothesis was correct. He then sums up his findings with a conclusion. The conclusion of a scientific process is a statement of whether the original hypothesis was supported or refuted by the observations gathered.

1. Find the English equivalents in the text:

Дотримуватися процедури, отримати знання, варіюватися в широких межах, охоплювати всі науки, виявити (з'ясувати), продумане питання, передбачати результат, впорядковане дослідження, спростувати гіпотезу, мати вирішальне значення, бути спростованим спостереженнями.

2. Translate the following words and word-combinations:

Scientific disciplines, scientific process, to lead to a hypothesis, to test the hypothesis, to make observation, scientific equipment, to compare results, to sum up findings.

3. Answer the following questions:

1. What is scientific method?
2. What steps characterize the scientific method?
3. What is hypothesis?
4. What is an experiment?
5. How is a scientific observation defined?
6. What does a conclusion prove?

4. Read the text; put 3 questions to it; discuss it with a partner.

The six steps of the scientific method do not always occur in the same order.

The scientific method usually employs all six of the steps, but the steps don't always occur in the same order. Real scientists may go back and repeat steps many times before they come to any conclusions. It's actually better to use the word 'elements' to describe the steps, since the first step, question, does not always come first. Sometimes, for example, it's an observation that came first and spawned the initial question. Likewise, observations that are made during an experiment can inspire more questions that scientists have to answer.

5. Make an annotation of the article.

Robert Boyle

From Chemical Heritage Foundation

Robert Boyle (1627–1691) was born at Lismore Castle, Munster, Ireland, the 14th child of the Earl of Cork. As a young man of means, he was tutored at home and on the Continent. He spent the later years of the English Civil Wars at Oxford, reading and experimenting with his assistants and colleagues. This group was committed to the New Philosophy, which valued observation and experiment at least as much as logical thinking in formulating accurate scientific understanding. At the time of the restoration of the British monarchy in 1660, Boyle played a key role in founding the Royal Society to nurture this new view of science.

Although Boyle's chief scientific interest was chemistry, his first published scientific work, *New Experiments Physico-Mechanicall, Touching the Spring of the Air and Its Effects* (1660), concerned the physical nature of air, as displayed in a brilliant series of experiments in which he used an air pump to create a vacuum. The second edition of this work, published in 1662, delineated the quantitative relationship that Boyle derived from experimental values, later known as "Boyle's law": that the volume of a gas varies inversely with pressure.

Boyle's theories of material change did nothing to eliminate the possibility of the transmutation of base metals to gold that was at the heart of alchemy. Indeed he practiced alchemy until the end of his life, believed that he had witnessed transmutation, and successfully lobbied Parliament to repeal England's ban on transmutation.

Boyle also wrote extensively on natural theology, advocating the notion that God created the universe according to definite laws.

Doing a literature review

(from Cambridge English for Scientists by Tamzen Armer)

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

6. Which natural phenomenon (a-f) do you think inspired each of the following inventions (1-6)?

a) beetle
b) plant leaves
c) boxfish
d) termite mound
e) snail shell
f) mosquito

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

7. 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.
3. What disciplines do you think might be included in a biomimetics group?

8. 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 e t 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).

9. 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)?

10. 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 H -6 A I-4 V 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.

11. 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 Ca2+ 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).

Discussion point
What does the future hold?

(from Headway Students' Book Upperintermediate by John and Liz Soars. Oxford English)

12. Read and tell your friends what surprise you most in this book.

In 1932 an English writer, Aldous Huxley, wrote a book called *Brave New World.* In it, he envisaged life six hundred years into the future. Later in his life, he said that if he rewrote the book, he would place the same vision only one hundred years into the future, because so many of his prophesies had already come true.

This is the vision of the future that *Brave New World* describes.

Which aspects …

- have already come true?
- will come true soon?
- might come true some time?
- couldn't possibly come true ever?

World

The world is controlled centrally, following a nine-year war between super powers which led to economic collapse.

There is total social stability. World population is maintained at two thousand million. English is the only language, all others are dead. There is no religion. History and literature are censored.

People

Everyone is happy. Babies are born in test-tubes, and by careful use of chemicals and conditioning (babies are taught in their sleep), people are designed to perform certain functions in life. There are five classes of people. There is no

illness or disease, but there is also no emotion or privacy. Everyone looks young until they are sixty, when they are sent to hospital to die.

Entertainment

People go the feelies, where they not only see pictures, but also feel and smell them. There is no love or marriage, and sex is an important form of entertainment.

Everyone takes a drug called soma, in the evenings with friends and for sleep holidays that last two weeks.

The economy

Everybody works seven and a half hours a day, not because this is necessary (they have the technology to allow no-one to work) but because people like their work and would otherwise have too much free time.

It is a throwaway, consumer society.

Travel

The better classes travel everywhere by helicopter, and go on weekend holidays to the other side of the world. Rockets can go from London to America in six and half hours, travelling at 1,250 kilometres per hour.

Grammar

12. Translate the sentences with Prepositional Infinitive Construction into Ukrainian:

1. It is desirable for you to know it. 1. He waited for the papers to be published. 3. There is only one thing for you to do. 4. For the experiment to be successful he had to do much work. 5. Have you got anything for me to read? 6. For the meeting to be a success much preliminary work must be done. 7. No efforts are large enough for the research to be completed. 8. We are waiting for the jury to announce their verdict. 9. It will take a number of years for the two sides to come to an agreement. 10. It will be expedient for them to postpone the visit. 11. It will be convenient for all of us to have the examination on Tuesday.

13. Complete the following sentences:

1. It is necessary for her … 2. It is advisable for them … 3. They waited for us … 4. It was important for them … 5. There was no reason for him … 6. It will be dangerous for him … 7. It was high time for them … 8. It is better for her … 9. The best thing for me was … 10. She will wait for me …

14. Make up sentences using "For … to + Infinitive" construction:

Necessary	journalists	take a different view
Important	economists	take some interest in politics
Essential	politicians	confront reality / face facts
Impossible	philosophers	deny the progress of science

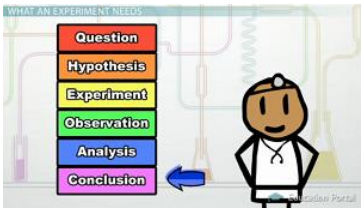
15. Translate the following sentences into English:

1. Не існує серйозних перешкод тому, щоб ці країни жили у мирі. 2. Він дав нам декілька статей, щоб ми використали його дані у нашому

дослідженні. 3. Лектор говорив достатньо голосно, щоб всі могли чути його. 4. Вкрай важливо, щоб ви прочитали його біографію. 5. Всі ми повинні вчитися на власному досвіді. 6. Необхідно, щоб ця проблема була вирішена негайно.

Lesson 2

The Design of Scientific Experiments



Experiment is one of the key components of the scientific method, which is a set of procedures that scientists follow to gain knowledge about the world.

Other components of the scientific method are questions, hypotheses, observations, analyses, and conclusions.

While experiments are only one part of a scientific investigation, they end up being accountable to the other elements.

A scientific experiment is an ordered investigation that attempts to prove or disprove a hypothesis. So its primary purpose is to test whether someone's prediction is correct.

Scientific experiments are different from other kinds of tests because they are required to fit in with the scientific method. Another important factor is peer review by the science community. A scientist's work isn't generally recognized unless he follows the standards set by other scientists around the world. A few basic rules apply to the design of a good experiment. What does a science experiment need?

Rule 1: The experiment must show that a hypothesis is either supported or not supported. In science, we try to avoid using terms like 'right' and 'wrong,' and we don't say that hypotheses are 'proven' or 'disproven' until we're really sure about it. A single experiment is not enough to prove anything with 100% certainty.

Rule 2: The results of an experiment must be measurable and objective. Scientists use standard units to measure different properties like length, time, volume, mass, and speed. Sometimes we need special equipment to observe things in a measurable way. For example, we can't see ultraviolet light or hear infrasonic sounds. We need special devices to detect and measure those properties for us.

Rule 3 for scientific investigations: The experiment must be repeatable by other scientists. Peer reviewers want to make sure that other scientists can run the same experiment and get similar results. This is one of the reasons we standardize our measuring tools and equipment. Scientists must be able to read anyone else's report, follow the steps exactly the same way, and compare their findings to the original test. In science, new ideas aren't taken seriously until many scientists have tested them many, many times. So it's important that scientists share their techniques and confirm each other's findings.

1. Find the English equivalents in the text:

Наукове дослідження, правильне передбачення, вписуватися в науковий метод, експертна оцінка (рецензування), підтримати гіпотезу, уникати використання терміну, упевненість в 100%, вимірні та об’єктивні результати, переконуватися, виконати той же експеримент, підтвердити висновки (отримані дані).

2. Translate the following words and word-combinations:

To disprove a hypothesis, science community, to measure different properties, length, time, volume, mass, speed, special equipment, ultraviolet light, infrasonic sounds, scientific investigation, measuring tools, to compare findings, to share techniques.

3. Answer the following questions:

1. What are the components of the scientific method?
2. What does a scientific experiment attempt?
3. What is the primary purpose of a scientific experiment?
4. What is the difference of scientific experiments from other kinds of tests?
5. Why do we standardize our measuring tools and equipment?

4. **Read the text; put 5 questions to it; discuss it with a partner.**

Theories and Laws

So how do scientific ideas become part of the community knowledge base? If everyone's always double-checking each other's work, how do hypotheses become theories? How do theories become scientific law? Well, first of all, keep in mind that theory in the world of science is not the same thing as a theory in everyday language. I might have a 'theory' that my friend Jackie is going to ask her classmate Jimmy on a date, but that's not the same as a scientific theory.

In science, a theory is a statement that is generally accepted as a summary for a hypothesis or a group of hypotheses. You can also call a theory an accepted hypothesis. When one hypothesis has been tested by many different scientists and most of them have come to the same basic conclusion, then we can start calling the hypothesis a theory. There isn't any 'grand master of science' who makes the final decree about a theory. It's more like a general consensus. And a theory can still be disproven if further research reveals enough evidence to refute it.

Theories become laws when the results of an experiment cannot be disproven

A law is different from a theory in that it is viewed as a universal fact. A scientific law is a general statement about a group of observations that has no exceptions to the rule. Most laws can be stated as mathematical equations, like Boyle's Law and Pascal's Law. Laws in biology are statements about how living things work - for example, Mendel's Laws. To explain the results of his experiments with peas, Gregor Mendel developed the Law of Segregation and the Law of Independent Assortment. No genetics experiment has ever disproven Mendel's laws, and so his statements are still viewed as laws today.

5. Make an annotation of the article.

Gregor Mendel

From Gregor Mendel Biography
By Biography.com Editors

Gregor Mendel was an Austrian monk who discovered the basic principles of heredity through experiments in his garden. Mendel's observations became the foundation of modern genetics and the study of heredity, and he is widely considered a pioneer in the field of genetics.

Gregor Mendel, known as the "father of modern genetics," was born in Austria in 1822. A monk, Mendel discovered the basic principles of heredity through experiments in his monastery's garden. His experiments showed that the inheritance of certain traits in pea plants follows particular patterns, subsequently becoming the foundation of modern genetics and leading to the study of heredity.
Gregor Johann Mendel was born Johann Mendel on July 22, 1822, to Anton and Rosine Mendel, on his family's farm, in what was then Heinzendorf, Austria. He spent his early youth in that rural setting, until age 11, when a local schoolmaster who was impressed with his aptitude for learning recommended that he be sent to secondary school in Troppau to continue his education. The move was a financial strain on his family, and often a difficult experience for Mendel, but he excelled in his studies, and in 1840, he graduated from the school with honours.

In 1853, upon completing his studies at the University of Vienna, Mendel returned to the monastery in Brno and was given a teaching position at a secondary school, where he would stay for more than a decade. It was during this time that he began the experiments for which he is best known.

In 1865, Mendel delivered two lectures on his findings to the Natural Science Society in Brno, who published the results of his studies in their journal the following year, under the title *Experiments on Plant Hybrids*. Mendel did little to promote his work, however, and the few references to his work from that time period indicated that much of it had been misunderstood. It was generally thought that Mendel had shown only what was already commonly known at the time—that hybrids eventually revert to their original form. The importance of variability and its evolutionary implications were largely overlooked. Furthermore, Mendel's findings were not viewed as being generally applicable, even by Mendel himself, who surmised that they only applied to certain species or types of traits. Of course, his system eventually proved to be of general application and is one of the foundational principles of biology.

Using evidence in arguing a point

(from Cambridge English for Scientists by Tamzen Armer)

6. 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 o f tiny water droplets, which are usually around 10 pm 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.

7. 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?

8. Listen to Rayna and Bryn's meeting. Is Bryn interested in Rayna's idea? Why / why not?

Rayna: *... So, as I said in my email, I think we could create a material which mimics the surface of the beetle's wings and so could be used to harvest water from fog.*

Bryn: *Yes, that might be possible, but I don't believe it would be any better than the lotus-inspired surfaces Meera and Zein are working on. In fact, what you are proposing seems to double the work - you'd need a hydrophobic and a hydrophilic surface.*

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

Bryn: *In what way?*

Rayna: *OK, as far as I'm aware, the lotus-inspired materials collect actual droplets of water, drops of rain. But this beetle seems to be able to collect water*

just from fog, not raindrops, so you wouldn't need actual rainfall.
Bryn: *Yes, I can see that ...*
Rayna: *But to mimic its surface—*
Bryn: *Sorry, before you go any further, what use do you see for this material?*
Rayna: *Oh, I think it could be useful in, say, refugee camps to collect drinking water or ...*
Bryn: *But I can't see how it would be better than the fog-catching nets which already exist.*
Rayna: *Oh, well, I think nets must be less efficient because of the holes in them. Surely some of the potentially useful fog blows straight through them?*
Bryn: *Hmm, I suppose so.*
Rayna: *So a lot of water is lost. And as well as creating a material to collect water for refugees, another use might be in cooling towers, to recycle the water.*
Bryn: *Aha, now that sounds like a profitable use. Yes, I can see that.*
Rayna: *So do you have any idea how to make this material? I guess we could use microcontact printing.*
Bryn: *We could, but I feel there must be a simpler way than that ...*

9. 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?

10. 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.

11. Listen to this extract from Rayna and Bryn's conversation and circle the phrase in bold that the speakers actually use.

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 / 1 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.

Check your answers:

***Rayna: I** think we could create a material which could be used to harvest water from fog.*
***Bryn:** Yes, that might be possible, but 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 this would be more efficient.*

12. Make the sentences below more polite by using the less certain and less direct kind of language in Exercise 11.

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.

Discussion point
Describing people

(from Headway Students' Book Upperintermediate by John and Liz Soars. Oxford English)

13. Find a word or expression in the brackets that means the same as the following:

Clothes
not ironed
not buttoned up
attractive and colourful

Hair
neat

Face
a soft smile
wrinkled
brown
ordinary

Character
thinking of oneself
having experience and knowledge
ordinary

(creased, deeply sunburned, gentle smile, lined, plain, carefully brushed, picturesque, open, immensely commonplace, selfish existence, knowing one's own mind)

14. Put the following compound adjectives into the right group, according to what they describe:

Character _____

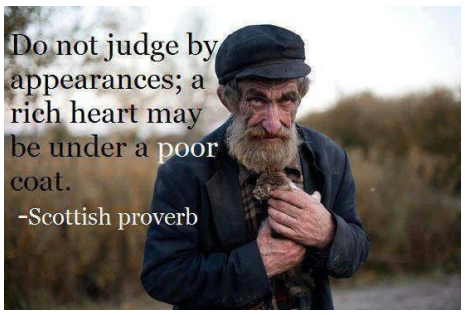
Clothes _____

Face _____

Body _____

Good-looking, well-dressed, left-handed, clean-shaven, straight-haired, well-behaved, blue-eyed, self-centred, bad-tempered, narrow-minded, easy-going, broad-shouldered.

15. Choose one of the pictures and describe the person in as much as you can. Begin with your general impressions (age, build, height) and then describe his/her face, hair and clothes. What sort of person does he/she seem to be?



Grammar

16. Transform the following sentences using Participle phrases instead of the Subordinate Clauses:

1. The scientists *who will take part in the conference* must submit their abstracts. 2. A dialect is a form of language *that differs from the generally accepted standards of speech.* 3. The Queen opens the Parliament with a speech *that sets out the Government's programme for the future.* 4. The man *who is addressing the meeting* is the leader of the opposition. 5. Science fiction is fiction *that deals with imagined scientific discoveries and advances.* 6. Anybody *who will touch that wire* will get an electric shock.

17. Open the brackets using Participle 1 according to the model:

Model: (to be a good teacher) he could explain everything simply and clearly. – Being a good teacher he could explain everything simply and clearly.

1. (to be a man of flexible views) he appreciated the new theory. 2. (to be tired she went to her room). 3. (to be a foreigner) the man couldn't understand what we were talking about. 4. (not to know the answer) he decided not to say anything. 5. (to have his term paper to write) the students couldn't visit his parents.

18. Transform the sentences using Participle 1:

1. *As he was clever enough*, he realized his mistake at once. 2. He fell silent and *thus showed that the interview was over*. 3. *When he discussed his research with his colleagues*, he saw some of its weak points. 4. They applied his method to concrete problems and *thus provided a valuable test for it.* 5. *When you exchange opinions with other people*, you enrich your mind.

19. Translate the following sentences into Ukrainian:

1. When dreaming, one tends to believe in the reality of the dream world. 2. When giving advice to others, think whether you would follow it yourself. 3. When introducing a new method of research, you must consider its practicability. 4. Skimming is appropriate when trying to decide if careful reading would be desirable. 5. When speaking English, I often make mistakes.

Lesson 3

Types of Scientific Experiments

There are many different ways to describe the types of scientific experiments. The three main types are experimental, quasi-experimental and observational.

The highest level of scientific experiment is known as experimental, or randomized control. In this type, as the name implies, there is the greatest amount of control. There are at least two groups used in this type of scientific experiment. Each group is made up of subjects that resemble each other as close as possible, such as by age, gender, etc. Subjects can be human, animal or the environment.

As the name also implies, the subjects are randomized to a group. For the sake of clarity, the description here will use two groups, but in experiments there can be more than two groups. There are many different methods to complete randomization.

The second type of scientific experiment is known as quasi-experimental. It's very similar to the randomized control experiment. However, there can be a process required in the control experiment that's missing or unable to be accomplished. Sometimes it's related to the randomization process. For example, two groups are formed but because of ethical considerations, the groups cannot be randomly assigned.

Some of the designs that are quasi-experimental include survey experiments describing answers provided in a questionnaire as well as correlational experiments, which examine the relationship between two or more variables. A basic example of a correlational experiment would be a study measuring cognitive ability in people with head injuries and people without.

Scientific observation is the central element of scientific method or process. The core skill of scientist is to make observation.

Observation consists of receiving knowledge of the outside world through our senses, or recording information using scientific tools and instruments. Any data recorded during an experiment can be called an observation.

1. Find the English equivalents in the text:

Рандомізований контроль, бути схожим один на одного, задля ясності, бути визначеним випадковим чином, оглядовий експеримент, когнітивні (пізнавальні) здібності, основне уміння.

2. Translate the following words and word-combinations:

Randomized control, at least, environment, description, ethical considerations, questionnaire, variable, scientific tool.

3. Answer the following questions:

1. What are the main types of scientific experiments?
2. What is the highest level of scientific experiment?
3. What is the difference of quasi-experimental type?
4. What may quasi-experimental type include?
5. What does observation consist of?
6. What can be called an observation?

4. Read the text; put 3 questions to it; discuss it with a partner.

Scientific investigation is the way in which scientists and researchers use a systematic approach to answer questions about the world around us.

Scientific investigation is a quest to find the answer to a question using the scientific method.

In turn, the scientific method is a systematic process that involves using measurable observations to formulate, test or modify a hypothesis.

Finally, a hypothesis is a proposed explanation for some observed phenomenon, based on experience or research. Scientific investigation is what people like you and me use to develop better models and explanations for the world around them.

5. Make an annotation of the article.

Blaise Pascal (1623–1662)

From Blaise Pascal Biography
By Biography.com Editors

Blaise Pascal was a French mathematician, physicist and religious philosopher, who laid the foundation for the modern theory of probabilities.

Mathematician Blaise Pascal was born on June 19, 1623, in Clermont-Ferrand, France. In the 1640s he invented the Pascaline, an early calculator, and further validated Evangelista Torricelli's theory concerning the cause of barometrical variations. In the 1650s, Pascal laid the foundation of probability theory with Pierre de Fermat and published the theological work *Les Provinciales*, a groundbreaking series of letters that defended his Jansenist faith. Pascal is also widely known for his body of notes posthumously released as the *Pensées*. He died in Paris on August 19, 1662.

Inventor, mathematician, physicist and theological writer Blaise Pascal, born on June 19, 1623 in Clermont-Ferrand, France, was the third of four children and only son to Etienne and Antoinette Pascal. His mother passed away when Blaise was just a toddler and he became exceptionally close to his two sisters Gilberte and Jacqueline. His father, Etienne, was a tax collector and talented mathematician.

The beginning of Blaise's education was geared toward languages, especially Latin and Greek. Even so, Etienne's plan backfired: The fact that mathematics was a forbidden topic made the subject even more interesting to the inquisitive boy, who at the age of 12 began exploring geometry on his own. He made up his own terminology, not having learned official mathematical terms, and quickly managed to work out that the sum of a triangle's angles are equal to two right angles.

Pascal's inventions and discoveries have been instrumental to developments in the fields of geometry, physics and computer science, influencing 17th-century visionaries like Gottfried Wilhelm Leibniz and Isaac Newton. During the 20th century, the Pascal (Pa) unit was named after the thinker in honor of his contributions to the understanding of atmospheric pressure and how it could be estimated in terms of weight. In the late 1960s, Swiss computer scientist Nicklaus Wirth invented a computer language and insisted on naming it after Pascal. This was Wirth's way of memorializing Pascal's invention of the Pascaline, one of the earliest forms of the modern computer.

Taking part in a meeting

6. 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?

7. 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:_____

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

1 Sahal

Before I went to the meeting, I thought my listening and speaking skills were quite good, but when I got there, I realised how hard it was to listen to so many people. When you're talking one-on-one, it's easy to follow and join in the conversation. But at the meeting, the topic seemed to change before I'd had time to understand what had been said. I didn't manage to say anything at all and left totally confused.

2 Hitomi

In Japan, we let one person finish what they're saying before we start to speak. It's polite. At the first meeting I went to, everybody seemed to talk at the same time. People weren't even interrupting politely. They just talked over the top of each other. It got louder and louder. I wanted to join in, but there was no chance for me to say anything. At the next meeting, I was more confident, but it was still hard for me to speak when someone else was already talking.

3 Sam

Most meetings in my department are quite short, only about 30 to 45 minutes long, but when I first started attending, they seemed to go on forever. I could understand for about the first 15 minutes, but after that I couldn't keep concentrating and so I would miss important information. The worst time was when someone asked my opinion and I had no idea what they'd been talking about.

4 Radek

The biggest problem I have at meetings is knowing how formal or informal my language should be. I'm not really sure which phrases are slang and things, you know. It's a real problem when I want to disagree with someone, without being rude, or when I want to ask what someone means or stuff like that.

8. 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.

Discussion point
Describing objects

(from Headway Students' Book Upperintermediate by John and Liz Soars. Oxford English)

9. Divide the following words into three groups: shape, material, and colour:

circular	glass	crimson
gold	wooden	rectangular
grey	metal	silver
rubber	scarlet	iron
cotton	purple	navy blue
cylindrical	oval	square
nylon	triangular	maroon
straight	round	turquoise

10. Look at the objects in the room around you. Can you see something with the shapes and colours, and made of the materials above?

11. Work in group. Describe an everyday object without saying what it is. Read out your description. Can the others guess what it is? If necessary, tell them also what it is for.

Grammar

12. Translate the sentences with Participle II:

Model: 1. The report written by an expert was of great interest. – *Доповідь, написана спеціалістом, представляла великий інтерес.* ***2. Written by an expert, the report could be trusted. –*** *Оскільки доповідь була написана спеціалістом, їй можна було вірити****. 3. If confirmed, these facts can be of great value. –*** *Якщо ці факти підтвердяться, вони можуть виявитися дуже цінними.* ***4. When offered help, they accepted it eagerly. –*** *Коли їм запропонували допомогу, вони прийняли її з готовністю.*

1. Science is knowledge arrange in an orderly manner. 2. Experiment is a test carried out to gain new knowledge. 3. The number of electronic computers used in any given field of human activity is an indication of the degree of its modernity. 4. Thinking expresses itself in words spoken or written. 5. If asked to assess the chances of victory in a war, the computer will analyse facts quite differently from a military expert. 6. When asked about the latest development in this African country, the UN spokesman gave a full account of the situation. 7. Asked to justify his belief, the scientist said that science is becoming an essential part of our everyday life.

13. Combine two simple sentences into one, using Participle II.

Model: The speaker refused to continue. He was infuriated by the interruptions. – Infuriated by the interruptions, the speaker refused to continue.

1. He decided to have some rest. He was exhausted by hard work. 2. We decided to go home. We were depressed by the news. 3. Art students fail to understand the importance of science. They are inclined to regard science only as the power behind mass production. 4. We changed the lines of our research. We were disappointed by the results. 5. The subject of the research was presented historically. It seemed to be more interesting.

14. Transform the following sentences, using Participle II.

Model: Though he was defeated, he remained a popular leader. – Though defeated, he remained a popular leader.

1. Though he was offered a large reward, he would not disclose the truth. 2. Though he was well-educated, he lacked any coherent philosophical background. 3. Although these publications remained unconfirmed, they stirred considerable unrest. 4. Though the explorers were exhausted by heat and privations, they would not give in.

15. Use the verb in brackets in the form of Participle I or Participle II:

1. Scientists (to deal) with the problems of pollution insist on its being exactly assessed. 2. The problem of pollution in industrial areas (to deal) with in this paper is one of the most important for modern science. 3. People (to use) force when it is not necessary cannot be justified. 4. Electronics computers (to use) in the research, saved the scientists a lot of time. 5. (To carry out) numerous experiments and tests, the scientists tried to prove the original hypothesis. 6. The experiments (to carry out) by a team of young scientists led to sensational results.