Researchers in Schools

Inflammation is swell – or is it?

Key Stage 4 Programme

Pupil Name

Coursebook Designed by Dr Sneezum

Contents

Uni Pathways launch event 4
Introduction to Uni Pathways 4
Pupils' experience of Uni Pathways 5
Virtual campus tours 5
Meet university students! 6
Reflection 6
Timetable and Assignment Submission 8
Timetable – Tutorials 8
Timetable – Homework Assignments 8
Assignment Submission – Lateness and Plagiarism 8
Course Rationale 9
Uni Pathways Mark Scheme 2020 10
Baseline Assignment: Pupil Feedback Report 12
Final Assignment: Pupil Feedback Report 13
Subject Vocabulary 14
Tutorial 1 – The world is full of many organisms 16
What is the Purpose of Tutorial 1? 16
Starter Activity – Who is MRS GREN? 16
Activity 1 – What's this course all about anyway? 17
Activity 2 – The five kingdoms of life, and viruses 17
Activity 3 – Microorganism: the clue is in the name 19
Homework – Baseline Assignment 20
Tutorial 2 – But not all organisms are friends 23
What is the Purpose of Tutorial 2? 23
Starter Activity – Quick Sketch! 23
Activity 1 – Pathogens: friend or foe? 24
Activity 2 – Is my dog a pathogen? 24
Activity 3 – Pathogen or disease? 24
Activity 4 – Communicable: like communicating a disease? 25
Homework 25
Tutorial 3 – The defence system of our body 27
What is the Purpose of Tutorial 3? 27
Starter Activity – Under attack! 27
Activity 1 – The immune system 27
Activity 2 – The first two lines of defence 28
Activity 3 – White blood cell soldiers 29
Homework 30
Tutorial 4 – Inflammation: what you see and what you don't 32
What is the Purpose of Tutorial 4? 32
Starter Activity – What's your favourite defence? 32
Activity 1 – Have you seen inflammation? 33
Activity 2 - Organisms, cells and molecules 33

Activity 3 - Inflammation from the cellular perspective 34
Homework 35
Tutorial 5 – Inflammation is a good thing, right? 37
What is the Purpose of Tutorial 5? 37
Starter Activity – Is life black or white? 37
Activity 1 - Are bacteria good or bad? 37
Activity 2 – Inflammatory diseases 38
Activity 3 – Controlling inflammation on the molecular level 38
Activity 4 – Referencing 39
Homework – Final Assignment 41
Tutorial 6 – Feedback tutorial 42
What is the Purpose of Tutorial 6? 42
Final assignment feedback from your Uni Pathways Teacher 42
Tutorial 7 – Final tutorial 44
Appendix 1 – The three lines of defence of the immune system 46
Appendix 2 - Independent research 48
Appendix 3 – Referencing correctly 49
How do I reference? 50
Figures 51
Notes 52

Uni Pathways launch event

Welcome to Uni Pathways! We are delighted to be able to launch the Uni Pathways programme with you. We hope that you are ready to embark on your Uni Pathways journey and that you enjoy the video.
You will be asked to pause the video at times to complete some work in this workbook, so make sure you have a pen / pencil to hand when you start the video.

By the end of the video, you will have:

- Learnt about what studying at university means
- Learnt about some of the skills that you will develop during Uni Pathways
- Heard from pupils who have participated in Uni Pathways or The Scholars Programme (which is the same programme!)
- Heard from current university students talking about what life is like at university

If you are in school your teacher will play the video. If you are at home and logged in to a session with your teacher, your teacher will play the video and show it to you. If you are participating independently your teacher will email you the link to the video or the video file. There are opportunities for you to answer some questions, and you will be told when to pause the video to answer them.

Introduction to Uni Pathways

1. Write down what you think a supra-activity is.

_____
_____
_____

2. Independent learning is

_____
_____
_____

3. Write down in your own words what resilience means, and come up with a different example to the one mentioned in the PowerPoint.

_____
_____
_____
_____

4. Why do you think analysis and evaluation skills are useful in your academic career?

_____
_____
_____
_____
_____

5. Why do you think analysis and evaluation skills are useful in life in general?

_____
_____
_____
_____
_____

6. What are the different types of learning that university students do?

Pupils' experience of Uni Pathways

You will now watch some pupils talk about their experience of learning a PhD topic and producing a final assignment. Some may refer to The Scholars Programme rather than Uni Pathways. As you heard in the introduction PowerPoint, The Scholars Programme is a very similar programme to Uni Pathways. Listen carefully and then respond to the questions below. Be prepared to share some of your responses with your peers.

1. How did the pupils describe talking about writing a long essay for their final assignment?

2. Write down something that one of the pupils mentioned was particularly interesting in their course.

3. What were some challenges that the pupils met?

Virtual campus tours

You will now go on a virtual tour of some universities! Once you have seen some of the university campuses, respond to the questions below.

1.Note down something that you liked out of any of the campus tours you saw. It may be a particular building, space, city etc.

2. Were there any similarities between the different university campuses? If so, what are the similarities?

3. If you had to pick one of those universities to go and visit in person, which one would it be and why?

4. Note down some of the societies that you could join at different universities

Meet university students!

You are about to virtually meet or hear from some current university students.
If you are virtually meeting them, think about what questions you would like to ask the students, share your questions with a partner and note those questions down in the space below.

If you are not meeting them but watching some videos that they have made, use the space below to note down what else you would like to find out about university. You can then ask your teacher during Uni Pathways tutorials!

Reflection

Congratulations on completing the launch of the Uni Pathways programme. Before you go, take some time to reflect on what you have learnt by answering the following questions:

1. Are there any aspects of university style learning that you would look forward to? If so, what are they?

2. What challenges do you think students face when learning at university? How would you try to overcome these challenges?

3. What skills do you hope to develop during your Uni Pathways course?

4. What part of Uni Pathways seems the most challenging for you?

5. What are you most looking forward to about Uni Pathways?

Timetable and Assignment Submission

Timetable – Tutorials

Tutorial	Date	Time	Location
1			
2			
3			
4			
5			
6 (Feedback)			
7 (Feedback)			

Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1	Baseline assignment	
Tutorial 2	Communicable and non-communicable diseases	
Tutorial 3	The three lines of defence of the immune system	
Tutorial 4	Independent research and assessing source reliability	
Tutorial 5	Final assignment	

Assignment Submission – Lateness and Plagiarism

Lateness	
Submission after midnight on 9th August	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Course Rationale

Have you ever noticed that when you get cut that your skin swells, goes red and gets hot? Have you ever popped a spot and seen that horrible gunky yellow stuff called pus that comes out? If you have, then you have watched the immune system in action!

Human beings live in this world alongside many other living things such as plants and animals, as well as many microscopic organisms that we can't see with the naked eye. These microorganisms include bacteria and viruses. Many of these microorganisms don't harm us and some even benefit us, but some can infect us and cause disease. These are called pathogens.

The immune system is how our body protects itself against these pathogens. The immune system contains specialised cells called white blood cells which act like the soldiers of our body. When we get cut, the white blood cell soldiers rush to the site of the cut to kill any entering pathogens. This recruitment of cells is what causes the redness, swelling and heat that we see. This process is called inflammation.

Inflammation is necessary for us to be able to fight pathogens and stop us from getting sick or even dying. However, inflammation is a double-edged sword. If it isn't properly controlled it can also lead to diseases such as arthritis.

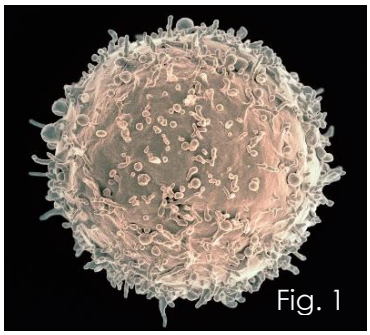


Fig. 1

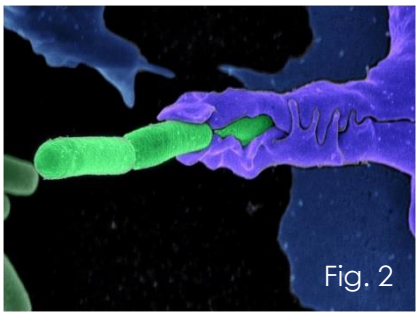


Fig. 2

Fig. 3

In this course, you are going to learn about what different types of pathogens there are and how the immune system is able to protect us from them. You will learn what inflammation is and be able to describe it on the organismal, cellular and molecular levels. You will also be able to describe how inflammation can be harmful for our health, why it is therefore crucial to properly control it and how it can be controlled at the molecular level.

This course will be taught in the style of university tutorials. The final assignment will be similar to how you would receive assignments at university and will be marked using a university-style grading system.

The overall aims of this course are to:

- Understand what the immune system and inflammation are and be able to describe them on an organismal, cellular and molecular level
- Be able to argue why inflammation is a double-edged sword
- Develop transferable skills of critical analysis, independent research, scientific writing and forming arguments using examples
- Experience University-style teaching and marking to give you an idea of what it would be like to progress into further education

Uni Pathways Mark Scheme 2020

	Subject Knowledge	Critical Thinking	Written Communication
1st	The work shows a depth of knowledge and understanding of key concepts and scientific methods, through engaging with relevant sources. Knowledge is used to build and support highly effective scientific arguments and explanations.	Analyses key scientific evidence, arguments, and reasoning. Interprets meaning and makes connections. Identifies and critically evaluates key scientific arguments and evidence, deciding on their credibility, strength, and relative significance, drawing convincing conclusions.	The work has a coherent flow and is well structured. The writing style is appropriate; scientific language and key scientific terms are used accurately and effectively to support the arguments and explanations made. There are no, or very few, errors in spelling or grammar. Consistent referencing, appropriate paragraphing and use of correctly labelled tables and graphs matching the style taught in the course.
2:1	The work shows an understanding of key concepts and scientific methods, drawing on relevant sources. Knowledge is used to build and support effective scientific arguments and explanations.	Analyses relevant scientific evidence, arguments, and reasoning. Identifies and critically evaluates relevant scientific arguments and evidence, deciding on their credibility and strength, drawing reasonable conclusions. Shows some understanding of the relative value of evidence and arguments.	The work is well-structured. The writing style is appropriate; scientific language and key terms are used correctly. There are few errors in spelling or grammar. Mostly consistent referencing and use of tables and figures; matching the style taught in the course.
2:2	The work shows an understanding of key concepts and scientific methods, with no major misconceptions. Beginning to apply this knowledge to build and support effective scientific arguments and explanations.	Identifies and uses basic scientific evidence, arguments, and reasoning. Showing some understanding of the quality of scientific arguments and evidence. Not yet showing understanding of the relative value of evidence and arguments.	The work has some structure. The writing style can sometimes be informal; occasionally scientific language and key terms are not used when it would be appropriate to do so. There are some errors in grammar and spelling do not get in the way of communicating the content. Referencing has some consistency; matching the style taught in the course Limited use of tables and graphs.
3rd	Shows a developing understanding of key concepts and scientific methods, with some misconceptions.	Beginning to analyse scientific evidence, arguments, and reasoning.	The grammar, spelling, style, and structure of the work need improving in order

	Does not yet apply this knowledge to build and support scientific arguments and explanations.	Describes evidence and arguments, while not yet evaluating them.	to communicate ideas to the reader. Scientific language, key terms and references are not always used correctly. Limited, or no use of tables and graphs.

Baseline Assignment: Pupil Feedback Report

Name of Pupil	
Name of School	Broadoak Academy
Name of RIS teacher	Dr Sneezum
Title of Assignment	

How your assignment is graded:

Grade	Marks	What this means
1st	70+	Performing to an excellent standard at A-level
2:1	60-69	Performing to a good standard at A-level
2:2	50-59	Performing to an excellent standard at GCSE
3rd	40-49	Performing to a good standard at GCSE
Working towards a pass	0-39	Performing below a good standard at GCSE
Did not submit	DNS	No assignment received by The Brilliant Club

Lateness	
Any lateness	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Marks

OVERALL MARK / 100		FINAL MARK / 100 (including any deductions)	
DEDUCTED MARKS		FINAL GRADE	

If marks have been deducted (e.g. late submission, plagiarism) the teacher should give an explanation in this section:

Mark Breakdown and Feedback

Subject knowledge	
	mark
Critical thinking	
	mark
Written communication	
	mark

Final Assignment: Pupil Feedback Report

Name of Pupil	
Name of School	Broadoak Academy
Name of RIS teacher	Dr Sneezum
Title of Assignment	

How your assignment is graded:

Grade	Marks	What this means
1st	70+	Performing to an excellent standard at A-level
2:1	60-69	Performing to a good standard at A-level
2:2	50-59	Performing to an excellent standard at GCSE
3rd	40-49	Performing to a good standard at GCSE
Working towards a pass	0-39	Performing below a good standard at GCSE
Did not submit	DNS	No assignment received by The Brilliant Club

Lateness	
Any lateness	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Marks

OVERALL MARK / 100		FINAL MARK / 100 (including any deductions)	
DEDUCTED MARKS		FINAL GRADE	

If marks have been deducted (e.g. late submission, plagiarism) the teacher should give an explanation in this section:

Mark Breakdown and Feedback

Subject knowledge	
	mark
Critical thinking	
	mark
Written communication	
	mark

Subject Vocabulary

Word	Definition	In a sentence
Organism	Any individual living entity	
Microorganism	A very small living thing that can only be seen under the microscope	
Pathogen	A microorganism that causes disease	
Communicable disease	Diseases which can be passed from one human to another	
Non-communicable disease	Diseases which cannot be transferred between people or organisms	
Immune system	The body's defence system against entry of any foreign body, including pathogens and agents such as pollen grains. The role of the immune system is to prevent disease	
Phagocyte	A type of immune cell which digests invading microorganisms	
Phagocytosis	The process by which phagocytes digest invading microorganisms	
Lymphocyte	A type of immune cell which produces antibodies	
Antibody	A protein released by lymphocytes which binds to specific antigens	
Inflammation	A process of the immune system which involves the recruitment and activation of immune cells at a specific site to clear pathogens and heal wounds	

Tutorial 1 – The world is full of many organisms

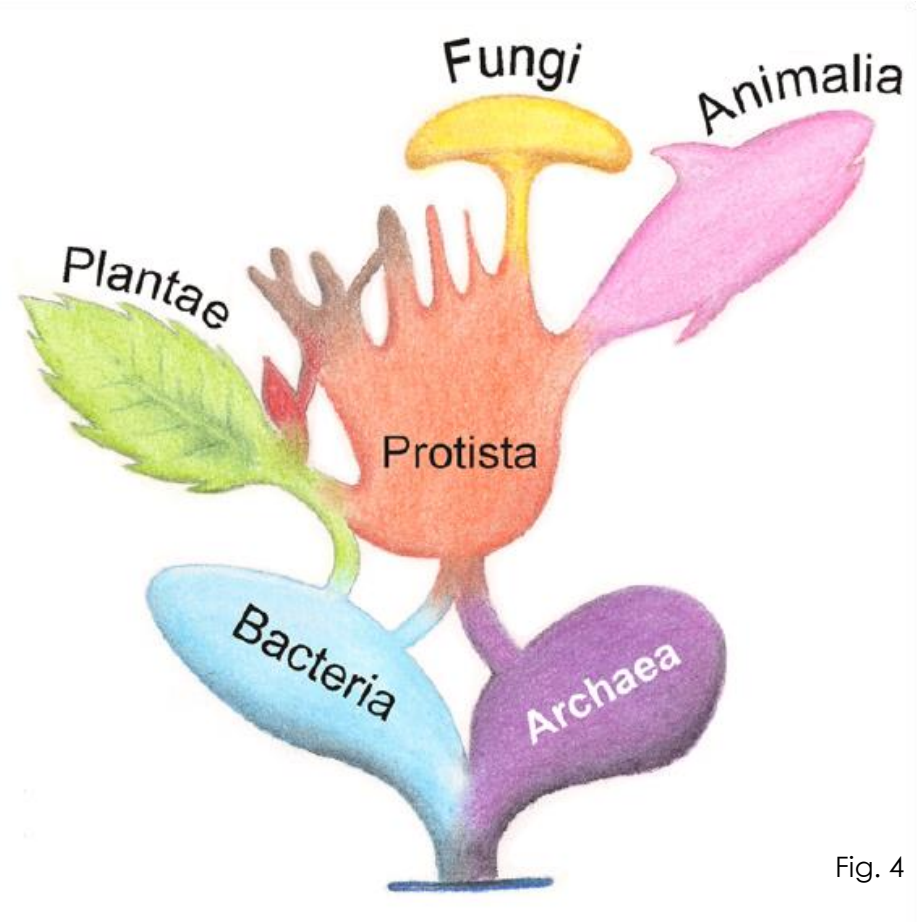


Fig. 4

What is the Purpose of Tutorial 1?

This tutorial will first give an overview on what this course is all about – a teaser if you like. Then we'll go into the six main types of different living things that humans share this planet with, including those that we can't even see with the naked eye.

Learning objectives:

- I can summarise what will be covered in this Uni Pathways Course
- I can list and describe the 5 kingdoms of life plus viruses
- I can define a microorganism

Starter Activity – Who is MRS GREN?

Complete the mnemonic that describes the 7 characteristics of living organisms

M _____

R _____

S _____

G _____

R _____

E _____

N _____

Activity 1 – What's this course all about anyway?

After the presentation, write down two sentences summarising what this Uni Pathways course will cover

Activity 2 – The five kingdoms of life, and viruses

Complete the tables:

	ANIMAL	**PLANT**
Plural		
Examples		
Description		

Microorganism?		

	FUNGUS	**BACTERIUM**
Plural		
Examples		
Description		
Microorganism?		

	PROTIST	VIRUS
Plural		
Examples		
Description		
Microorganism?		

Activity 3 – Microorganism: the clue is in the name

Write down the definition of a microorganism in your own words:

Homework – Baseline Assignment

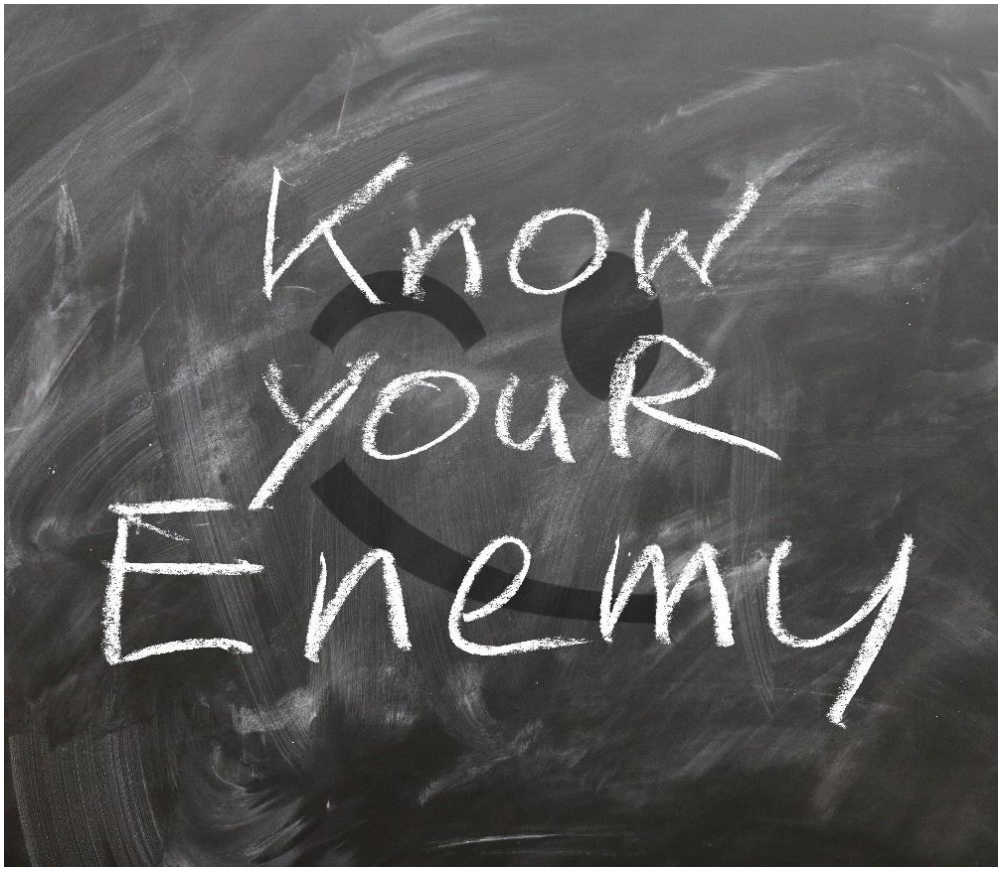
Write 400 – 500 words to answer the following questions:

1. **Start with a brief introduction which describes what organisms are by listing the 7 characteristics of living things (HINT: MRS GREN)**
2. **Describe the 5 kingdoms of living organisms and viruses:**
    a. **State whether they are microorganisms**
    b. **Include at least one example of each**
    c. **Describe how they are different from each other based on their cellular structure and in relation to MRS GREN**
3. **Discuss whether a virus is a living thing. Using the characteristics of MRS GREN, provide arguments both for and against and finish with your own opinion.**
4. **With viruses and the current pandemic included in your answer:**
    a. **What is the defence system of the body called?**
    b. **Why do you think it's important that we have this defence system?**
    c. **Can you think of any reason how it might be bad for us?**

Make sure to:

- Organise your writing into paragraphs (hint: each question can be one paragraph)
- Link each paragraph together
- Write in full sentences
- Use independent research, stating the source of your information in brackets

Tutorial 2 – But not all organisms are friends



What is the Purpose of Tutorial 2?

This tutorial is all about disease. Last tutorial we learnt about microorganisms: many of these are harmless, or can even benefit us, but some cause disease – you might have heard these be referred to as something along the lines of "nasty bugs". However, humans can get diseases in other ways and we will look into that too.

Learning objectives:

- I can define a pathogen
- I can distinguish the difference between a pathogen and a disease
- I can explain the difference between a communicable and a non-communicable disease

Starter Activity – Quick Sketch!

Do a 30 second sketch of each of the living organisms we looked at last tutorial

ANIMAL	PLANT	FUNGUS	BACTERIUM	PROTIST	VIRUS

Activity 1 – Pathogens: friend or foe?

Write down one sentence describing what a pathogen is

Activity 2 – Is my dog a pathogen?

Write down whether the following organisms can be pathogens

Animals	
Plants	
Bacteria	
Fungi	
Protists	
Viruses	

Activity 3 – Pathogen or disease?

Pair the cards and stick in to complete the table

PATHOGEN	DISEASE

Activity 4 – Communicable: like communicating a disease?

Write down the difference between a communicable and a non-communicable disease

Homework

Use independent research to write 200 - 300 words to address the following:

- **Description of communicable and non-communicable diseases**
- **Three examples of each type of disease, including their causes and main symptoms**
- **Explain the five main types of disease transmission for communicable diseases**

Tutorial 3 – The defence system of our body

What is the Purpose of Tutorial 3?

All these pathogens can sound scary but fortunately our body has a defence system in place to protect us against them. This tutorial will be all about this defence system, which is called the immune system, and how it is split into three different lines of defence.

Learning objectives:

- I can understand what the immune system is
- I can build an image of the immune system using physical barriers, chemical barriers and cells
- I can differentiate between phagocytes and lymphocytes

Starter Activity – Under attack!

Imagine that something was coming to attack your home. List three different types of defences you could put in place to protect yourself.

Activity 1 – The immune system

Following the presentation, write down a one-sentence description of the immune system in your own words

Activity 2 – The first two lines of defence

Fill in the boxes below: write down a description and examples on the right-hand side, and make a representative drawing on the left-hand side

PHYSICAL BARRIERS	
Description	
Examples	

CHEMICAL BARRIERS	
Description	
Examples	

Activity 3 – White blood cell soldiers

Make a drawing of a phagocyte and a lymphocyte on the left-hand side and write three bullet points describing each cell-type on the right-hand side

PHAGOCYTES	
LYMPHOCYTES	

Homework

Appendix 1 contains information about the three lines of defence of the immune system that we learnt about in the tutorial. Use this information as well as independent research to write 200 - 300 words to:

Describe in detail the three lines of defence of the immune system, including at least three different organs and two types of white blood cell. Choose one pathogen and discuss how they can enter the human body (transmission) but what immune system defences are in place to stop them.

Tutorial 4 – Inflammation: what you see and what you don't

Fig. 5

What is the Purpose of Tutorial 4?

Inflammation is one of the cool biological processes that we can actually see with the naked eye, but there is a lot going on that we can't see. This tutorial is all about how inflammation looks on the organismal, the cellular and the molecular levels.

- I can name the three characteristics of inflammation on the organismal level
- I can describe inflammation on the cellular level
- I can explain how inflammation is coordinated on the molecular level

Starter Activity – What's your favourite defence?

Based on your homework from last tutorial and appendix 1, write down which line of defence of the body is your favourite and why

Activity 1 – Have you seen inflammation?

In pairs, write down anything you have seen on your body about inflammation in the box below (hint: what happens when you get cut?)

Write down the three characteristics of inflammation on the organismal level

Activity 2 - Organisms, cells and molecules

Explain what it means to describe something on the organismal level

Explain what it means to describe something on the cellular level

Explain what it means to describe something on the molecular level

Activity 3 - Inflammation from the cellular perspective

Fill in the flow chart with text and diagrams to explain each step

Homework

Using Appendix 2 and independent research, write 200 – 300 words to address the following:

- **Write one sentence explaining what independent research is**
- **List 5 different sources of information that could be used for independent research**
- **Explain what you think it means to assess the reliability of a source**
- **Give two examples of reliable sources and explain why you think they are reliable**
- **Give two examples of unreliable sources and explain why you think they are unreliable**

Tutorial 5 – Inflammation is a good thing, right?

What is the Purpose of Tutorial 5?

The immune system and inflammation protect us against pathogens and disease, and without them we would not be alive for very long at all. However, like many things in biology, they aren't only good. This tutorial is about how inflammation can also be detrimental to human health. We will also prepare for the final assignment by looking into referencing.

Learning objectives:

- I can argue why inflammation is a double-edged sword with the use of examples
- I can describe how inflammation is controlled at the molecular level, using one named protein
- I can reference my written work using websites, papers and books

Starter Activity – Is life black or white?

In pairs, think of two examples where something can be either good or bad, depending on the context

1.

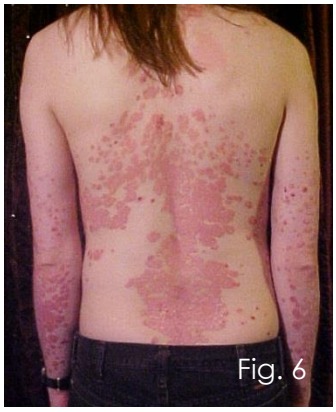
2.

Activity 1 - Are bacteria good or bad?

Describe the difference between pathogenic and commensal bacteria

Activity 2 – Inflammatory diseases

Write down the name of the inflammation-associated disease and the organ they affect:

Fig. 3	Disease
	Affected organ
 Fig. 6	Disease
	Affected organ
Fig. 7	Disease
	Affected organ

Activity 3 – Controlling inflammation on the molecular level

What is one protein that is crucial to control inflammation?

How do we know this?

What does this protein do?

Activity 4 – Referencing

1. Summarise the following except from the given website including a reference

https://www.bbc.co.uk/news/health-54296223

'Long Covid': Why are some people not recovering?

By James Gallagher
Health and science correspondent

For most people, Covid-19 is a brief and mild disease but some are left struggling with symptoms including lasting fatigue, persistent pain and breathlessness for months.

The condition known as "long Covid" is having a debilitating effect on people's lives, and stories of being left exhausted after even a short walk are now common.

Complete the bibliography:

_____, "'Long Covid': Why are some people _____

_____", https://www.bbc.co.uk/news/_____

[11 October 2020]

2. Summarise the following except from the given paper including a reference

Context-Dependent IL-1 mRNA-Destabilization by TTP Prevents Dysregulation of Immune Homeostasis Under Steady State Conditions

Lucy Sneezum[1], Kevin Eislmayr[1], Helene Dworak[1], Vitaly Sedlyarov[1], Anita Le Heron[1], Florian Ebner[1], Irmgard Fischer[1], Yoichiro Iwakura[2] and Pavel Kovarik[1]*

In agreement with the role of TTP in destabilization of inflammatory mRNAs, $TTP^{-/-}$ mice are born healthy but develop progressive and eventually lethal, pleiotropic inflammation: the so called "TTP deficiency syndrome"

Complete the bibliography:

_____ et al, "Context-dependent IL-1 mRNA destabilisation by _____

_____ Immune Homeostasis Under Steady State

Conditions", *Frontiers of Immunology*, 2020

Homework – Final Assignment

Write 2000 words to answer the following question:

Why is inflammation a double-edged sword?

In your essay, include the following:

- An introduction which briefly and concisely describes what will be covered in the essay
- An overview of what the immune system is and why we need one, including:
  - A definition of a pathogen
  - Four different types of pathogens with at least one example of each and the disease they cause
  - The three lines of defence of the immune system
- A description of inflammation at the organismal, cellular and molecular levels
- An explanation of how inflammation is controlled at the molecular level, including one named protein and the experimental evidence for its involvement
- Why inflammation can be described as a double-edged sword
- Discuss how something being good or bad depending on the context is a common phenomenon in biology, providing two additional examples within biology and health
- A conclusion summarising the main points of the essay

Success criteria for final assignment

I understand:	I am able to:
• The different types of pathogens and how the immune system is able to protect us against infection • What inflammation is on the organismal and cellular level, and how it is controlled at the molecular level • How one thing can be both harmful or beneficial to health depending on the context	• Write a well-structured essay including an introduction and a conclusion • Use knowledge and examples to argue both sides of an argument • Do independent research, assess the reliability of a source and reference literature

- Your essay is structured with subheadings, including an introduction and a conclusion that clearly and concisely introduces and summarises the main ideas of the paper
- You have made use of key words from the glossary and provided definitions
- You have found at least two articles in your own research and have used and correctly referenced to them, as well as commented on their reliability if necessary
- You have checked your spelling and grammar

Tutorial 6 – Feedback tutorial

What is the Purpose of Tutorial 6?

- To receive feedback on your final assignment
- To respond to the feedback from your Uni Pathways teacher
- To write targets for improvement on your final assignment

Final assignment feedback from your Uni Pathways Teacher

(Remember to look at the mark scheme to help you understand what you have done well so far, and how you can do even better in your final assignment)

Here are three things that my Uni Pathways Teacher thought I did well in my draft assignment
•   •   •

Here are three things that my Uni Pathways Teacher thinks that I could do to get a higher mark in my final assignment
•   •   •

Tasks from my Uni Pathways Teacher to do during the feedback tutorial to help me improve
•   •   •
My response:

Actions I will take to improve my final assignment after this tutorial…
•   •   •

Hand in date for my final assignment:	

Tutorial 7 – Final tutorial

What is the Purpose of Tutorial 7?

- To receive feedback and a grade on your final assignment.
- To reflect on the programme including what you enjoyed and what was challenging.
- To ask any questions you may have about university.

Final assignment feedback from my Uni Pathways Teacher

Final mark:	University style grade:
Feedback: Here are three things that my Uni Pathways teacher thought I did well in my final assignment • • •	

Here are three things that my Uni Pathways teacher thinks I should remember for when I am doing this kind of study in the future
• • •

University

What questions do you still have about University after taking part in Uni Pathways?
•   •   •

Reflecting on Uni Pathways

What did you most enjoy about Uni Pathways?
•   •   •

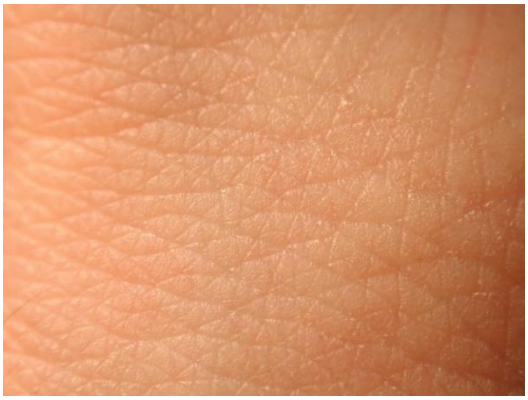
What did you find challenging about the programme?	How did you overcome these challenges?
• • •	• • •

Appendix 1 – The three lines of defence of the immune system

For a human army to be successful in war, they will build many different lines of defence. Their land will be protected by walls and fences, soldiers will be on guard and they might even lay booby traps. If an enemy manages to break through these protections, soldiers will be ready for combat. The defence system of our body, the immune system, is very similar. It consists of three lines of defence.

The first two lines of defence: physical and chemical barriers
Physical barriers are there to physically prevent pathogens from getting through, or they make it very hard to do so. Chemical barriers are often present at physical barriers and they work by reacting with substances in the pathogens to either kill them or make them inactive.

The skin: sebum and sweat



The skin is actually an organ! The skin itself is a barrier to physical damage, microbe infection and dehydration. Sebaceous glands in the dermis secrete sebum (an oily substance which helps keep skin pliable), but is also acidic which lowers the pH of the skin and consequently inhibits the growth of some types of bacteria. Sweat is also a defence mechanism as it contains salts and enzymes which make it difficult for bacteria to inhabit the skins surface.

The eye: eyelashes, blinking and tears

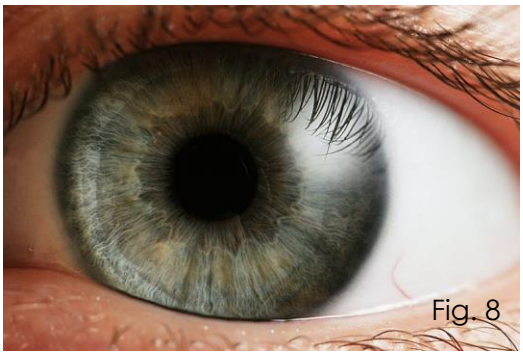


Fig. 8

The eyelashes and eyelids act as physical barriers blocking entry to the mucous membrane of the eye (the conjunctiva). Any airborne microorganisms that manage to make it past these barriers will be flushed out blinking. Blinking also bathes the eye in tears which contain chemicals called lysozymes which are enzymes that destroy bacterial cells.

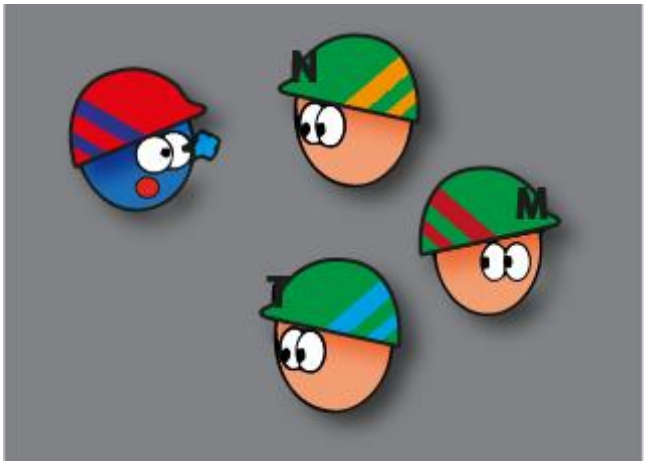
The stomach: hydrochloric acid

Glands in the wall of the stomach produce hydrochloric acid which makes the pH of the stomach very acidic and kills some bacteria present in food and drink. However, not all bacteria are killed by stomach acid, especially bacteria present in contaminated meat and dairy products.

The respiratory system: mucus and cilia

The nose, mouth and lungs are lined with mucous membranes: layers of epithelial cells which secrete mucus. Mucus functions to trap small particles including microorganisms which are then moved out of the respiratory tract by cilia. The mucus is then expelled by sneezing or coughing, or is swallowed and destroyed in the stomach. Internal hairs within the nose additionally act as a physical barrier to large particles.

The final line of defence: leukocytes



White blood cells, also called leukocytes, are the final line of defence of the immune system. There are two main types of leukocytes called phagocytes and lymphocytes. Phagocytes get their name because they phagocytose pathogens – this is the process whereby the phagocyte's membrane binds to the pathogen and surrounds it, eventually engulfing the pathogen into the cell. There, it uses enzymes to destroy the pathogen. Lymphocytes do not phagocytose pathogens but instead recognise proteins on their surfaces called antigens. The lymphocytes use the information from the antigen to release antibodies specific to that antigen which are also therefore specific to that pathogen. Released antibodies bind to the surface of pathogens, a mechanism which has two functions: 1) it marks the pathogens for destruction which improves the rate of phagocytosis by phagocytes and 2) it neutralises the pathogen, which means that covering the pathogen in antibodies prevents it from causing disease.

Appendix 2 - Independent research

What is independent research?
A lot of university work relies on undertaking independent research – on a simple level, this is a fancy way of saying finding out something for yourself, without the teacher telling you the answer explicitly. In modern society, we have access to information everywhere – it's basically impossible to go even an hour without seeing some unless you quite literally live under a rock. It's on TV, it's in books, it's on the radio, it's on your phone, it's on billboards and the sides of buses and pamphlets through your door and – the big one – the internet. The internet is its own universe where information is laid at your fingertips in the form of social media, blogs, search engines, articles, news sites, online encyclopaedias and so on. Therefore, doing independent research is really easy right, you just look it up on the internet?

Can you trust everything you read?
The problem with this, however, is that of course not everything on the internet is true. The procedure of doing independent research also implies that you only use reliable sources (and that you reference them, see appendix 3). But why would a source be unreliable? There is one main reason for this – that the person who is giving you that information (no matter the medium) stands to gain something if you believe what they are telling you. This is more often than not for financial gain – either directly if you, the consumer, then consequently buys a product, or indirectly, such as the more clicks on their article they get, the more likely they are to get more writing work or a promotion.

Why can we know if a source is reliable?
The best way to know if a source is reliable or not is to check whether it has been peer-reviewed. Information in biological research science is shared through journals, such as Nature and Science, and for work to be published in these journals, they have to be peer-reviewed. This means that other experts in the same field critically look at the work to make a judgement about whether they believe the data justifies the conclusions drawn – and it can only be published if they agree that it does.

What sources can I use?
At university, you will use peer-reviewed primary research articles and reviews in journals to inform your writing. The best search engine for finding such papers in biology is PubMed (https://pubmed.ncbi.nlm.nih.gov/) which only searches databases of peer-reviewed papers. Wikipedia is a source used by many but because every page can be edited by anyone, any information you find on Wikipedia needs to be fact-checked in sources you can trust – for instance by finding a paper through PubMed. Wikipedia helps you out, because it lists references that can initiate your independent research, but you should never reference Wikipedia articles.

Sources you are encouraged to use in your final assignment:

- BBC Bitesize
- BBC News articles – if you make a comment on its reliability (hint: check author)
- Peer-reviews articles or reviews (found using PubMed)

Sources you should not use in your final assignment:

- Social media
- Wikipedia
- Any website where you cannot check the reliability of the author

Appendix 3 – Referencing correctly

When you get to university, you will need to include references in the assignments that you write, so we would like you to start getting into the habit of referencing in your Brilliant Club assignment. This is really important, because it will help you to avoid plagiarism. Plagiarism is when you take someone else's work or ideas and pass them off as your own. Whether plagiarism is deliberate or accidental, the consequences can be severe. In order to avoid losing marks in your final assignment, or even failing, you must be careful to reference your sources correctly.

What is a reference?

A reference is just a note in your assignment which says if you have referred to or been influenced by another source such as book, website or article. For example, if you use the internet to research a particular subject, and you want to include a specific piece of information from this website, you will need to reference it.

Why should I reference?

Referencing is important in your work for the following reasons:

- It gives credit to the authors of any sources you have referred to or been influenced by.
- It supports the arguments you make in your assignments.
- It demonstrates the variety of sources you have used.
- It helps to prevent you losing marks, or failing, due to plagiarism.

When should you use a reference?

You should use a reference when you:

- Quote directly from another source.
- Summarise or rephrase another piece of work.
- Include a specific statistic or fact from a source.

How do I reference?

There are a number of different ways of referencing, and these often vary depending on what subject you are studying. The most important to thing is to be consistent. This means that you need to stick to the same system throughout your whole assignment. Here is a basic system of referencing that you can use, which consists of the following two parts:

1. **A marker in your assignment**: After you have used a reference in your assignment (you have read something and included it in your work as a quote, or re-written it your own words) you should mark this is in your text with a number, e.g. [1]. The next time you use a reference you should use the next number, e.g. [2].

2. **Bibliography**: This is just a list of the references you have used in your assignment. In the bibliography, you list your references by the numbers you have used, and include as much information as you have about the reference. The list below gives what should be included for different sources.

    a. **Websites** – Author (if possible), title of the web page, website address, [date you accessed it, in square brackets].

    E.g. Dan Snow, 'How did so many soldiers survive the trenches?', http://www.bbc.co.uk/guides/z3kgjxs#zg2dtfr [11 July 2014].

    b. **Books** – Author, date published, title of book (in italics), pages where the information came from.

    E.g. S. Dubner and S. Levitt, (2006) *Freakonomics*, 7-9.

    c. **Articles and papers** – Author, 'title of the article' (with quotation marks), *where the article comes from* (newspaper, journal etc.), date of the article.

    E.g. Maev Kennedy, 'The lights to go out across the UK to mark First World War's centenary', Guardian, 10 July 2014

Figures

1. "Human B Lymphocyte" by NIAID is licensed under CC BY 2.0, https://www.flickr.com/photos/54591706@N02/29122039942
2. "Anthrax bacteria (green) being swallowed by an immune system cell" by ZEISS Microscopy is licensed under CC BY-NC-ND 2.0, https://www.flickr.com/photos/75834543@N06/14255824790
3. "gouty hand arthritis" by handarmdoc is licensed under CC BY 2.0, https://www.flickr.com/photos/65036744@N07/9209626057
4. Adapted from "Phylogenetic-symbiogenetic tree of living organisms" by Maulucioni y Doridi, licensed under CC BY-SA 3.0, https://commons.wikimedia.org/wiki/File:Tree_of_Living_Organisms_2.png
5. "Fire" by Elena Penkova is licensed under CC BY-NC-SA 2.0, https://www.flickr.com/photos/126710094@N04/16767529578
6. "Psoriasis on back" by User:The Wednesday Island (of the English Wikipedia) is licensed under CC BY-SA 3.0, https://commons.wikimedia.org/wiki/File:Psoriasis_on_back.jpg
7. "Current State (July 2006)" by FatMandy is licensed under CC BY-NC-ND 2.0, https://www.flickr.com/photos/35723943@N00/183178455
8. "Human eye" by Petr Novák is licensed under CC BY-SA 2.5, https://commons.wikimedia.org/wiki/File:Eye_iris.jpg

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