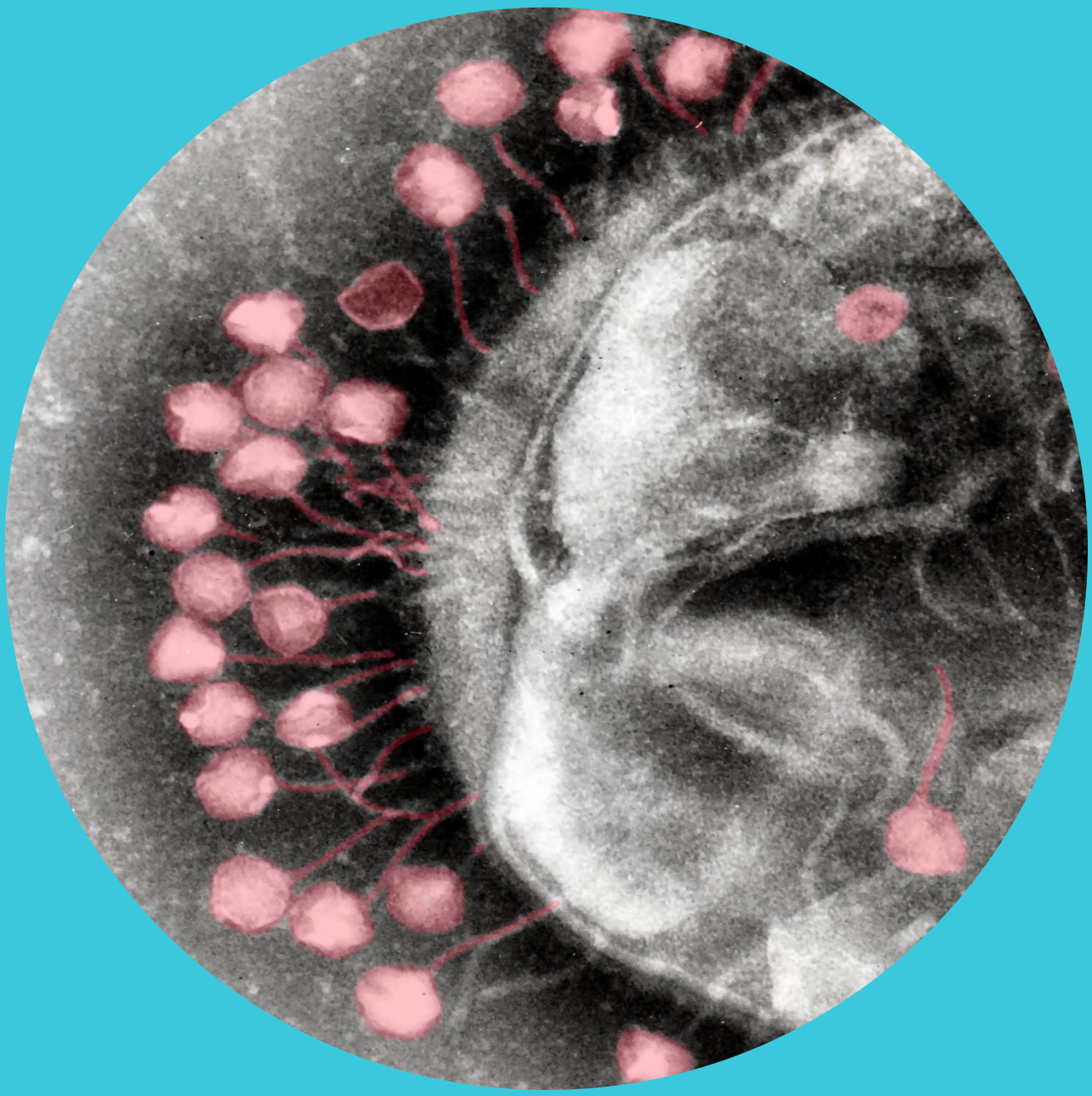
Researchers in Schools



How can viruses help us?

Key Stage 4 Programme

Pupil Name

Coursebook Designed by **Dr. Hargreaves**

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 Assessment	
Tutorial 2	"Hexagon" a phage infection cycle.	
Tutorial 3	A useful phage	
Tutorial 4	DNA from scratch: making a "man-made" bacterium.	
Tutorial 5	Final Assessment	

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

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Course Rationale

Microbial life is too small to see, however the impacts of microbes, such as bacteria and viruses, have on own life are massive!

We typically think of bacteria and viruses as being bad for our health because they can cause infections. Think of the last time you had a tickly cough or runny nose. Usually, our bodies can fight the bacteria that cause infections by themselves, but sometimes more serious infections need special drugs, called antibiotics, to kill the bacteria.

However, bacteria that used to be able to be killed by antibiotics have become "Superbugs" – gaining a "super power" to survive. This resistance to antibiotics is a major challenge we face in today's world. Scientists and healthcare professionals are working on new ways to prevent or treat infections. And, surprisingly, of these ways is by using viruses.

So, how do we find viruses? What makes a useful virus? Why do we need to check if they are safe to use in humans? This course will give an introduction to microbial diversity, bacteria and viruses. We will learn about scientific techniques to work with viruses and explore how bacterial viruses could be used to treat bacterial infections.

The course will be taught in the style of university tutorials and the final assignment will be similar to that you would be set at university. You will learn how to work with experimental datasets as well as to write a scientific essay based on what you have learnt during the course.

Course Objectives

- To understand how important microorganisms are in our world.
- To evaluate the need for new treatments against bacteria and how viruses may be used.
- To work scientifically and develop transferable skills in critical thinking, communication and analytical skills.
- To experience university style teaching and give you an idea of what it would be like for study at higher education.

Uni Pathways Mark Scheme 2019 – problem-set assignments

	Skills	1st (70-100)	2:1 (60-69)	2:2 (50-59)	3rd (40-49)	Mark /100
Subject knowledge	Knowledge and understanding	o All content included and materials used are relevant to the general topic and to the specific question/title o Good understanding of all the relevant topics. o Technical terms are defined and used accurately throughout o Clear justification of how the material and content included is related to the specific issues that are the focus of the assignment	o Most of the content included is relevant to the general topic and to the specific question/title o Good understanding of most the relevant topics o Technical terms are used accurately but not always clearly defined. o Adequate justification of how the content included is related to the specific issues that are the focus of the assignment	o Some of the content included is relevant to the general topic and to the specific question/title o Good understanding on some of the relevant topics but occasional confusion on others. o Scientific terms are used mostly accurately with occasional confusion and often not defined. o Some justification on how the content included is related to the specific issues that are the focus of the assignment	o The content included and materials used are not applied to the question/title in a relevant manner o There is confusion in how understanding of the topics is expressed	
Critical thinking	Research and evidence	o Uses evidence/calculations to support claims/assertions/ideas, consistently clearly and convincingly o Data is effectively analysed, and appropriate assumptions/conclusions are reached o Includes rich sources of research findings, data, quotations or other sourced material as evidence for the claims/ideas	o Uses evidence/calculations to support claims/assertions/ideas, mostly clearly and convincingly o Data is analysed and the assumptions/conclusions that are reached are mostly appropriate o Includes adequate sources of research findings, data, quotations or other sourced material as evidence for the claims/ideas	o Uses evidence/calculations to support claims/assertions/ideas, at times clearly and convincingly o There is an attempt to analyse data is and draw assumptions/conclusions o Includes some sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas	o Data is presented largely without analysis	
	Developing an argument	o Argument/proof is <u>exceptionally</u> well-developed and well-justified o Uses content from the tutorials in an unfamiliar context and does so accurately and confidently.	o Argument/proof is <u>clear and well-developed,</u> and position is justified o Uses some content from the tutorials in an unfamiliar context, but not always accurately	o Argument/proof is <u>clear but not well-developed</u> o Limited use of content from the tutorials in other contexts	o Sometimes the argument/proof is not clearly established o Limited use of content from the tutorial and often inaccurately	
	Critical evaluation	o Effectively critiques the problem set and effectively establishes a thorough response to it	o Some evidence of critiquing the problem set and establishes a reasonable response to it	o Limited evidence of critiquing the problem set and establishes a response to it that has some coherence	o The problem is explored in the work but without explanation	
Wri tte	Structure and presentation	o Ideas are presented in paragraphs and arranged in a logical structure that is appropriate for the	o Ideas are presented in paragraphs and arranged in a structure that is mostly appropriate for the	o Ideas are presented in paragraphs and arranged in a structure o The introduction mentions how the	o Ideas are presented in paragraphs but there is a lack of structure in	

		assignment o The introduction clearly outlines how the essay/report will deal with the issues o The conclusion summarises all the main points clearly and concisely o All calculations, formulas and methods are clearly structured, clear to follow and correct o Tables and graphs are effectively constructed including appropriate headings, units and scales. o All sources are referenced correctly in an agreed format	assignment o The introduction adequately describes how the essay/report will deal with the issues o The conclusion summarises most of the main points clearly o Calculations, formulas and methods are mostly structured, clear to follow and correct o Most tables and graphs are well constructed o Most sources are referenced correctly in an agreed format	essay/report will deal with the issues o The conclusion summarises some of the main points clearly o Calculations, formulas and methods are not always structured, clear to follow and correct. o Some tables and graphs are well constructed but contains some errors o Some sources are referenced correctly in the agreed format with occasional errors	how the work is presented o The work lacks an introduction that establishes the scope of the question o The work lacks a conclusion that summarise the main points raised o Work is not referenced accurately	
	Language and style	o <u>No</u> spelling, grammar or punctuation errors o Writing style <u>consistently</u> clear, tone appropriate and easy to follow o <u>Accurate and consistent use of technical language</u> and vocabulary	o <u>Minimal</u> spelling, grammar or punctuation errors o Writing style <u>mostly</u> clear, tone appropriate and easy to follow o <u>Some attempts of using technical language</u> and vocab alary, but not always accurate	o <u>Some</u> spelling, grammar or punctuation errors o Writing style <u>moderately</u> clear, tone appropriate and easy to follow o Use of <u>simple language and vocabulary</u> effectively but struggles to use technical language	o There are a significant number of spelling, grammar and punctuation errors o Use of <u>simple language and vocabulary</u> effectively but a lack of technical language	

Overall Mark for written element (average of the 6 marks from the criteria above)/100	
	+
Problem Set mark/100	
	÷ 2
Final mark/100	

Baseline Assignment (problem-set): Pupil Feedback Report

Name of Pupil	
Name of School	
Name of RIS teacher	
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

Knowledge and Understanding		Research and Evidence	
	mark		*mark*
Developing an Argument		**Critical Evaluation**	
	mark		*mark*
Structure and Presentation		**Language and Style**	
	mark		*mark*

Problem Set	
Comment	*mark*

Final Assignment (problem-set): Pupil Feedback Report

Name of Pupil	
Name of School	
Name of RIS teacher	
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	
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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

Knowledge and Understanding		Research and Evidence	
	mark		*mark*
Developing an Argument		**Critical Evaluation**	
	mark		*mark*
Structure and Presentation		**Language and Style**	
	mark		*mark*
Problem Set			
			mark

Subject Vocabulary

Word	Definition	In a sentence
Microorganism	Small (micro) life form (organism) which is typically too small to be seen by eye.	
Bacterium (plural bacteria)	A member of a large group of single celled microorganisms.	
Pathogen	A microorganism which can cause disease in humans, plants or animals.	
Virus (plural viruses)	Considered microorganisms because they are too small to be seen by eye but is not strictly alive. It has to take over cells in order to make more copies of itself.	
Bacteriophage	A type of virus which infects and destroys bacteria. "Bacterio" meaning bacteria and "phage" meaning eating.	
Antibiotic resistance	When the normal antibiotics used to treat an infection, no longer work to kill the bacteria causing the infection.	
Evolve	Permanent changes to a living organism over time incorporated in their genetic material.	
Genome	The genome of an organism is the entire genetic material of that organism.	
DNA	The genetic material in the nucleus of a cell is composed of a chemical called DNA. DNA is a polymer made up of two strands forming a double helix. A DNA strand is made up of four molecules, adenosine (A), cytosine (C), tyrosine (T) and guanine (G).	
Gene	A short section of the genome which codes for a protein.	
Phage Therapy	Using bacteriophages (phage) as a treatment (therapy).	

Bacterial culture	Bacteria grown under controlled conditions.	
Bacterial colony	Bacterial growth from a single cell into many cells from this first cell, on a surface.	
Plaque	A hole in a bacterial culture that shows a zone of killing caused by viruses.	
Viral host range	The different types of bacteria that a virus is able to infect.	
Endolysin	A protein that is produced by the virus during cell infection, which digests the cell wall leading to cell death.	

Tutorial 1 – the invisible world around us

What is the Purpose of Tutorial 1?

Tutorial Objectives
By the end of this tutorial I will be able to…

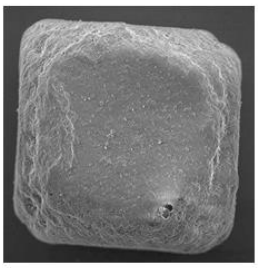
- Describe what a microorganism is and how varied microbial life is.
- Explain what occurs during an infection.
- Explore what contributes to antibiotic resistance.

Starter. What connects these three images?

Discuss in the group and choose your top answer.

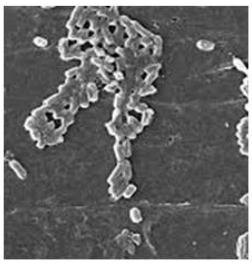
Activity 1. So what exactly are microorganisms?

Identify the microorganisms in the following images.

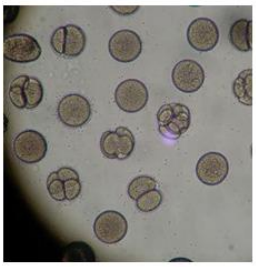


Grain of salt

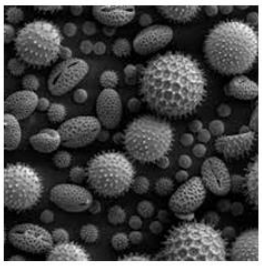
Viruses



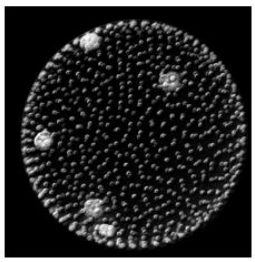
Bacteria



Sea urchin eggs



Pollen



Algae

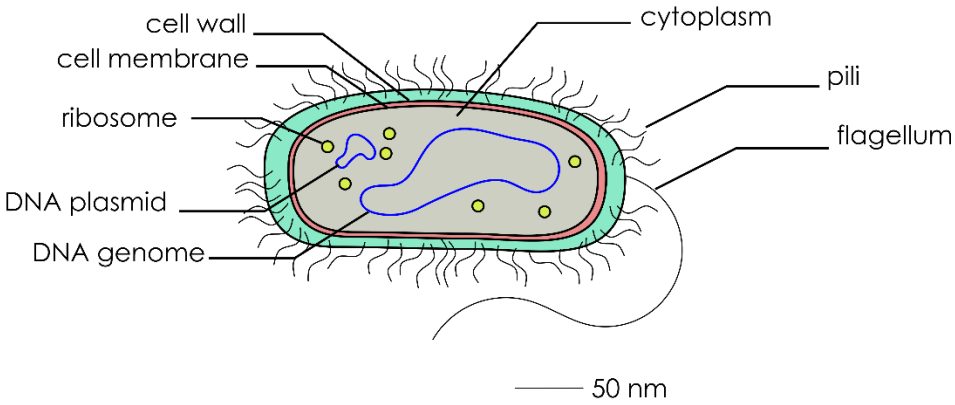
Are all microbes bad?

In pairs, discuss any examples you know. Be prepared to share this with the group.

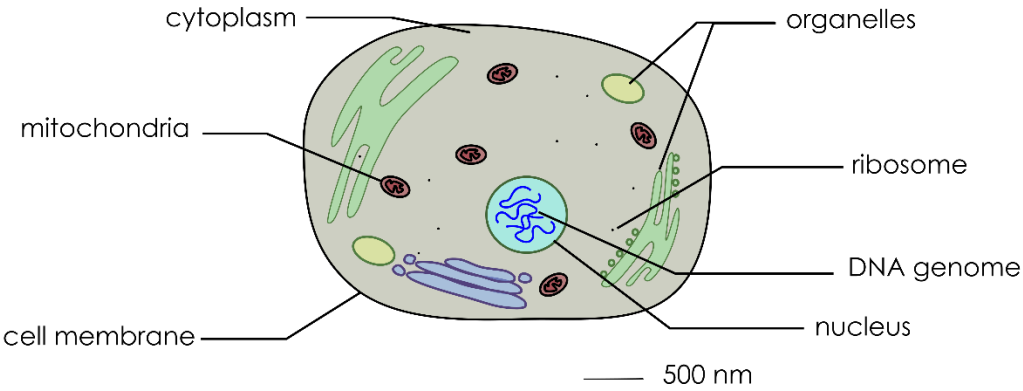
Activity 2. Infection…a growing problem.

Bacteria are prokaryotes, meaning their cells are very different from our own body cells, which are eukaryotic cells. Highlight differences between the two cell types.

Bacterial cell

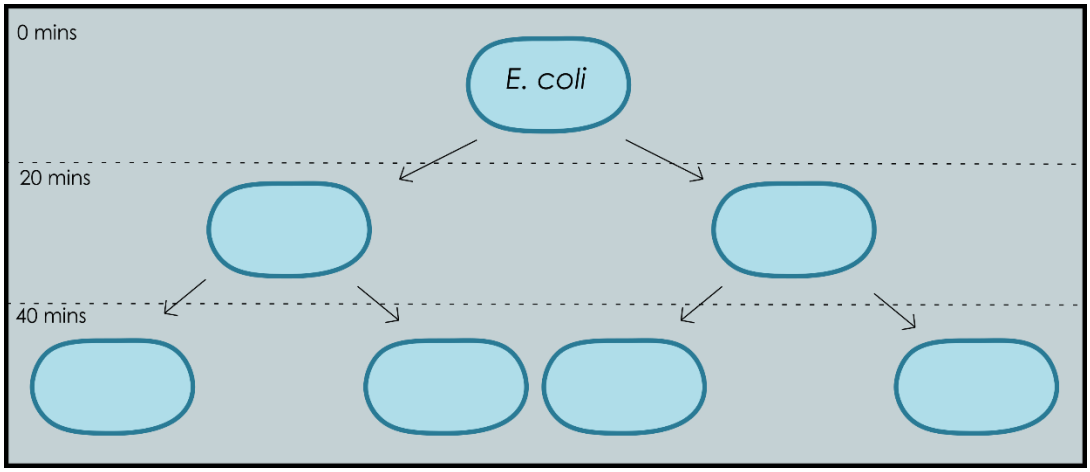


Animal cell



Bacteria divide by binary fission. This means each cell divides into two daughter cells every round of replication.

An *E. coli* cell divides about once every 20 minutes.



If a patient was infected with one bacterium, how many bacteria would there be after 24 hours?

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An *E.coli* cell weighs $9.5e^{-13}$ g.

The average weight of an adult person is 62 kg.

What would be the weight of the extra bacterial cells after a day's growth?

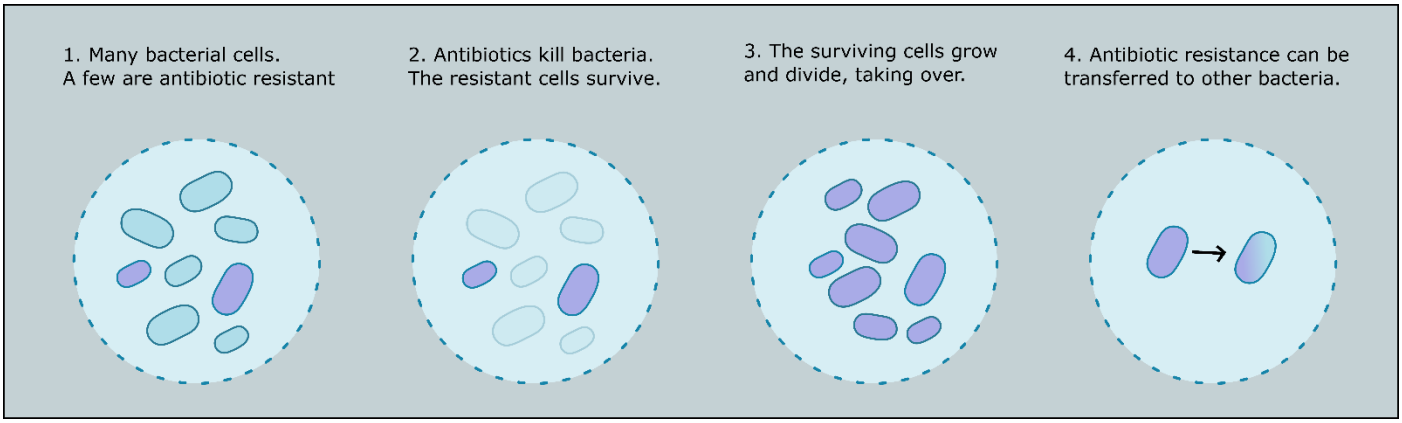
.....

In pairs, order the card statements to follow an infection timeline.

Here, write a number from 1-7 in the box by the corresponding statement, with 1 being the first stage.

Order (1-7)	Infection stages.
	The bacteria replicate, and may release toxins.
	The host's immune response defends against infection or, antibiotics are taken.
	Bacteria spread through the body to their sites of infection.
	Disease symptoms appear in the host.
	The bacteria incubate, taking some time to be ready to grow and replicate.
	The bacteria enter (are transmitted) to the human host.
	The numbers of bacterial cells are reduced and the infection ends.

Activity 3. How do bacteria become superbugs?



Read the follow excerpt from an article reviewing antibiotic resistance. Highlight any words you don't recognise.

"Antibiotics are medicines used to prevent and treat bacterial infections. Antibiotic resistance occurs when bacteria change in response to the use of these medicines. Bacteria, not humans or animals, become antibiotic-resistant. These bacteria may infect humans and animals, and the infections they cause are harder to treat than those caused by non-resistant bacteria. Antibiotic resistance leads to higher medical costs, prolonged hospital stays, and increased mortality."

Write down one result of antibiotic resistance and explain why this a problem.

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The EU monitors when bacteria infections are no longer treated by antibiotics. They provide reports on all this data to help shape policies for healthcare bodies.

The following data is taken directly from the EU report on antibiotic resistant *E. coli* infections.

	2014			2015			2016			2017		
Antibiotics groups	# of Isolates tested	% resistant	# of Isolates tested	# of Isolates tested	% resistant	# of Isolates tested	# of Isolates tested	% resistant	# of Isolates tested	# of Isolates tested	% resistant	# of Isolates tested
Group 1.	83863	25.4		90137	24.8		124306	25.2		138652	25.7	
Group 2	73881	58.5		77813	58.9		107838	59		122955	58.7	
Group 3	85092	14.2		90126	14.6		123087	14.9		137677	14.9	
Group 4	84015	11.3		90050	11.6		123625	11.6		138883	11.4	
Group 5	81776	0.1		86487	0.2		121774	0.1		137728	0.1	

We want to know how many isolates are resistant to antibiotics.

We can work this out by calculating the percentage of resistant bacterial isolates from the total numbers of isolates tested.

So for antibiotics group 1 in 2014 we calculate (25.4/100) x 83,863 = 21,301

How many isolates are resistant to group 1 antibiotics in 2015?

.....

What is the percentage change in the number of isolates resistant between the two years?

To do this, find the difference between in the number of isolates in 2014 and 2015.
Divide this difference by the first number of isolates in year 2014.
Times this number by 100 to give you the percentage change.

.....

Baseline assignment title: Is antibiotic resistance a threat to today's world?

Baseline assignment instructions:

1) Use the dataset to produce a graph charting the incidence of antibiotic resistance for two different antibiotics between years. You will need to convert the percent of resistant isolates to the number of isolates.

2) In a paragraph, explain the findings from this dataset and evaluate the most urgent threat.

3) Using the report published by the WHO to write a report to discuss if antibiotic resistance is a threat around the world. Provide examples to support your reasoning. (250-300 words)

Include three potential ways we can address the problem of antibiotic resistance in your essay.

Baseline assignment success criteria:

- To produce a scientific graph with correct labelling and data points
- To describe and evaluate findings from the graph
- To summarise, evaluate and evidence information from research reading
- To use scientific terminology and keywords in your writing

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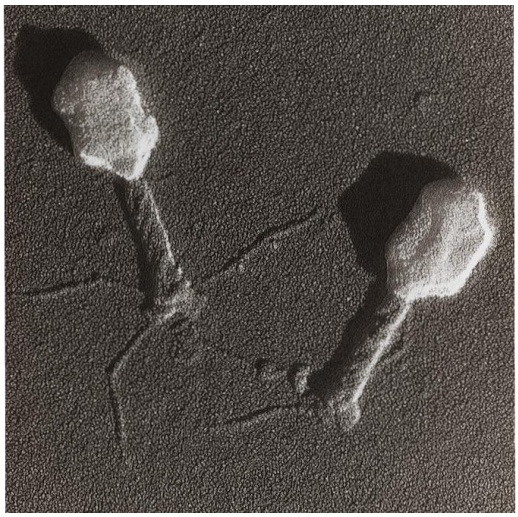
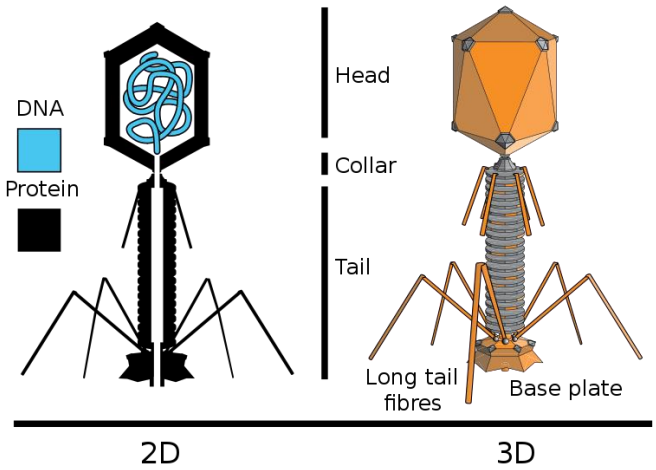
Tutorial 2 – Bacteriophages…. some assembly required.





What is the Purpose of Tutorial 2?

Tutorial Objectives
By the end of this tutorial I will be able to…

- Explain what a bacteriophage is.
- Describe what a phage is made of.
- Explain the phage infection cycle.

Starter. It's all relative (and very small).

Sort the microorganisms into size order.

Use the relative size scale guide to help you correct this order if needed. Write down the largest microorganism and the smallest.

Largest …… Smallest ……..

Activity 1: What is a bacteriophage?

Write an explanation of what a bacteriophage is.

……

Write down one reason why bacteriophages do not infect human body cells.

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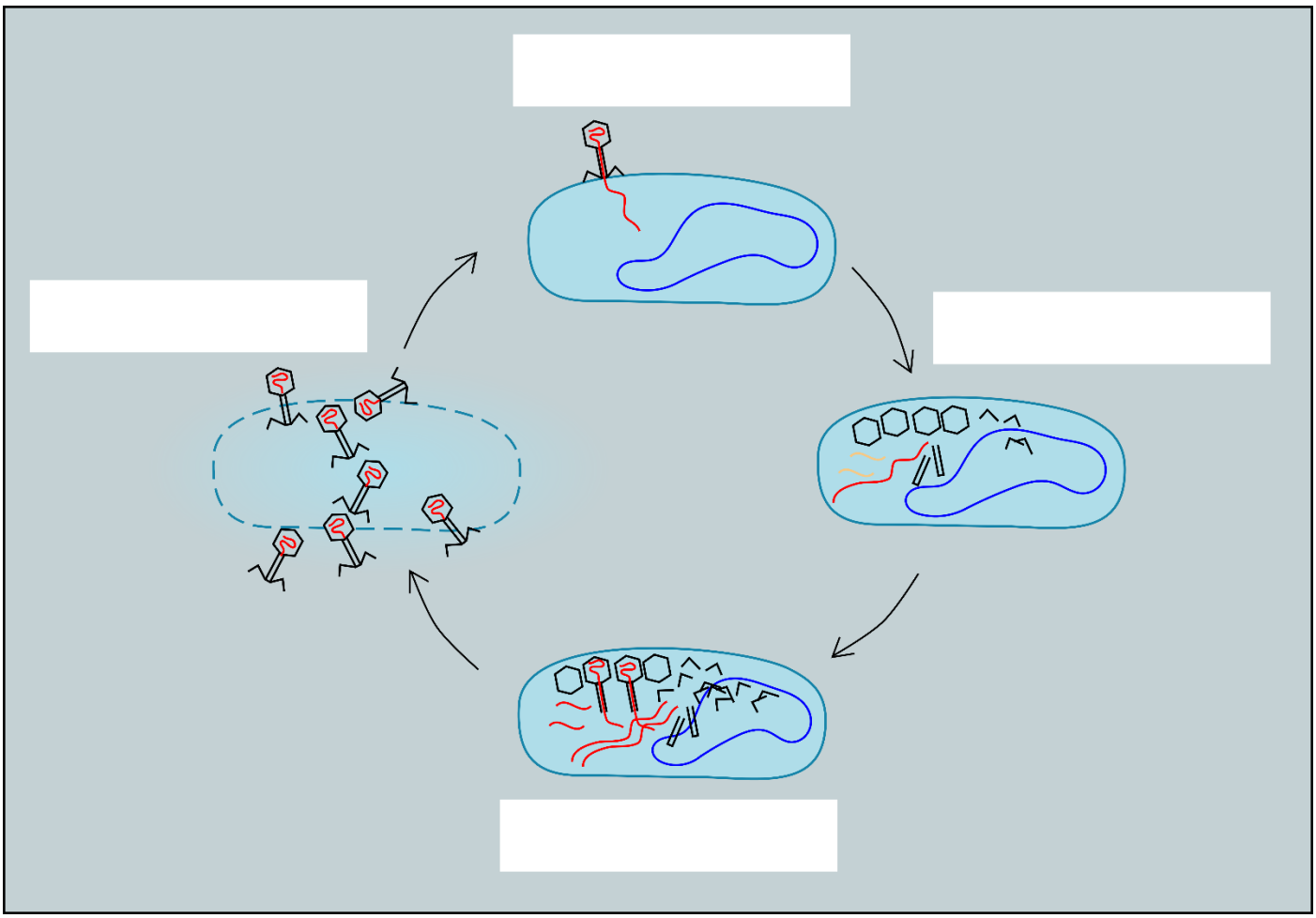
……
……

Activity 2: The phage infection cycle.



Make notes during the phage infection cycle about what happens at key points during the cycle.

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Match up the stages of the phage infection cycle with the microscope photographs (micrographs)

1. Phage attaching to a bacterial cell.
2. The phage DNA genome is inserted into the bacterial cell.
3. Normal bacterial cell functions stop as the phage performs a host takeover, with proteins from the phage genome being made.
4. The cell becomes a viral factory with the production of virus particle proteins.
5. The viral particles begin to assemble.
6. The phage DNA genome is replicated inside the cell and then is packaged into the virion particles.
7. Specific phage proteins called endolysins work to destroy the bacterial cell wall.
8. The bacterial cell lyses and new phage particles are released into the environment.

Stick in the micrographs in their correct order.

Activity 3: Build-a-phage

Follow the guide to make your very own paper phage. Labe blue post-its and stick on the phage with the structural names.

Capsid

Collar

Tail

Tail fibers

Labe yellow post-its and stick on the phage with

Where the DNA genome is contained.

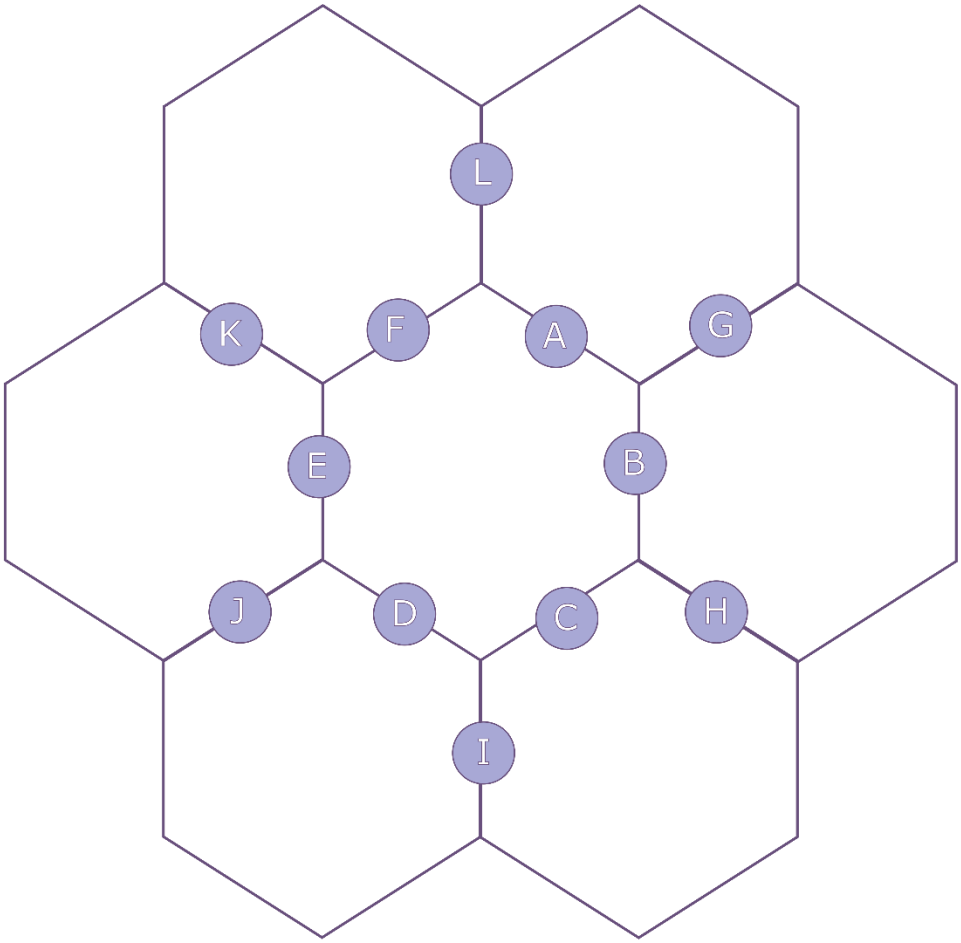
Where attaches to the bacterial cell.

Homework title: “Hexagon” a phage infection cycle.

Homework instructions: Think of key words associated Include the key words bacterial cell, attachment, lysis, replicate, genome, takeover and endolsyin.

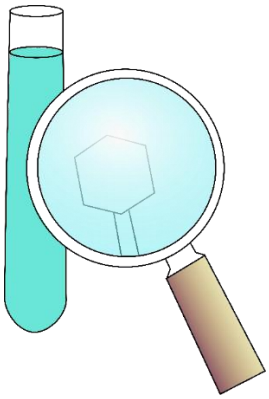
Homework success criteria:

- Use key terminology and explain connections
- Synthesis information from tutorial 1 and 2



A	E	I
B	F	J
C	G	K
D	H	L

Tutorial 3 – Finding a new phage.



What is the Purpose of Tutorial 3?

By the end of this tutorial I will be able to…

- Explain how phages are isolated for target bacteria.
- Perform calculations to work out CFU/ml.
- Analyse host range data to identify the most "useful" phage.

Starter: Where to start looking?

Bacteriophage can be thought of as predators of bacteria, their prey. This can be helpful when figuring out where we should look to find new phages.

A researcher has isolated an antibiotic resistant *E. coli* strain from a patient in hospital. Knowing that phages prey on bacteria, where might the scientist find phages?

……
……
……

Activity 1: Phage isolation flow chart.

Together as a group, you will use the resources to put together a flow chart for the steps a scientist would take to isolate and work with a new phage.

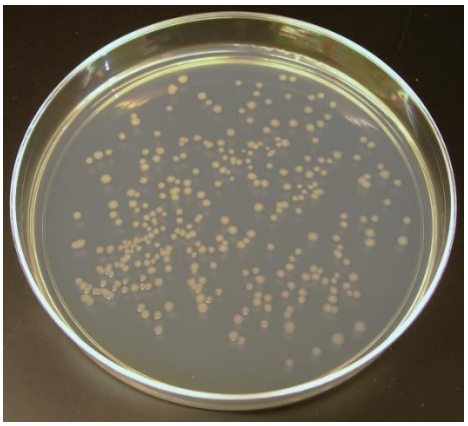
Activity 2: Characterising the phage.

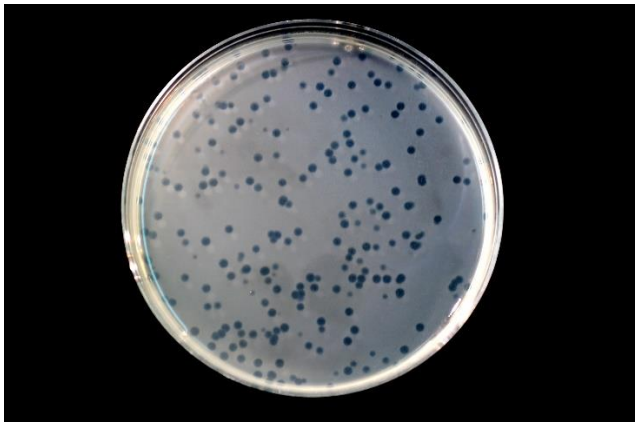
Once a scientist has their new phage, there starts the important task of characterising the phage. Characterising means finding out what type of phage it is, how well it grows (or kills) different bacteria, and how stable it is in different conditions, such as at different temperatures and pH.

Here, we will look at a particular phage's ability to kill bacteria. First, the phage and bacteria are mixed together and then left to grow. The growth of the phage can depend on how well the bacteria grow.

Over time, there will be a reduction in the number of bacteria if the phage is killing them when they are grown together. We can see this by different methods, one is by "plating" out the bacteria and counting how many cells are in the culture, after they grow and make colonies.

Alternatively, we can work out how many phage are growing in the culture, by taking samples from the experiment and plating the phage on to "lawns" of new bacteria on a petri dish.





On the left is a petri dish with bacterial colonies, and on the right is a petri dish with phage plaques.

Do they look the same to you? What is different?

……
……

Counting colonies and calculating CFU (colony forming units).

To calculate the colony forming units from a petri dish, we first count how many colonies there on the plate. Then we multiply this number based on the volume.

Colonies x sample volume = CFU

So if we had a petri dish with 25 colonies on it, and we had used 1 ml of the bacterial culture to plate on the petri dish

25 x 1 = 25 CFU/ml

However, this method often requires another step, which is to dilute the bacterial culture before plating. This is because, as we have learnt, bacterial cells can grow quickly and become millions in a short space of time. There would be too many to count without first diluting the sample in order to get individual cells on the petri dish.

The formula to calculate CFU then is added to include this dilution.

(Colonies x sample volume)/dilution factor = CFU

For example if the sample was diluted 100 times, we would calculate (25 x 1)*100 = 2500 CFU/ml.

We would then use standard form to write the data as 2.5×10^3 CFU/ml.

An experiment was set up to grow bacteria and sample every 10 minutes:

Time (min)	Petri dish	Number of colonies	Volume plated (ml)	Dilution factor	CFU/ml
0	A	32	1	10	
10	B	16	1	100	
20	C	26	1	1000	

What happens to the CFU/ml over the time?

……
……
……

Homework title: A useful phage

Homework instructions: Plot a series of graphs to chart the bacterial killing curves for 2 different phages. Based on the results, evaluate which phage may be the most effective as a therapy. Be prepared to justify your answer in the next tutorial.

A laboratory has sent over to us a set of results for different phages killing *E. coli*. These experiments were done on the same day, over the course of the day.

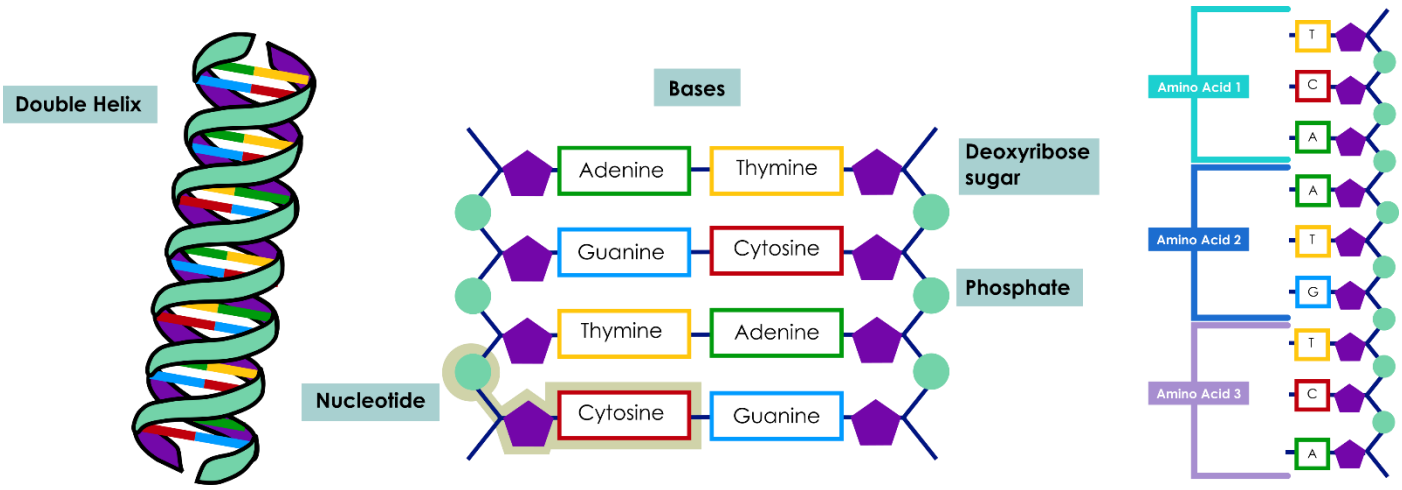
We also have a set of data from a control which is only bacteria with no phage added.

We can plot the data to compare what happens to the bacteria with no phage, and when we add phage.

Homework success criteria:

- To produce a scientific graph with correct labelling and data points
- To describe and evaluate findings from the graph (100 words).

Tutorial 4 – What's in a genome?



What is the Purpose of Tutorial 4?

Tutorial Objectives

By the end of this tutorial I will be able to…

- Explain what a genome is made from.
- Analyse a DNA sequence.
- Determine the predicted protein for an unknown gene.
- Search a genome for specific protein encoding genes.

Starter: We have our phage… what next?

As a group, discuss the findings from your homework assignment. Which phage would be the best candidate to use in new treatment? Be ready to justify your decision.

Activity 1: The genome - cracking the code.

A gene is a small section of DNA. Each gene codes for a particular sequence of amino acids, to make a specific protein.

DNA contains four bases, A, C, G and T.

A sequence of three bases is the code for a particular amino acid. The order of bases controls the order in which amino acids are assembled to produce a particular protein.

There are 20 different types of amino acid. Each amino acid is coded for in the DNA by sets of three bases, called a codon.

Here is part the DNA sequence which codes for a phage capsid protein.

ATGACTTTGGCATAA

Write out the first five codons.

1.

2.

3.

4.

5.

There are 20 amino acids, but there are 64 possible codons from the 4 bases. This means there are some codons which code for the same amino acid. The term for this is redundancy in the genetic code.

Use the codon wheel to determine the corresponding amino acid for the five codons that you identified.

1.

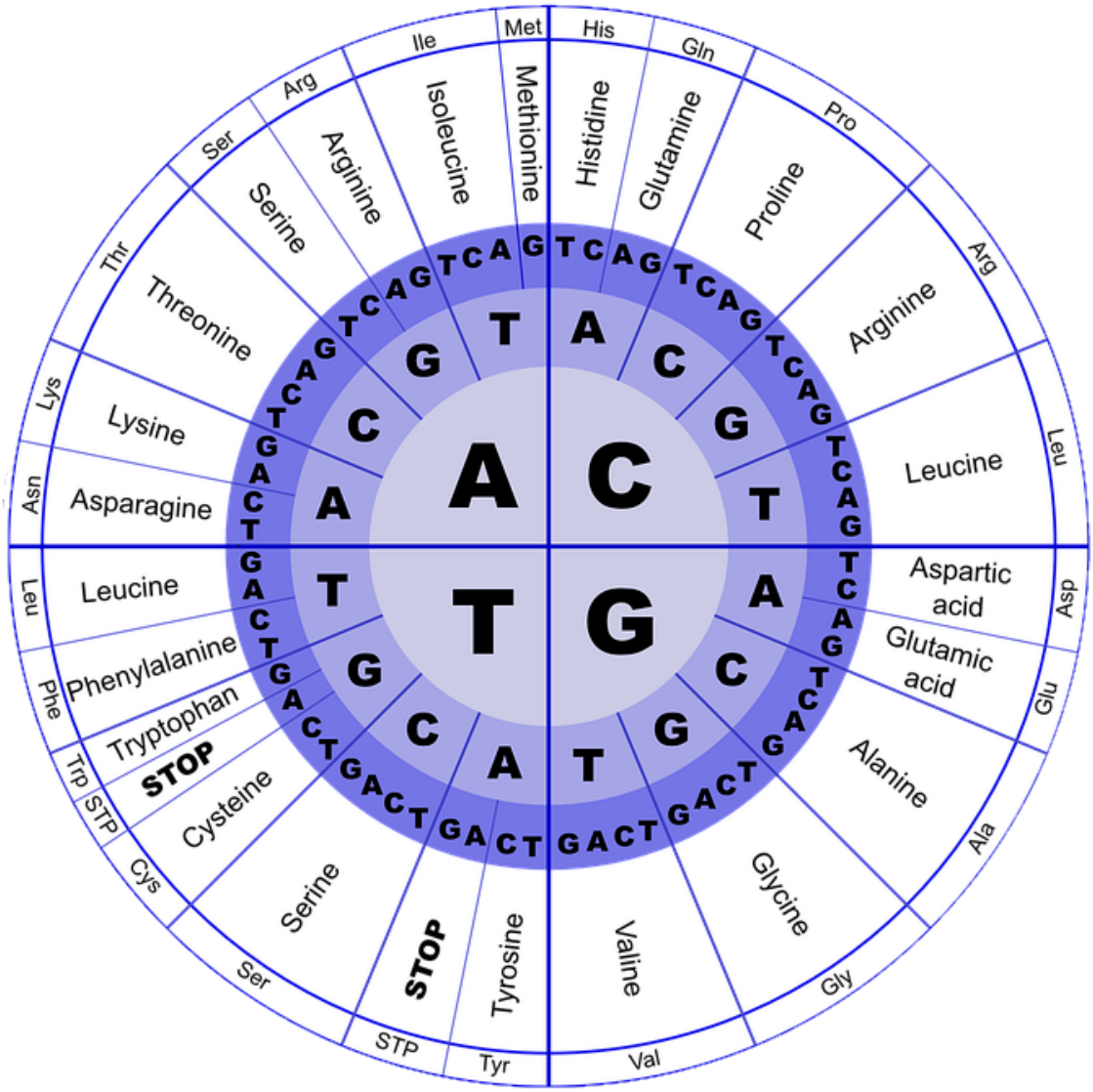
2.

3.

4.

5.

Could any of the amino acids identified be coded for using a different codon?



Activity 2: Genome sequencing.

Based on your knowledge of what makes up a phage, and what happens during an infection cycle, can you predict one protein that might be encoded for in a phage genome?

.....

Finding similarity.

Researchers analyse genomes with the help of computers and large data bases.
The first step of DNA sequencing is to send the DNA molecule for sequencing. This is done using different methods, but all result in a file that contains the DNA sequence made up of A, C, T and G letters to represent the four bases.

Genes have start and stop positions, and these are used to predict all the potential genes in a DNA sequence.

Scientists can then search the gene sequence to previously sequenced and published genes in a database. This predicts what protein the DNA codes for based on what is known from the matching

sequences. Matches are made based on similarity to the DNA sequences, and are assigned scores based on the likelihood of this match occurring.

We will use the public database of genomes hosted by the American National Institute for Heath at https://www.ncbi.nlm.nih.gov.

This database contains all the published sequences for organisms, not just viruses.

We have our sequenced phage genome, and gene sequences have been identified using a computer programme.

We do not know what these sequences might code for yet.

It's your job to search the database and find the best prediction.

Gene sequence 1.
……..

Gene sequence 2.
……..

Activity 3: Genome explorers.

Can you find a phage capsid protein?

Can you find the phage endolysin protein?

Homework title: DNA from scratch: making a “man-made” bacterium.

Homework instructions:
Scientists have been trying to produce entirely human-made genomes with the help of computers over the past decade in order to understand the basics of what a cell needs to grow and function.

Using the article, evaluate how useful making a synthetic bacteria could be.

In your answer, describe what the scientists did and include at least one reason why this is useful and one reason why there is more work to be done for this to be used to understand how a cell works. Include in your answer the question why all the letters of the DNA code could not be replaced, referencing the redundancy in the genetic code.

Tutorial 5 – Hero viruses – are we there yet?

Tutorial Objectives

By the end of this tutorial I will be able to…

- Describe what processes a new medicine needs to go through before being approved for use in clinics.
- Analyse why a phage treatment would be the same or different to a new medicine.
- Understand what patents are and why there is controversy around patents and research.

Starter: from test tube to patient.

In the group, think of three things that we should consider when wanting to bring a new medicine the clinic?

Write them on post-its and rank them by what you think is the most important. Can they be ranked easily?

Activity 1: Getting a new antibiotic to the clinic.

Modern drugs have to be carefully tested for both safety and efficacy. The rights of those involved in the testing must be considered, as well as the reliability of the test results.

In this activity you are given a list of the procedures that need to take place, from the discovery of a new substance to be tested, to the marketing of a drug passed as safe for prescription. You have to put these procedures in the right order and then to match a reason to each stage.

1. Cut up the table on worksheet 2.

2. Discuss in your group to decide on the correct order for these stages. Place the 13 stages on paper in the order in which they would take place.

3. When you have decided on the order check that you have the correct order.

4. Stick the stages in the left hand column of the table in worksheet 1.

5. Now discuss the reasons for each stage and place the cut up 'reasons for development' from worksheet 3 in the correct position in the second column.
Discuss with your group, and check before you stick these in.

Activity 2: Phages in the clinic – the story so far.

While watching this video, make notes about any key steps that either the patient or medical doctor spoke about that made using phages an option in this case.

Why did the doctor use phages to treat the patient?
……
……
……
……
Find three ways in which this case is different or the same when using a new medicine for patients.

1)……
……

2)……
……

3)……
……

Activity 3: Who pays for phages?

It takes a great deal of investment from business and science researchers to work on new medicines. There is a financial incentive for producing a new treatment that works, and could be sold to healthcare bodies.

New inventions can be patented by individuals or companies, and this includes medicines. It also includes other areas of research when there is new way to use something in existence but these cases can be controversial.

Read the following passage about patenting a gene. Highlight any words or ideas you aren't sure about their meaning.

Can genes be patented?

A gene patent is the exclusive rights to a specific sequence of DNA (a gene) given by a government to the individual, organization, or corporation who claims to have first identified the gene. Once granted a gene patent, the holder of the patent dictates how the gene can be used, in both commercial settings, such as clinical genetic testing, and in non-commercial settings, including research, for 20 years from the date of the patent. Gene patents have often resulted in companies having sole ownership of genetic testing for patented genes.

On June 13, 2013, in the case of the Association for Molecular Pathology v. Myriad Genetics, Inc., the Supreme Court of the United States ruled that human genes cannot be patented in the U.S. because DNA is a "product of nature." The Court decided that because nothing new is created when discovering a gene, there is no intellectual property to protect, so patents cannot be granted. Prior to this ruling, more than 4,300 human genes were patented. The Supreme Court's decision invalidated those gene patents, making the genes accessible for research and for commercial genetic testing.

The Supreme Court's ruling did allow that DNA manipulated in a lab is eligible to be patented because DNA sequences altered by humans are not found in nature. The Court specifically mentioned the ability to patent a type of DNA known as complementary DNA (cDNA). This synthetic DNA is produced from the molecule that serves as the instructions for making proteins (called messenger RNA)

Taken from https://ghr.nlm.nih.gov/primer/testing/genepatents

Do you think there are any similarities between patenting a gene and patenting a phage?
……
……
……

.....

.....

Do you think there are any differences between patenting a gene and patenting a phage?

.....

.....

.....

.....

.....

Final assignment title: Are phages the future?

Final assignment instructions:

1) Use the dataset to produce a graph from the scientist's experimental results. You will need to convert the bacterial counts to CFU/ml.

2) In a paragraph, explain the findings and evaluate the best phages to take forward as potential treatment against this bacteria.

3) Using the articles to help, answer the question are phages the future?

Introduce what phages are and why they have the potential to be useful. Go on to explain whether phages could be used commonly in the future, using examples to back up any reasoning. (250-300 words)

Include three potential issues which need addressing if phages can be used as medicine.

Final assignment success criteria:

- To produce a scientific graph with correct labelling and data points
- To describe and evaluate findings from the graph
- To summarise, evaluate and evidence information from research reading
- To use scientific terminology and keywords in your writing

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 – 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 I 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** – 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.

Notes

Notes

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