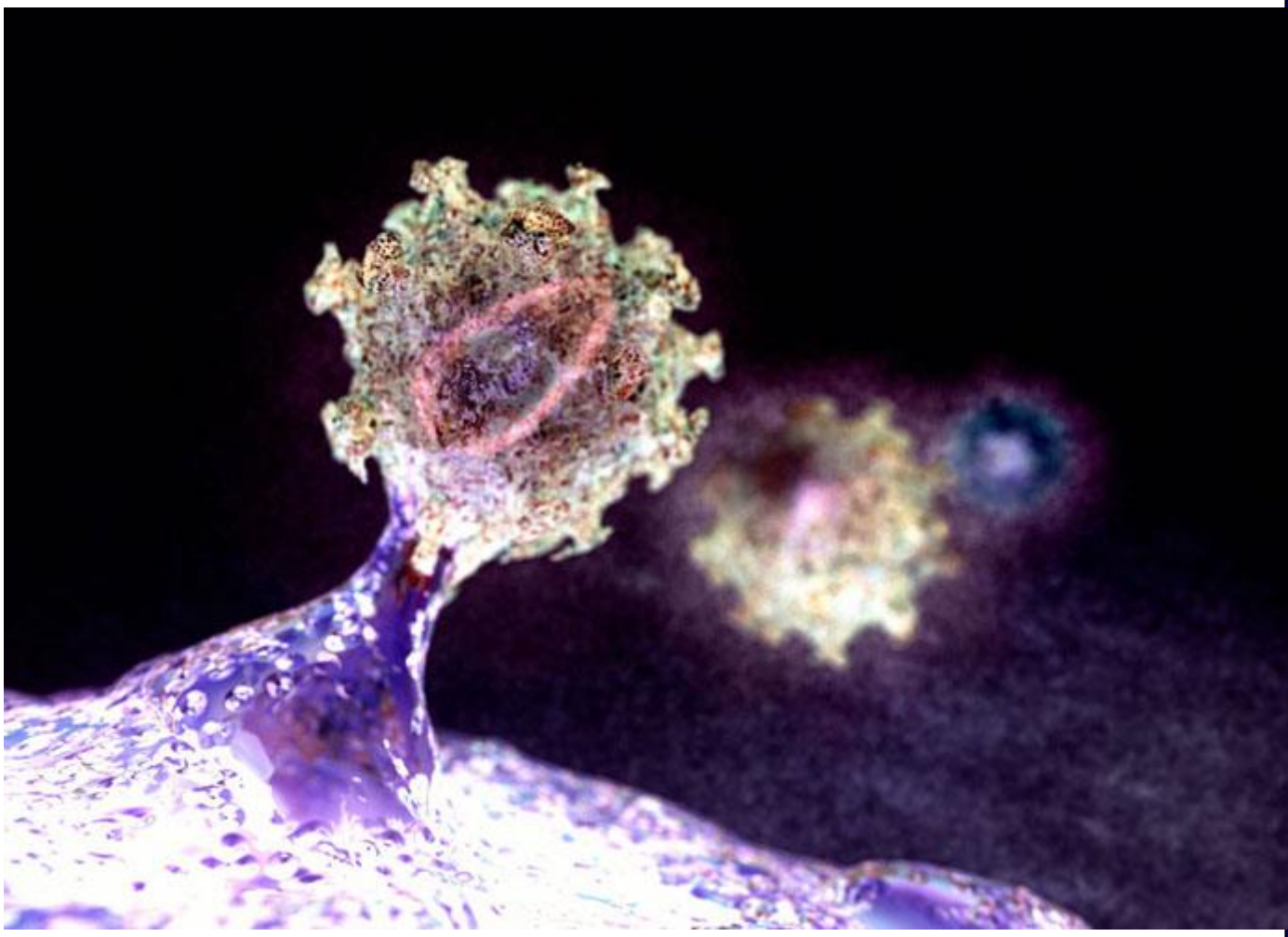

Disease Detective: Putting the pieces together to solve the mystery of what drives disease

Key Stage 4 Programme – 2016-2017

Teacher Name: Dr Len

Pupil Name_____

Timetable and Assignment Submission

Fill this in with your teacher.

Timetable – Tutorials

Tutorial	Date	Time	Location
1			
2			
3			
4			
5			
6			

Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1		
Tutorial 2		
Tutorial 3		
Tutorial 4		
Tutorial 5		

Assignment Submission – Lateness and Plagiarism

Lateness	
Submission after 4.00pm on **Put date here**	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

KS4 Programme 2016-17 – Pupil Feedback Report

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 current key stage
3rd	40-49	Performing to a good standard at current key stage
Working towards a pass	0-39	Performing below a good standard at current key stage
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

Name of RIS Teacher			
Title of Assignment			
Name of Pupil			
Name of School			
ORIGINAL MARK / 100		**FINAL MARK / 100**	
DEDUCTED MARKS		**FINAL GRADE**	

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

Learning Feedback Comment 1 - *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	**How you could improve in the future** *Enter feedback here*
Learning Feedback Comment 2 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	**How you could improve in the future** *Enter feedback here*
Learning Feedback Comment 3 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	**How you could improve in the future** *Enter feedback here*
Resilience Comment	
How you showed learning resilience during the course *Enter feedback here*	**How you could build learning resilience in the future** *Enter feedback here*

Example

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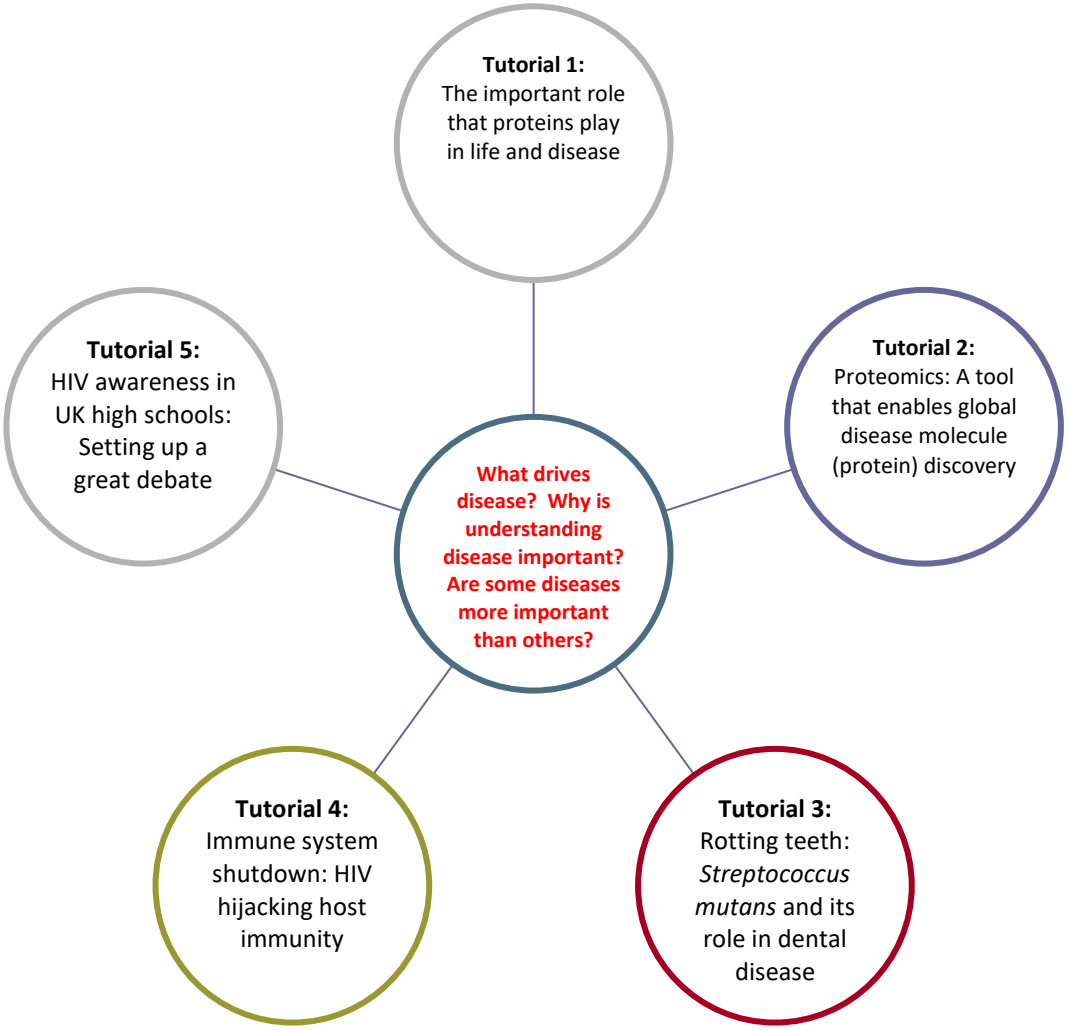
Course Rationale

Have you ever sat there and wondered what drives a cell to become cancerous, spread and possibly become resistant to chemotherapy and how to overcome the resistance? Or how HIV is able to destroy an individual's immune system to a point where they're susceptible to many diseases and identify a way to block HIV replication? Or how an individual can go blind rapidly and to find ways to restore or halt blindness? The objectives of this course is to deliver information on a cutting edge biomedical technology Proteomics, which has advanced our understanding of a wide range of diseases from a molecular perspective. Proteomics is a powerful tool/technology that has enabled researchers to take a 'snapshot' of all proteins expressed at any given time and space, which can provide the identification of disease biomarkers. This can subsequently lead to identifying novel drug targets that can be used to combat a disease. This course will appeal to students who are looking into undertaking biology, chemistry and/or physics in preparation for applying for an undergraduate course in Biotechnology, Biomedicine or Medicine.

Students will firstly be introduced to key concepts about proteins and their function as building blocks and machinery that enable life (Biology), different types of proteins and their function and cellular location (chemistry), and how proteins can be analysed globally by mass spectrometry (physics). They will be also taught the difference between hypothesis and non-hypothesis driven experiments. Once the students are confident with the concepts, they will then be shown how proteomics was applied to 2 different diseases that Dr Len worked on during her postdoctoral career. Pupils will be guided through how experiments were designed, the different techniques used and what other tools were employed to further enhance the understanding of each disease process. This course not only aims to arm students with the ability to critically analyse research papers but to also appreciate the impact that high calibre medical research has on improving people's lives. The students' final assignment will involve being part of a judged debate and write a critical report about it. The debate will focus on the impact of HIV on society and in particular looking into what are the pros and cons of increasing awareness of HIV education at a secondary level.

Course Map


Tutorial 1:
The important role that proteins play in life and disease
Tutorial 2:
Proteomics: A tool that enables global disease molecule (protein) discovery
Tutorial 3:
Rotting teeth: *Streptococcus mutans* and its role in dental disease
Tutorial 4:
Immune system shutdown: HIV hijacking host immunity
Tutorial 5:
HIV awareness in UK high schools: Setting up a great debate
What drives disease? Why is understanding disease important? Are some diseases more important than others?

Mark Scheme

Key Skill	1st	2.2
Research Skills	☐ All the outside sources are correctly referenced in the agreed format. ☐ Uses a purposeful but imaginative range of sources; reliable, relevant, and balanced in their choice. ☐ Comprehensive research is evidenced; sources of information go beyond the obvious choices	☐ Sources are not always referenced correctly. ☐ A limited range of sources has been used. ☐ Sources that have been found outside of the course reading may be unreliable; inappropriate for the subject; or heavily biased; limited attempt made to balance these with other sources.
Contextualising	☐ Current theories or work in the field are outlined making it clear how the assignment material fits into that context. ☐ Explains clearly why the topic is significant and worthy of discussion or investigation. ☐ Context and significance are explored through comprehensive use of current literature.	☐ Little reference is made to current theories or work in the field, it is not clear how the assignment materials fits into that context. ☐ Attempts but no clear discussion of why the topic is significant and worthy of discussion. ☐ 'Worthiness of investigation' is only covered from a personal motivation point of view.
Communication	☐ Writing is coherent and organised following a logical sequence. ☐ Almost faultless spelling, punctuation and grammar. ☐ Writing is of an appropriate style for the scientific document and follows stylistic techniques.	☐ As times the writing is poorly organised with a lack of coherent structure. ☐ The spelling, punctuation and grammar are weak in places. ☐ Inconsistent use of style throughout resulting in lack of clarity.
Critical thinking and Evaluation	☐ Validity of all data is discussed without the need to be prompted to do so. ☐ Critical evaluation of the data is systematic and logical – the limitations of the data are explained clearly and most of the main points have been covered. ☐ Evaluation is consistent across the different data sets being used. ☐ Not too critical of the data they are using (e.g. does not refuse to use it because of a minor flaw in the experimental design). ☐ Appropriate suggestions are made for improvement of the experimental design to increase the reliability of the results. **Evaluation** ☐ Shows a good understanding of what a hypothesis is and how the data presented supports or refutes it. ☐ Generalisation of the argument (if appropriate) has been performed correctly and succinctly with no superfluous steps or irrelevant reasoning. ☐ Conclusions are well-reasoned and clearly	☐ Validity of some of the data they are using is discussed. ☐ Critical evaluation of the data covers some of the main points but at times the reasoning is not clear or lacks a logical progression. ☐ Can be inconsistent in the evaluation of different data sets (e.g. where two data sets were collected using the same methodology, the reliability of only one set is discussed). ☐ Can be too critical of the data (e.g. refuse to use it because of a minor flaw in the experimental design). ☐ Suggestions are made for improvement of the experimental design, but these can be unrealistic or would not have the desired effect. **Evaluation** ☐ Some understanding of what a hypothesis is, but this might be confused with a theory. ☐ Discusses how the data presented

	supported by the data, but the limitations of the data are also recognised and discussed. Data from a range of sources is used for comparison with their results and any differences are discussed.	supports the hypothesis, but some steps in the reasoning may be missing and/or irrelevant points have been included. ☐ Generalisation of the argument has been attempted but not accurately. ☐ Results have not been compared to literature.
Analysis	☐ Uses all sources of data and evidence to support a conclusion. ☐ A quantitate form of analysis is used to infer a relationship (e.g. Stating proportionality due to doubling of quantities). ☐ Stages of analysis covered in tutorials (numeric or written) are correctly implemented and easy to follow, these are effective applied to unseen problems. ☐ Has considered the limitations of data/evidence sources where appropriate. Using this to support their conclusion. ☐ The argument towards the conclusion is well developed and logical.	☐ Uses some but not all sources of data/evidence to support a conclusion. ☐ Uses qualitative analysis effectively, quantitative analysis may be incorrect at times. ☐ Stages of analysis covered in tutorials are correctly use, there may be difficulty in applying these to unknown problems. ☐ There is some consideration into the limitations of the evidence sources. ☐ The argument towards the conclusion is not well developed and difficult to follow

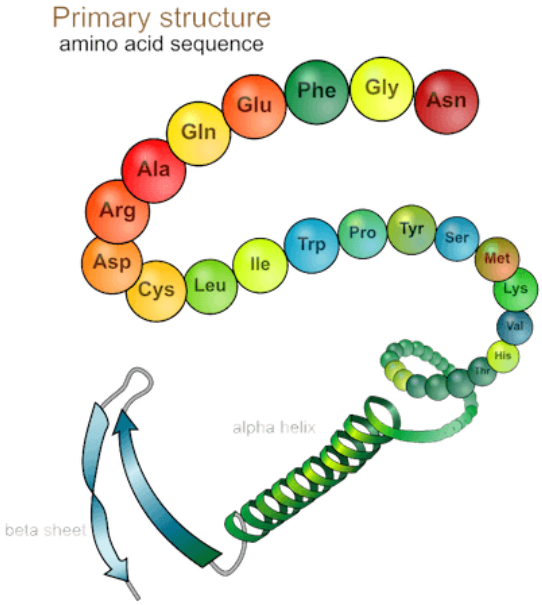
Glossary of Keywords

Word	Definition
Protein	Are made from long chains of different amino acids. Enzymes are a type of **protein** that speeds up the chemical reactions inside cells. Each type of enzyme does a specific job. Enzymes work best at optimum temperatures and pH values.
Peptides	Are made from short to medium length chains of different amino acids
hydrophobic	'water-hating' - that forms chemical bonds with oils but not with water.
hydrophilic	'water-loving' - that forms chemical bonds with water but not with oils
acid	Acids have a **pH** of less than 7
base	Bases have a **pH** of more than 7
Cytoplasm	Cytoplasm is the jelly like substance inside a cell where chemical and metabolic reactions take place. It contains enzymes to help speed up reactions taking place and also contains mitochondria from which energy is released
Cell Membrane	controls the movement of substances into and out of the cell
Pathogen	Pathogens are microorganisms - such as bacteria and viruses - that cause **disease** otherwise known as illness.
Bacteria	Bacteria are **microscopic organisms**. They come in many shapes and sizes, but even the largest are only 10 micrometres long - 10 millionths of a metre. Bacteria are **living cells** and, in favourable conditions, can multiply rapidly. Once inside the body, they release poisons or toxins that make us feel ill. Diseases caused by bacteria include: - food poisoning - cholera - typhoid - whooping cough - gonorrhoea - a sexually transmitted disease
Streptococcus mutans	Is able to survive in environments with and without oxygen and is a round bacterium commonly found in the human oral cavity and is a significant contributor to tooth decay.
Virus	Viruses are many times smaller than bacteria. They are among the smallest organisms known and consist of a fragment of genetic material inside a protective protein coat. Viruses can only reproduce **inside host cells**, and they damage the cell when they do this. A virus can get inside a cell and, once there, take over and make hundreds of thousands of copies of itself. Eventually the virus copies fill the whole host cell and burst it open. The viruses are then passed out in the bloodstream, the airways, or by other routes. Diseases caused by viruses include:

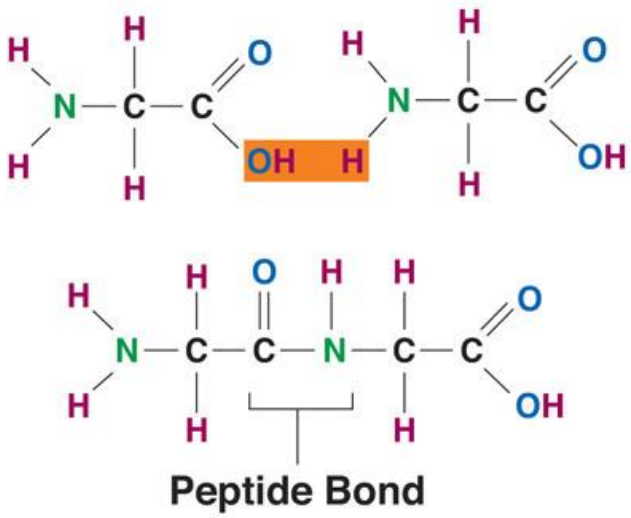
	- AIDS (HIV) - influenza - flu - colds - measles - mumps - rubella - chicken pox
Human Immunodeficiency Virus (HIV)	Acquired immunodeficiency syndrome (AIDS) is a chronic, potentially life-threatening condition caused by the **human immunodeficiency virus** (**HIV**). By damaging your immune system, **HIV** interferes with your body's ability to fight the organisms that cause disease. **HIV** is a sexually or blood transmitted infection.
Virological synapse	Where a virus creates a specialised area of cell-to-cell contact that promotes the directed transfer/transmission of the virus between cells.
Molecule	A **molecule** is a particle containing two or more atoms.
Genome	The genetic information in an organism is called its **genome**.
Proteome	The **proteome** is the entire set of **proteins** expressed by a genome, cell, tissue, or organism at a certain time. More specifically, it is the set of expressed **proteins** in a given type of cell or organism, at a given time, under **defined** conditions. The term is a blend of **proteins** and genome.
Proteomics	**Proteomics** is the large-scale study of proteins or the proteome.
Gel Electrophoresis	**Gel electrophoresis** is a laboratory method used to separate mixtures of DNA, RNA, or **proteins** according to molecular size. In gel electrophoresis, the molecules to be separated are pushed by an electrical field through a gel that contains small pores. The molecules travel through the pores in the gel at a speed that is inversely related to their lengths. This means that a small protein molecule will travel a greater distance through the gel than will a larger protein molecule.
Liquid chromatography	Chromatography can be used to separate mixtures of molecules or compounds such as proteins and peptide in the case of liquid chromatography.
qualitative	**Qualitative analysis** - this type of test identifies whether a substance is present, but not how much of it exists. A common example would be using a pH indicator to see if an acid is present.
Quantitative	**Quantitative analysis** - this type of test identifies the amount of a substance that is present. A common example would be using an acid-base titration to determine exactly how much acid is present.
Phosphorylation	A biochemical process that involves the addition of phosphate to an organic compound such as a protein.
Dynamic temporal analysis	Investigating a change over time

Tutorial 1 – Proteins in Life and Disease

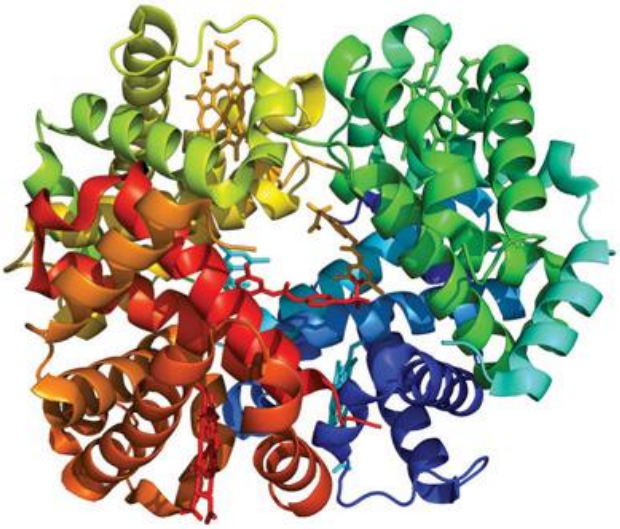
Amino acids → Peptides→Proteins



Chemical structure of a peptide bond



3D Structure of a protein



Today's Key Question(s):

- What are proteins?
- What are they made of?
- What types of protein groups run life?
- What is disease?
- Do proteins drive disease?

What is the Purpose of Tutorial 1?

- To briefly introduce Dr Len's research area in academia
- Explain the fundamental importance of proteins role not only in life but in disease as well

Today's activities:

- **Think – Pair – Share Proteins:** List as many things or places where you can find proteins
- **Making building blocks of proteins:** Molymod task of building an amino acid (maybe glycine) – students will begin to appreciate what 4 elements are required to build an amino acid and proteins. Each student will join their amino acid they have made with other pupils amino acids to make an 8 amino acid long peptide.
- **Quiz-quiz- share:** amino acids and proteins

Today's Homework is:

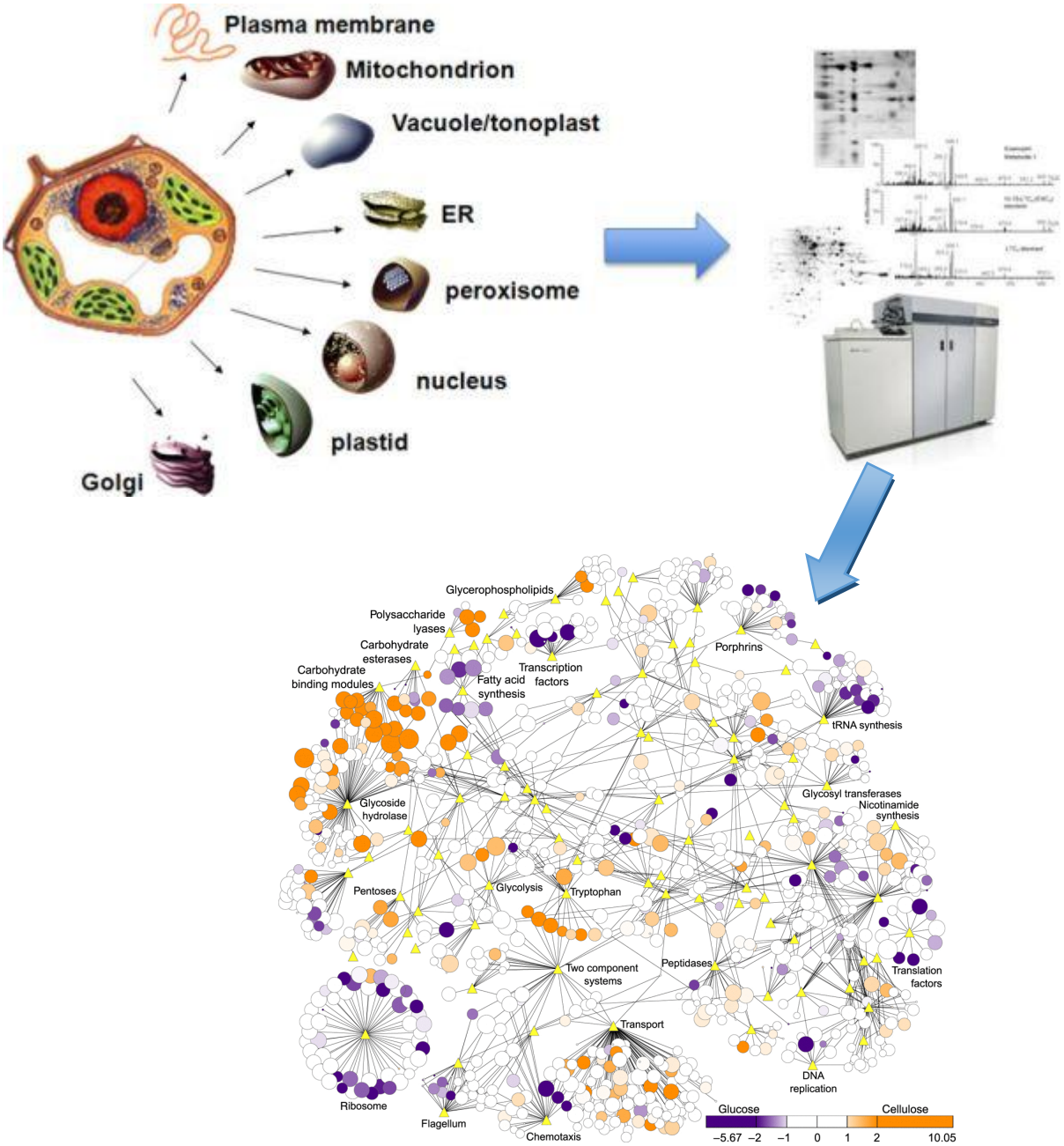
- Baseline Assessment

Homework 1 – Baseline Test

The homework assignment for the first tutorial is a baseline test to see your initial level of attainment in this subject area. The assignment will test for some or all of the subject specific skills that are required later in the final assignment. However, it is shorter than the final assignment and it will be an introduction to the subject as well as a challenge!

Do not worry too much about doing 'well' or 'badly' on the baseline test, it takes into account the fact that you may not be familiar with the subject area. It is designed to help you and your PhD tutor identify where you are at the start of the programme and to help you measure your progress along the way.

Tutorial 2 – Proteomics: Taking a global snapshot of all proteins expressed at any given time and space



Today's Key Question(s):

- https://www.youtube.com/watch?v=TWIYMvIyPJI
- What is a proteome?
- What is proteomics?
- What type of key protein separation methodologies are used for this technique?
- What advancement/progress has been made since 'proteome' was first coined in 1994?

- Qualitative versus quantitative

What is the Purpose of Tutorial 2?

- Students will gain an understanding that the proteome is an entire set of proteins expressed by a genome, cell, tissue or an organism at any given time.
- Students will gain insight into the 2 main streams of proteomic analysis – gel vs non gel based analysis.
- A timeline of major milestones in proteomic research/technology discoveries.

Today's activities:

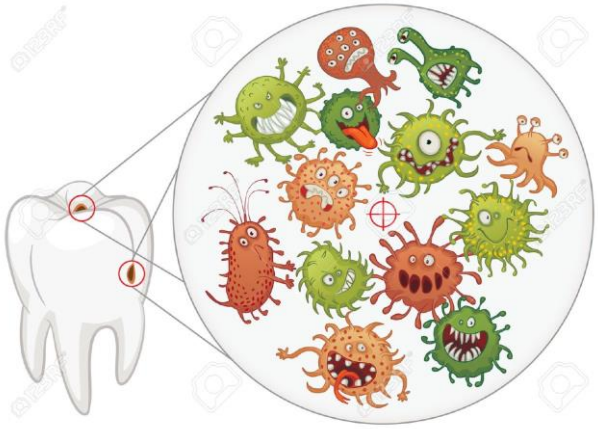
- **2D Gel activity:** Create your own 2 D Gel of proteins
- **All write round robin:** 2D Gels versus non-gel peptide/protein separation

Today's Homework is:

- Students will write a 300 word summary **describing the benefits** of using Proteomics for the discovery of disease markers. Students will need to reference their summary (please look at the appendix 1 of this course handbook for guidance on referencing) and add their references in the form of a bibliography at the end of their summary.

- Here is a list of literature resources students can use to help support their summary;
    - https://scholar.google.co.uk/
    - https://www.ncbi.nlm.nih.gov/pubmed
    - http://www.freemedicaljournals.com/
    - http://www.gopubmed.org/web/gopubmed/
    - http://www.nature.com/omics/index.html

Tutorial 3 – Rotting Teeth: *Streptococcus Mutans* and its role in dental disease



Today's Key Question(s):

- What is *S. mutans*?
- Why is it so important to study this dental pathogen?
- What did the qualitative proteomics analysis reveal?
- What did the quantitative proteomic analysis reveal?
- Qualitative vs quantitative?

What is the Purpose of Tutorial 3?

- Students will get an insight into the dental pathogen *S. mutans* and that it is a bacterium.
- To understand the importance in researching this pathogen and to appreciate why projects like this one are funded.
- To understand the difference between qualitative and quantitative proteome analysis.

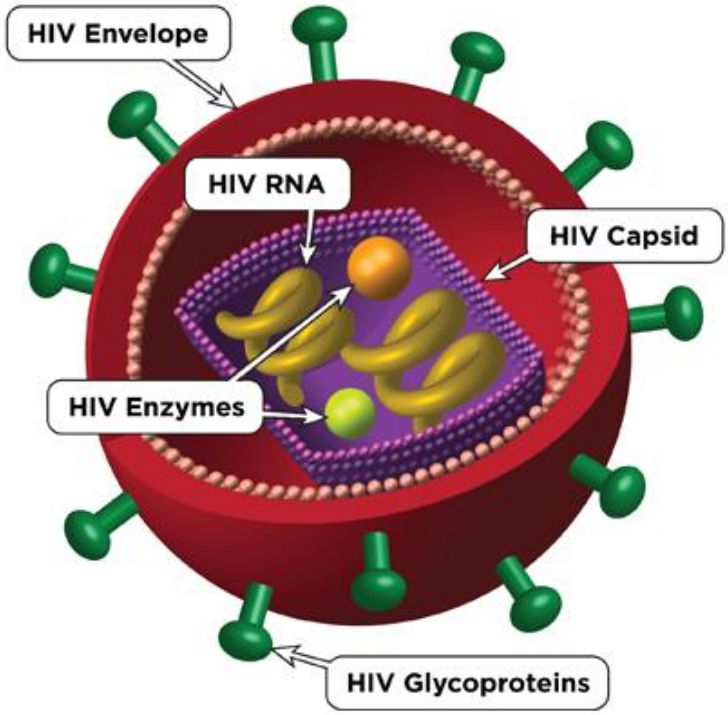
Today's activities:

- **What's growing on your teeth?:** A microscopy practical for students to look at the bacteria growing on their teeth

Today's Homework is:

- Students will write a 500 word discussion on whether they think dental caries is an important disease to investigate and invest in or not. Their discussion should include the reasons why as well as why not and to provide their overall choice – yes or no.
- Look at '10 take away tips – critical analysis' hand out to help construct the discussion.
- Watch this guide to essay writing at GCSE level – lots of useful handy tips; https://www.youtube.com/watch?v=XB40-KM14RA
- Students will need to reference their discussion (please look at the appendix 1 of this course handbook for guidance on referencing) and add their references in the form of a bibliography at the end of their discussion.

Tutorial 4 – Immune system shutdown: HIV hijacking host immunity



Key to Terms

HIV capsid: HIV's bullet-shaped core that contains HIV RNA

HIV envelope: Outer surface of HIV

HIV enzymes: Proteins that carry out steps in the HIV life cycle

HIV glycoproteins: Protein "spikes" embedded in the HIV envelope

HIV RNA: HIV's genetic material

Today's Key Question(s):

- What is HIV?
- Why is studying HIV so important?
- What is phosphorylation and why is it important in the context of proteins?
- What were the key findings in this paper?

What is the Purpose of Tutorial 4?

- Understand the importance of HIV research and why it is one of the most highly researched diseases in the world.
- Understanding how protein phosphorylation dictates protein regulation and function – acting as an 'on/off' switch.
- Showcase the advancement in understanding how HIV transfer from once cell to another to promote AIDS.

Today's activities:

- **Build a HIV model:** Students will use fimo or nutty putty to build a HIV model and label the virus. Students will get into pairs and describe their designated virus component to the rest of the group.

Today's Homework is:

- Students will write a 500 word discussion on whether they think HIV/AIDS is an important disease to investigate and invest in or not. Their discussion should include the reasons why as well as why not and to provide their overall choice – yes or no.

- Look at ’10 take away tips – critical analysis’ hand out to help construct the discussion.
- Students will need to reference their discussion (please look at the appendix 1 of this course handbook for guidance on referencing) and add their references in the form of a bibliography at the end of their discussion.

Tutorial 5 – Debate time! Increasing HIV awareness in UK high schools will drastically lower the prevalence of the disease amongst teenagers

Today's Key Question(s):

- What is debating?
- How do you go about researching your debate topic?
- How to set up a successful debate?
- What are the key points each team wants to make?

What is the Purpose of Tutorial 5?

- To understand what a judged debate is
- To understand how to work as a team to set up affirmative or negative case arguments
- To work as a team to assign who will take what role in the debate
- To start researching evidence for students affirmative or negative case

Today's Homework is:

- To work in your debate teams on formulating your evidence based arguments for the debate topic given.
- Watch the following videos to help inspire you and with understanding how a debate is set up and run;
    - https://www.youtube.com/watch?v=Aa5zbnl3ZQI
    - https://www.youtube.com/watch?v=nhvtzYFAoQ4
    - https://www.youtube.com/watch?v=1zZ4YEuThRw

The Deadline is:

Tutorial 6 – Feedback

What is the Purpose of Tutorial 6?

- Reflect on skills learned on the programme with a view to encouraging resilience
- Receive feedback on final assignment

What are the key questions?

- What strengths have I demonstrated in my work and what areas of development are there left for me to address?
- What steps do I need to take to improve my academic output?

Activity 1 – Marking your own

Using the mark scheme, identify three things you did well and three things you could improve.

What went well?

1.

2.

3.

What could be improved?

1.

2.

3.

Activity 2 – Responding to feedback

Read through your feedback sheet and highlight on your assignment where you received positive feedback (one colour) and areas for improvement (different colour). You might find it helpful to annotate this with a brief comment or two.

Activity 3 – Looking Forwards: Think, Pair Share

1. Think about how you can use this feedback in your future school work.
2. Talk to your partner about how you both plan to make changes to your school work in the future as result of this feedback
3. Share your ideas as a group.

You may choose to keep/delete this Appendix: 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:

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].

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.

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].

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.

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.

Appendix 2 – University Applications Guidance

For course choices and careers information:	www.brightknowledge.org.uk
For information and statistics on universities and course:	www.unistats.direct.gov.uk
For comprehensive information on universities, including rankings:	www.thecompleteuniversityguide.co.uk

PLEASE NOTE – The Researchers in Schools programme is designed to support the university applications process at your school. The work you complete for the programme should add to your schoolwork rather than detract from it. Please be aware of deadlines and try to manage your workload appropriately. If you are worried about the programme interfering with your schoolwork then please speak to your teacher.

Subject Specific Top Tips for strengthening an application?

Researching the Biology / Medicine / Healthcare career area that you are interested in can really help when it comes to writing and strengthening your application for university admission into a course that aligns with it. The following websites are great resources to help you with your application journey.

http://university.which.co.uk/advice/personal-statements/personal-statement-advice-biology-students

Career in Biology:

- http://www.qegschool.org.uk/attachments/download.asp?file=930&type=pdf
- https://www.rsb.org.uk/images/Teacher_careers_resource_KS4_2016.pdf
- https://www.rsb.org.uk/images/Bioscience%20Careers%20Resources%20for%20schools.pdf

Career in Medicine:

- https://www.rsm.ac.uk/sections/sections-and-networks-list/student-members-group.aspx