Researchers in Schools

Do anti-wrinkle creams reduce the ageing process?

Key Stage 4 Programme

Pupil Name	
Coursebook Designed by	**Dr K Muscat**

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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?

_____
_____
_____
_____
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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 assessment	
Tutorial 2	What is oxidative stress and does it play a role in the ageing process?	
Tutorial 3	Physiological importance of superoxide dismutase	
Tutorial 4	Are anti-wrinkle creams effective?	
Tutorial 5	Final assignment	

Assignment Submission – Lateness and Plagiarism

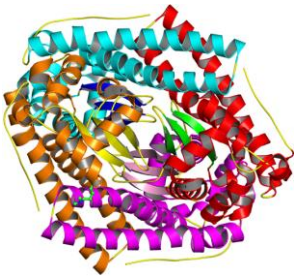
Lateness	
Submission after midnight on the due date	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Course Rationale

What is a healthy cell? Why do cells age? What changes occur within the cell as ageing begins? **Oxidants**, such as UV radiation, radicals, reactive oxygen species (ROS) and pollutants contribute towards the ageing process. They are reactive chemicals that cause damage to DNA, proteins and lipids.

Antioxidants such as vitamin C and vitamin E protect the cell from the damaging effects of oxidants. Furthermore, cells have evolved a battery of enzymatic antioxidants to help against the damaging effects of oxidants. In healthy aerobic organisms, the production of reactive oxygen species (ROS) is approximately balanced by antioxidant defence systems. The balance is not perfect, however, and ROS-mediated damage occurs continuously.

Oxidative stress refers to the situation of a serious imbalance between production of ROS and antioxidant defence. One of the factors that contribute towards the ageing process is from the random deleterious damage to tissues by oxidants.



Molecular structure of the antioxidant enzyme Manganese Superoxide Dismutase (MnSOD) found in the inter-membrane space of mitochondria.

This course outlines the differences between healthy and ageing cells. The process of genetic engineering will be discussed and how this method can be used to investigate the functions of specific proteins. We will look at claims made by cosmetic companies of some anti-ageing creams and examine their efficacy. You will learn how to interpret data from scientific peer-reviewed journals and compare such work with published articles from cosmetic companies. You will then critically analyse and evaluate the conclusion of such studies.

The course will comprise of 7 tutorials and will be presented as though they were in the style of university tutorials. This will conclude with a final assignment, like that given at university.

The overall aims of the course are:

- To describe the role oxidants and antioxidants play in the process of oxidative stress.
- To understand how oxidative stress contributes towards the ageing process.
- To critically analyse and evaluate data published in peer-reviewed scientific journals and articles.
- To experience university style teaching and write a scientific essay with references.

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 to communicate ideas to the reader.

	Does not yet apply this knowledge to build and support scientific arguments and explanations.	Describes evidence and arguments, while not yet evaluating them.	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	
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

Subject knowledge	
	Mark
Critical thinking	
	Mark
Written communication	
	Mark

Final Assignment: Pupil Feedback Report

Commented [HM1]: Delete if you have a problem set in your final assignment

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

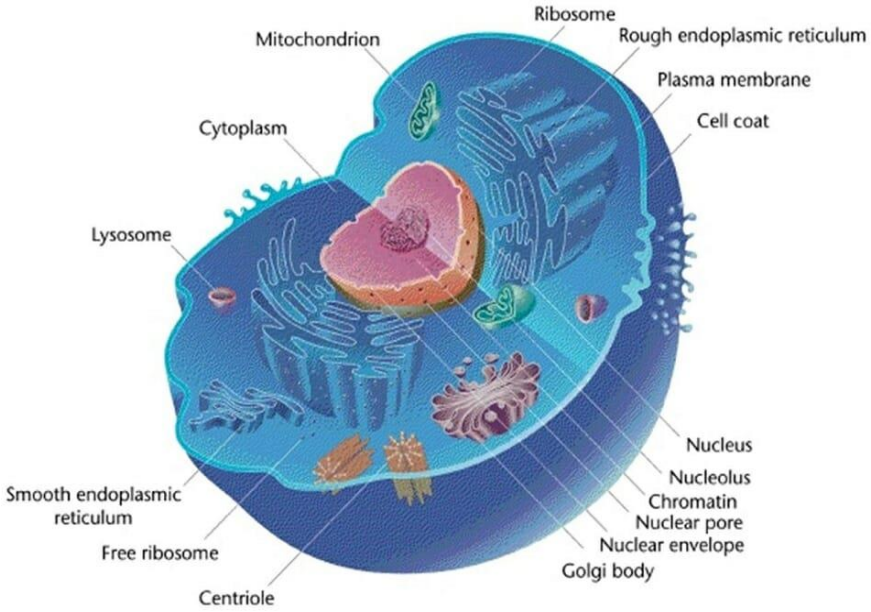
Subject knowledge	
	mark
Critical thinking	
	mark
Written communication	
	mark

Subject Vocabulary

Word	Definition	In a sentence
Aerobic respiration	This is the process of making energy with oxygen present in the cell.	
Antioxidant	These are chemicals that remove harmful reactive radicals.	
Deoxyribonucleic acid (DNA)	Hereditary material found in the nucleus of cells.	
Enzyme	A molecule that speeds up chemical reactions in cells.	
Genes	These are the instructions to make a protein.	
Genetic engineering	It is the process of altering the genes on the DNA of an organism.	
In vivo	Taking place in a living organism.	
Mitochondria	It is the organelle in the cytoplasm that generates energy.	
Mutant	An organism that has its DNA altered.	
Nucleus	The largest organelle in the cytoplasm of cells that contains the genetic material.	
Organelle	Cellular structure that performs a specific function.	
Oxidant	Reactive molecule that causes damage to a cell.	

Oxidative stress	The imbalance between free radicals and antioxidants and in turn causes damage/stress in the cells.	
Reactive Oxygen Species (ROS)	Very reactive molecules that cause damage to other parts of a cell.	
Superoxide dismutase (SOD)	An antioxidant enzyme found in cells that removes the superoxide radical.	

Tutorial 1 – What Is A Healthy Cell?



What is the Purpose of Tutorial 1?

In this tutorial you will identify the major organelles in healthy cells. We will describe how these organelles move and communicate with each other. Proteins are being produced constantly and you will identify the important role each protein plays in the cell.

We will describe the critical role mitochondria play in aerobic cells as well as the hazardous by-product it produces, the superoxide radical. It is suggested that 1 – 3% of the oxygen reduced in mitochondria during respiration may form the superoxide radical. The concept of Reactive Oxygen Species (ROS) will be introduced.

We will revisit the concept of a tissue and an organ and identify the function of the skin in multicellular organisms.

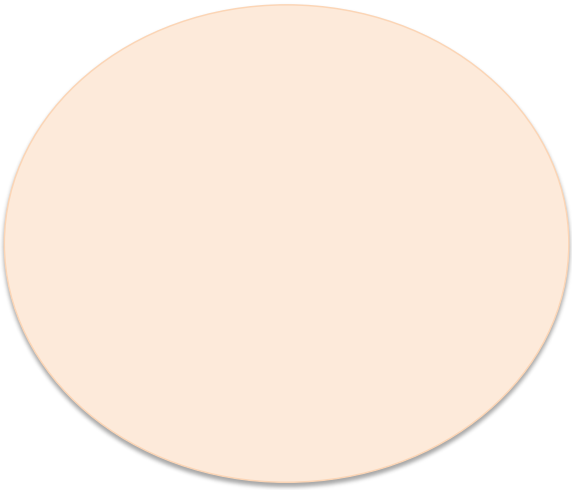
By the end of this tutorial, you should be able to:

- Identify the main organelles in a cell and define their function.
- Recognise that cells are protein factories.
- Recall the function of mitochondria and that the by-product of respiration is the superoxide radical.

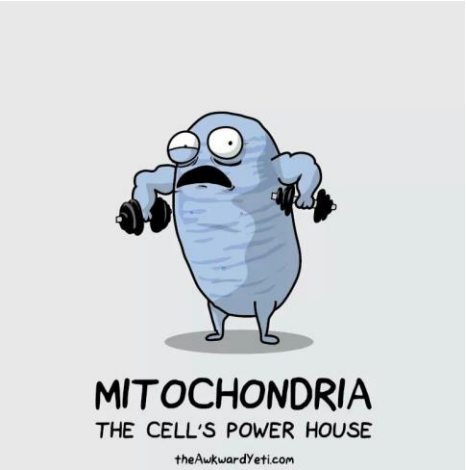
Activity 1 – Moving Organelles

In the space below, write down the organelles you recognise. You will be given a few minutes to recall their function.
https://www.labxchange.org/library/items/lb:LabXchange:60b18a7b:video:1

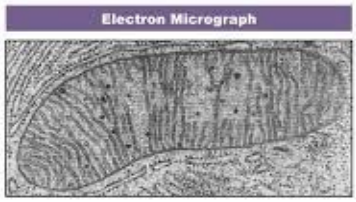
Structure of an animal cell – annotate the diagram.

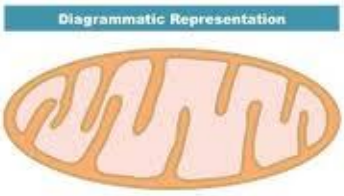


Activity 2 – Function of The Mitochondria – Double-Edged Sword



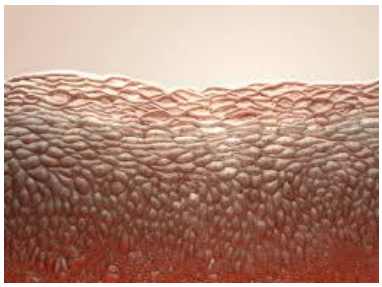
Why are mitochondria so important to living cells? Give examples of tissues that have many mitochondria. What is the by-product of cellular respiration? Why may this be harmful?
https://www.labxchange.org/library/items/lb:LabXchange:a5926d9f:video:1

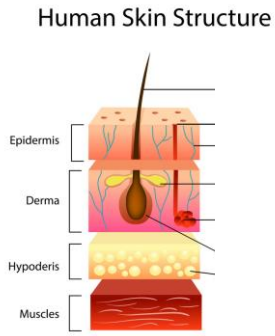




Activity 3 – The Largest Organ

What is the function of the skin?
Think-pair-share





Tutorial Glossary

Use this space to write down any words you have learned today.

Word	Definition	In a sentence

Notes

Homework – Baseline Assessment

Cosmetic companies make several claims about how certain creams can reduce wrinkles to rejuvenate skin.
Write 400 to 500 words to answer the following questions:

- **What is the importance of skin?**

- **What do cosmetic companies claim are the effects of anti-wrinkle creams and what evidence is there to back-up these claims?**

I'm interested to hear what cosmetic companies claim and whether these claims are justified.
Remember to:

- **P**oint – make the point/claim clearly
- **E**vidence – explain the evidence for the point
- **E**xplanation – explain why the point/claim is relevant and important

Organise your writing into paragraphs:

- **Include** why skin is an organ and its function
- **Explain** what cosmetic companies claim
- **Discuss** whether there is evidence to back these claims
- **Summarise** your key points in a conclusion

Tutorial 2 – Oxidative Stress

What is the Purpose of Tutorial 2?

In this tutorial we will identify oxidants in the environment around us and discuss whether these may have a negative impact on the body. We will identify oxidants formed intracellularly and outline the mechanism of formation. Antioxidants counteract the effect of oxidants and are found in the food we eat as well as synthesised naturally in cells. We will further discuss their vital role in protecting cells from oxidative stress.

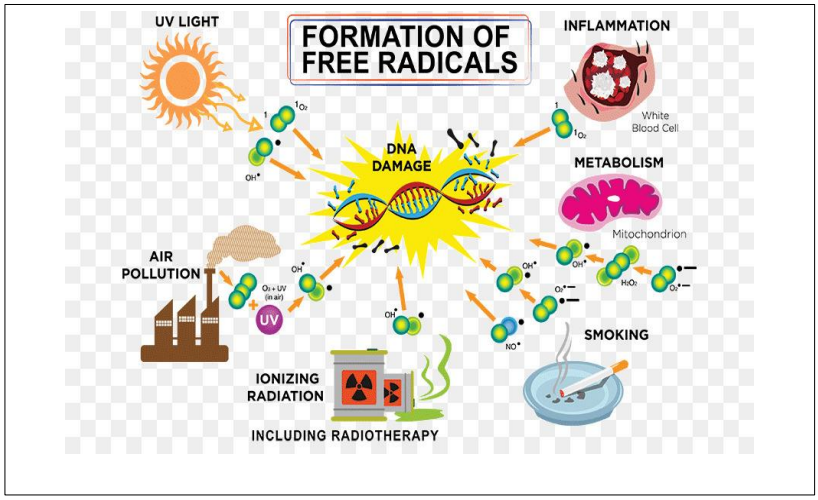
The general principles of ageing will be touched upon and the role oxidative damage has on ageing cells.

By the end of this tutorial, you should be able to:

- Give examples of oxidants and antioxidants.
- Explain their source of origin.
- Describe the process of oxidative stress and its involvement in disease and the ageing process.

Activity 1 – Reactive Oxygen Species (ROS)

A free radical is any species capable of independent existence that contains one or more unpaired electrons. An unpaired electron is one that occupies an atomic or molecular orbital by itself. Free radical species are highly reactive.

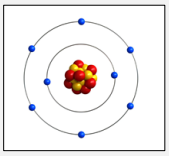


Discuss the following question in pairs and write your ideas in the boxes below.
What are free radicals?

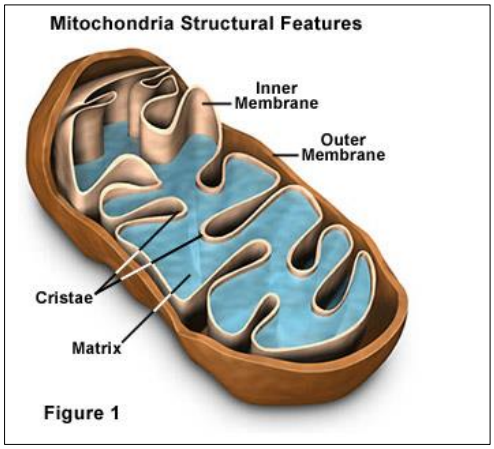
Identify the different sources of free radicals.

Oxygen – a major air pollutant

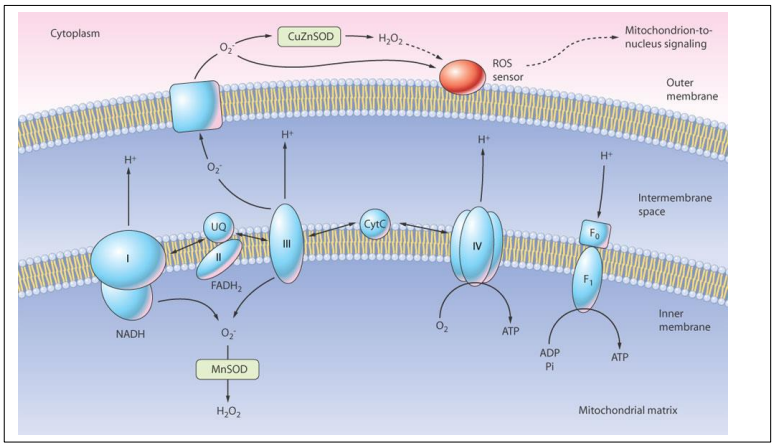
The element oxygen exists in air as a diatomic molecule. Except for certain anaerobic unicellular organisms, all animals, plants, and bacteria require oxygen for efficient production of energy. This need for oxygen obscures the fact that oxygen is a toxic mutagenic gas as well as a serious fire risk. Aerobes survive because they have antioxidant defences to protect against it.



Mitochondria and the superoxide radical



Identify the superoxide radical in this diagram



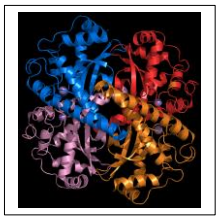
Summary of Reactive Oxygen Species.

What is the function of an antioxidant?

Antioxidants found around us.

Activity 2 - Superoxide Dismutase (SOD)

Oxygen is a poisonous molecule and aerobes only survive in its presence because they have evolved antioxidant defences. Here we will discuss antioxidant defences. Read the information in Appendix 2 and write down the function of Copper Zinc Superoxide dismutase (CuZnSOD)and Manganese Superoxide (MnSOD) dismutase.



SOD

Copper Zinc SOD

Manganese SOD

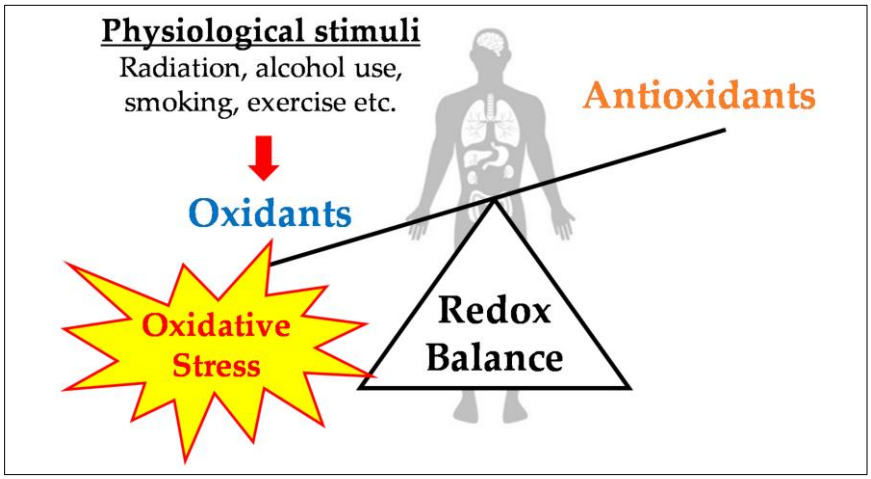
Function of CuZnSOD and MnSOD.

Other enzymatic antioxidant aerobic organisms evolved.

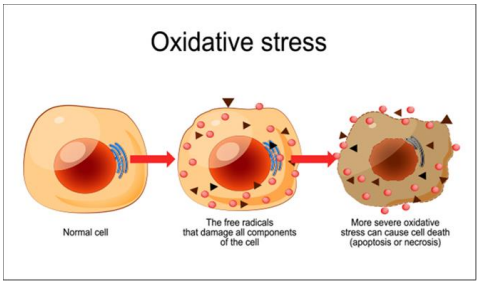
Use your own words to define an antioxidant.

Activity 3 - Oxidative Stress

When the level of oxidants (free radicals) in cells outweighs the level of antioxidants, and therefore the ability of the body to detoxify the harmful effects of radicals, a state of oxidative stress occurs and damage to cellular structures occurs.

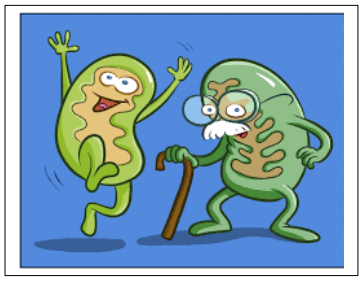


A cell exposed to severe oxidative stress may die. Cell death can result because of the inability of the cell to make energy (ATP), repair damaged DNA or because of severe cellular depletion of certain antioxidants. The process of Programmed Cell Death (PCD) or apoptosis occurs which is a sequence of events in the cells that leads to the neat elimination of that cell, without it affecting neighbouring cells.



Oxidative stress can be defined as:
Read the information in Appendix 2

Activity 4 – The Ageing Process



Oxidative stress causes structural damage within cells and is linked to several diseases. Watch the video and write a few notes on the conflicting data that has been published.
Does oxidative stress really accelerate the ageing process?

_____
_____
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_____

Tutorial Glossary

Use this space to write down any words you have learned today.

Word	Definition	In a sentence

Notes

Homework

Read Appendix 2 and write 200 – 300 words to answer the following question:

What is oxidative stress and does it play a role in the ageing process?

Key points to include:

- What are oxidant and antioxidants?
- What role does oxidative stress play in disease?
- Does oxidative stress play a role in the ageing process?

Tutorial 3 – Mutants

What is the Purpose of Tutorial 3?

The process of genetic engineering is a technique used to modify the DNA of an organism. Scientists use tools discovered in nature to cut DNA and remove specific proteins from the sequence. This way scientists can further understand the function of a protein in the mutant created.

By the end of this tutorial, you should be able to:

- Define the term genetic engineering.
- Describe the process of genetic engineering.
- Explain how genetic engineering can be used to further understand the function of a protein.

Activity 1 – Why Create Mutant Organisms?

The enzyme MnSOD is located in the inter-membrane space of mitochondria.
Discuss with your partner why scientists would want to remove that protein from an organism (for example from the unicellular yeast cell).

_____
_____
_____
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_____
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_____

Briefly describe the process of genetic engineering.

_____
_____
_____
_____
_____

How can scientists 'cut' DNA to remove the specific gene?

Activity 2 – Extraction Of DNA

Follow the instruction sheet in Appendix 4 to extract DNA from fruit.

Extracted DNA

Activity 3 – Genetic Engineering

Watch the animation on genetic engineering.
https://dnalc.cshl.edu/view/15928-How-insulin-is-made-using-bacteria.html
https://www.youtube.com/watch?v=LP5TctAPPUI

Keywords:
Chromosome – A sequence of DNA that contains thousands of genes
DNA ligase – An enzyme that sticks 2 ends of DNA together
Gene – A small section of DNA that codes for specific protein
Plasmid – A circular piece of DNA that can be inserted into a bacterial cell
Restriction enzyme – An enzyme that cuts DNA at a specific place
Vector – A DNA molecule that carries a gene from one organism to another

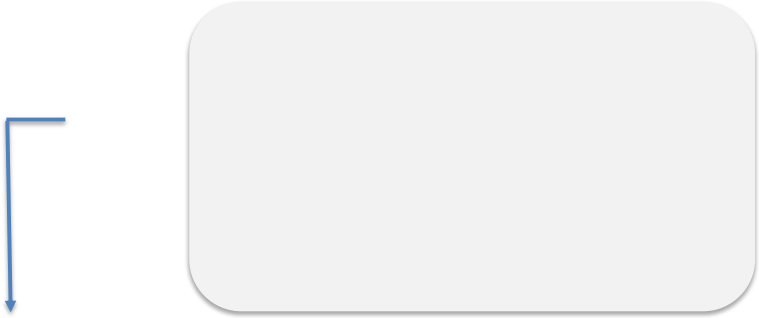
Fill in the flowchart with text and diagrams explaining the production of insulin. Use Appendix 5 to help with the stages in producing a transgenic bacterium.

STEP 1 Remove a plasmid.

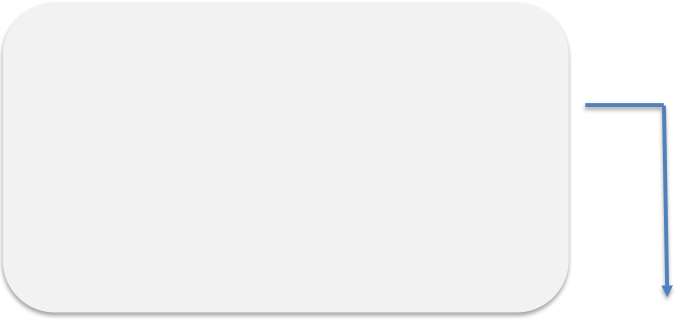
STEP 2 Cut open with restriction enzymes.

STEP 3 Locate and remove human insulin gene using same restriction enzymes.

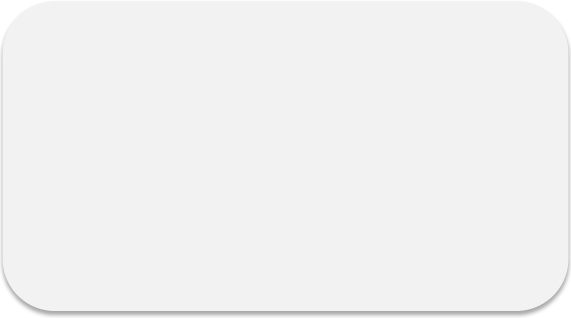
STEP 4 DNA is combined with plasmid using ligase enzyme.



STEP 5 Bacteria are incubated with new recombinant plasmid.



STEP 6 Bacteria take up plasmid and produce insulin.



Tutorial Glossary
Use this space to write down any words you have learned today.

Word	Definition	In a sentence

Notes

Homework

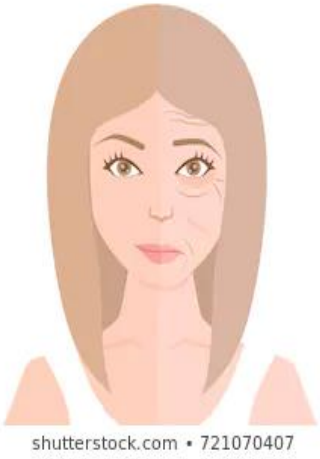
Read Appendix 3 on 'Gene knockouts in bacteria and yeast' and 'Transgenic animals' and look up other sources. Write 200 – 300 words to answer the following question:

What evidence is there for the physiological importance of superoxide dismutase?

Key points to include:

- What have gene knockouts in bacteria and yeast shown?
- What conclusions have scientists drawn using transgenic animals?

Tutorial 4 – Anti-Wrinkle Creams



What is the Purpose of Tutorial 4?

In this tutorial we will identify claims made by cosmetic companies about their products. We will identify the active ingredients of anti-wrinkle creams and understand their function. We will analyse published results that back these claims and determine whether the results are reliable and conclusive.

By the end of this tutorial you should be able to:

- Identify the active ingredients in anti-ageing products.
- Explain the function of certain ingredients.
- Evaluate data from different sources.

Activity 1 - Ingredients

Read the information sheets provided and describe the function of the active ingredients in creams. Fill the table below.

Active Ingredient	Type of chemical	Function of chemical
Retinoids		
Vitamin C		
Hydroxy acids		
Collagen		

Hyaluronic acid		
Jojoba oil		
Niacinamide		

Activity 2 – Cause of Wrinkles

Listen to the video and read the information sheets provided to understand the science behind the formation of wrinkles.

Causes of wrinkles.

Activity 3 – The Skin Barrier

'How do formulation chemists deliver active ingredients deep into the skin when the skin is such a good barrier and, with so many potent active ingredients and antioxidants now being added to formulations, how do they avoid these ingredients reacting with each other before the cream ever sees a face?'

'Does anyone really know what is happening to the composition, structure, and concentration, much less the transport into the skin?

'It's a huge area of debate, because realistically the vast majority of cosmetics don't penetrate more than 10 or 15 layers [of the skin], so a lot of the claims are based on tests that are done *in vivo*. But actually, putting the cream on the skin, you're not getting that effect on the epidermis.'

Howes, L (2012) There comes the science bit. Chemistry World https://www.chemistryworld.com/features/the-science-of-skincare/5494.article [11 October 2020]

Read the information above and identify the problems cosmetic companies face when producing anti-ageing creams. What do they claim? What are the problems they face? How can they justify these claims? Present your thoughts as a mind map below.

Anti-ageing cream

Activity 4 - Global Anti-Ageing Market

Think-pair-share; Why would one want to invest in the anti-ageing market?

Tutorial Glossary
Use this space to write down any words you have learned today.

Word	Definition	In a sentence

Notes

Homework

Cosmetic companies claim that anti-wrinkle creams reduce the aging process.

Write a paragraph that answers the following questions:

- What are the ingredients that cosmetic companies claim to use?
- Why are these chemicals used and what is their function?
- Are their claims justified?
- Do they penetrate the skin barrier? Is there published scientific studies to proves this?
- Are the experiments carried out *in vivo*?

Using the articles discussed in class and your own research, formulate your ideas on whether claims by cosmetic companies on the anti-wrinkle creams are justified. Your answer should be written using full sentences (200 words).

Tutorial 5 – Nutrition and Ageing Skin

What is the Purpose of Tutorial 5?

In this tutorial we will understand the link between nutrition and the ageing skin. We will read several published articles from reputable scientific magazines and peer-reviewed scientific journals. You will practise describing and explaining results as well evaluating experiments.

By the end of this tutorial you should be able to:

- Explain the link between nutrition and its effect on the skin.
- Describe and explain results.
- Identify peer-reviewed scientific journals and its impact factor.
- Plan and structure the final assignment
- Reference the final assignment with relevant sources.

Activity 1 – Beauty Comes from The Inside

"BODY MILK IS RUBBISH! NOT ONLY DOES IT TASTE AWFUL IN MY COFFEE BUT I STILL HAVE MY WRINKLES!"

Read the peer-reviewed scientific article by Schagen *et al.*, (2012) Discovering the link between nutrition and skin aging. Dermatoendocrinol, 4, 298 – 307.

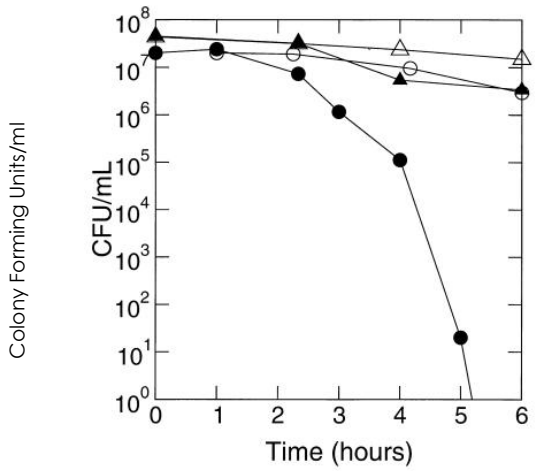
List the most important antioxidants found in our diet and explain why they are so important.

What information do you find interesting and what can you conclude from this article?

Activity 2 – Describing and Explaining Data

Seyler *et al.*, (2001). Superoxide dismutase-deficient mutants of Helicobacter pylori are hypersensitive to oxidative stress and defective in host colonization. Infect Immun., 69, 4034-4040.

Example 1:



Survival of bacterial cells under atmospheric oxygen and anoxic environments. Wild-type (not the mutant - triangles) or SOD mutant (circles) cells grown under 2% oxygen were suspended in 150 mM NaCl and incubated in either atmospheric oxygen (closed symbols) or without oxygen (open symbols).

Describe the graph above of growth of wild-type (normal) and SOD-mutant bacteria when exposed to no oxygen and atmospheric oxygen.

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Explain the possible reason for these results.

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Activity 3 – Planning the Final Assignment

Read through the question of the final assignment and highlight the keywords. This is the question:

Do anti-wrinkle creams reduce the ageing process?
The scientific essay should cover:

- The structure of a healthy cell and importance of aerobic respiration
- The redox balance in cells (oxidants and antioxidants) and effect of oxidants on cell structure
- Give special emphasis to experiments scientists published that investigate the role antioxidants play on the health of cells
- The effects of oxidative stress and the ageing process
- Discuss ingredients found in anti-aging creams and compare these ingredients to intracellular antioxidants found in living cells
- Claims of anti-wrinkle creams by cosmetic companies and evidence for their claims
- Evaluation of evidence by cosmetic companies and peer-reviewed scientific journals on the role oxidative stress plays in the ageing process

Write a plan or mind map with all the relevant topics for this essay.

In pairs, discuss what you would add to the introduction, main part of the essay and conclusion.

Introduction	Main body	Conclusion

Reference sources: when writing your final assignment, it is best to research more articles and published scientific papers. This way you learn more about the topic. You will need to acknowledge them by referencing their work after mentioning their work. Guidance on how to reference is given in Appendix 1.

In learning partners, discuss how to write a reference and write how you would reference the peer-reviewed scientific journal given to you today.

_____

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Tutorial Glossary

Use this space to write down any words you have learned today.

Word	Definition	In a sentence

Notes

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Homework – Final Assignment

There are several anti-ageing creams on the market that cosmetic companies claim reduce wrinkles and have an anti-ageing effect on the body. Write an opinion article for *New Scientist* (2000 words) that answers the following question:

Do anti-wrinkle creams reduce the ageing process?
The scientific essay should cover:

- The structure of a healthy cell and importance of aerobic respiration
- The redox balance in cells (oxidants and antioxidants) and effect of oxidants on cell structure
- Give special emphasis to experiments scientists published that investigate the role antioxidants play on the health of cells
- The effects of oxidative stress and the ageing process
- Discuss ingredients found in anti-aging creams and compare these ingredients to intracellular antioxidants found in living cells
- Claims of anti-wrinkle creams by cosmetic companies and evidence for their claims
- Evaluation of evidence by cosmetic companies and peer-reviewed scientific journals on the role oxidative stress plays in the ageing process
- A conclusion summarising your recommendation as to the most effective ways we can adopt to combat the ageing process

Success Criteria:

Your article should be structured using appropriate subheadings. You must write in full sentences and all work must be neatly presented. Add an introduction with the information discussed in tutorials. You may wish to add diagrams (with data provided) to help explain your point, discuss, and evaluate your argument. You must add a conclusion with your opinion with the key points you wish to conclude.

Extra reading and research are encouraged. Search for information about oxidative stress and ageing on the internet and look out for news articles and scientific websites. Make sure to comment on the reliability of these sources and reference them as stated below.

Understand (Subject knowledge):

- The structure of a cell and the function of organelles
- The role of oxidants and antioxidants in cells
- Techniques scientists use to investigate the function of antioxidants
- The effect on oxidative stress on the ageing process

Be able to do (Academic skills):

- Demonstrate high level of knowledge and understanding
- Use evidence to support points
- Assess different viewpoints and establish a clear point of view

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 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. 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 several 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.

Appendix 2 – Oxidative Stress and Ageing

Adapted from the book Free Radicals in Biology and Medicine by Barry Halliwell and John M. C. Gutteridge, Third Edition, Oxford Science Publication, 2001.

Oxygen and oxidants

Molecular oxygen (O_2) is a vital element required for the efficient production of energy by most animals and plants. It is a biradical and has two unpaired electrons. Reactive oxygen species (ROS) are highly unstable molecules and include both oxygen radicals and certain non-radicals that are oxidizing agents and/or easily converted into radicals. As the name implies, ROS attack cellular components by oxidizing lipids, proteins, and nucleic acids. ROS are formed in living organisms as a result of cellular metabolism, the mitochondria respiratory chain, the presence of pro-oxidants, exposure to ionizing radiation and the bacterial killing mechanism of the immune system is a pathway for the production of the superoxide radical.

Oxidative stress describes a condition in which cellular antioxidant defences are insufficient to keep the levels of ROS below a toxic threshold. This occurs because of excessive production of ROS or loss of antioxidant defences or even both. Lipid peroxidation is one of the biological structures affected by ROS. Proteins are also damaged, and their structure is altered. DNA damage occurs because of base modifications, several of which are mutagenic.

Intracellular antioxidants

Superoxide dismutase is an enzymatic antioxidant that catalyzes the conversion of the superoxide radical to hydrogen peroxide and helps maintain the redox balance by diffusing the superoxide.

Copper, Zinc Superoxide Dismutase (CuZn-SOD) is an enzyme that resides in the cytoplasm of cells and has recently been located in the mitochondrial intermembrane space, where it aids in oxidative protection. CuZn-SOD plays an essential role in protection against oxidants and many studies reported that yeast strains lacking this gene grow poorly in air.

Manganese Superoxide Dismutase (Mn-SOD) is located in the mitochondrial matrix where it dismutates the superoxide radical into molecular oxygen and hydrogen peroxide. Other enzymatic antioxidant enzymes found in cells include, Catalase, Glutathione peroxidase and Cytochrome c peroxidase.

Non-enzymatic antioxidants found in cells include Vitamin C, Vitamin E, Thioredoxin and Glutathione.

Oxidative damage theory of ageing

Oxidative stress is involved in several diseases, including cardiovascular and neurodegenerative diseases. In some diseases, it makes a significant contribution to tissue injury. It has been proposed that oxidative stress could be involved in the aging process itself. Ageing has been described as a progressive decline in the efficiency of physiological processes after the reproductive phase of life. It occurs in all multicellular organisms. Attempts have been made to test the role of ROS in the ageing process by supplying antioxidants to various organisms and examining their effect on longevity. The most striking results have been obtained with lower organisms. Indeed, Vitamin E prolongs the lifespan of several simple organisms such as Drosophila, nematode worms and the rotifer *Philodina*. However, the effects of administered antioxidants on the lifespan of mammals are small. High-dose vitamin E administration has no significant effect on lifespan in rodents.

There is evidence that oxidative damage may be focused on mitochondria with age. Levels of oxidative damage are balanced between rate of damage and rates of repair, or replacement of damaged molecules. Thus, rises in damage levels could be due not only to more damage but also to failure of repair systems with age. A positive correlation between the efficiency of DNA-repair enzymes and species longevity has been claimed.

Appendix 3 – Physiological Importance of Superoxide Dismutases

Adapted from the book Free Radicals in Biology and Medicine by Barry Halliwell and John M. C. Gutteridge, Third Edition, Oxford Science Publication, 2001.

Gene knockouts in bacteria and yeast

The biological role of SOD is to scavenge the superoxide radical, which is known to be generated *in vivo* in amounts increasing with oxygen exposure. The best way of proving that SOD is important would be to eliminate it from living organisms and observe the consequences. Removal of SOD genes from the bacteria *E. coli* demonstrated the important role these enzymes play as the bacteria would not grow aerobically. Very low concentrations of the superoxide radical is sufficient to lead to DNA damage, hypersensitivity to hydrogen peroxide and impairment of metabolic activity.

Similar studies carried out on other organisms, lacking SOD grow poorly aerobically. Inactivating the gene for MnSOD in baker's yeast *Saccharomyces cerevisiae* causes it to become hypersensitive to damage by oxygen. Drosophila lacking CuZnSOD show decreased lifespan, increased toxicity of oxygen and infertility.

Transgenic animals

The simplest way of evaluating effects of antioxidants on lifespan is to selectively manipulate antioxidant defences and examine the effects. Gene knockout techniques using embryonic stem cells have been used to generate mice completely lacking MnSOD. In one study, most of these animals died within the first 10 days of life, with cardiac abnormalities, fat accumulation in liver and skeletal muscle and metabolic acidosis. Severe mitochondrial damage in heart and in other tissues is evidenced by decreases in specific enzyme function, consistent with an essential role of MnSOD in maintaining normal mitochondrial function. MnSOD-defective strains that survive longer than this quickly succumb to a variety of pathologies, including severe anaemia and neurodegeneration. 'Knockout; mice lacking MnSOD do not live long enough for ageing rates to be examined. Transgenic mice overexpressing human MnSOD were found to be more resistant to lung damage by 95% oxygen than normal mice.

Knockout mice lacking CuZnSOD and glutathione peroxidase do survive for longer periods and may be useful models. When young they appear normal but as they age, neurological damage and cancers have been claimed by some scientists to develop at an accelerated rate and the mice have reproductive problems

Appendix 4 - Extraction of DNA

Adapted from the Future Learn website
https://www.futurelearn.com/info/courses/biochemistry/0/steps/21618

DNA is the hereditary material in all cells. The experiment described below allows you to isolate DNA from fruit.

Materials required

For this experiment you will need:

- Fruit – Kiwi, Strawberries, and Banana all work well
- 5 g washing up liquid
- 2 g salt
- 100 ml tap water
- 100 ml of ice cold alcohol (isopropyl alcohol can usually be found at the pharmacists); put in a freezer for at least 30 mins before starting the experiment
- Access to hot water – about 60 °C
- Sieve or coffee filter paper
- Two glass beakers (or old jam-jars)
- Several bowls of different sizes, including a large bowl for making a water bath
- A paperclip
- Safety spectacles – if desired

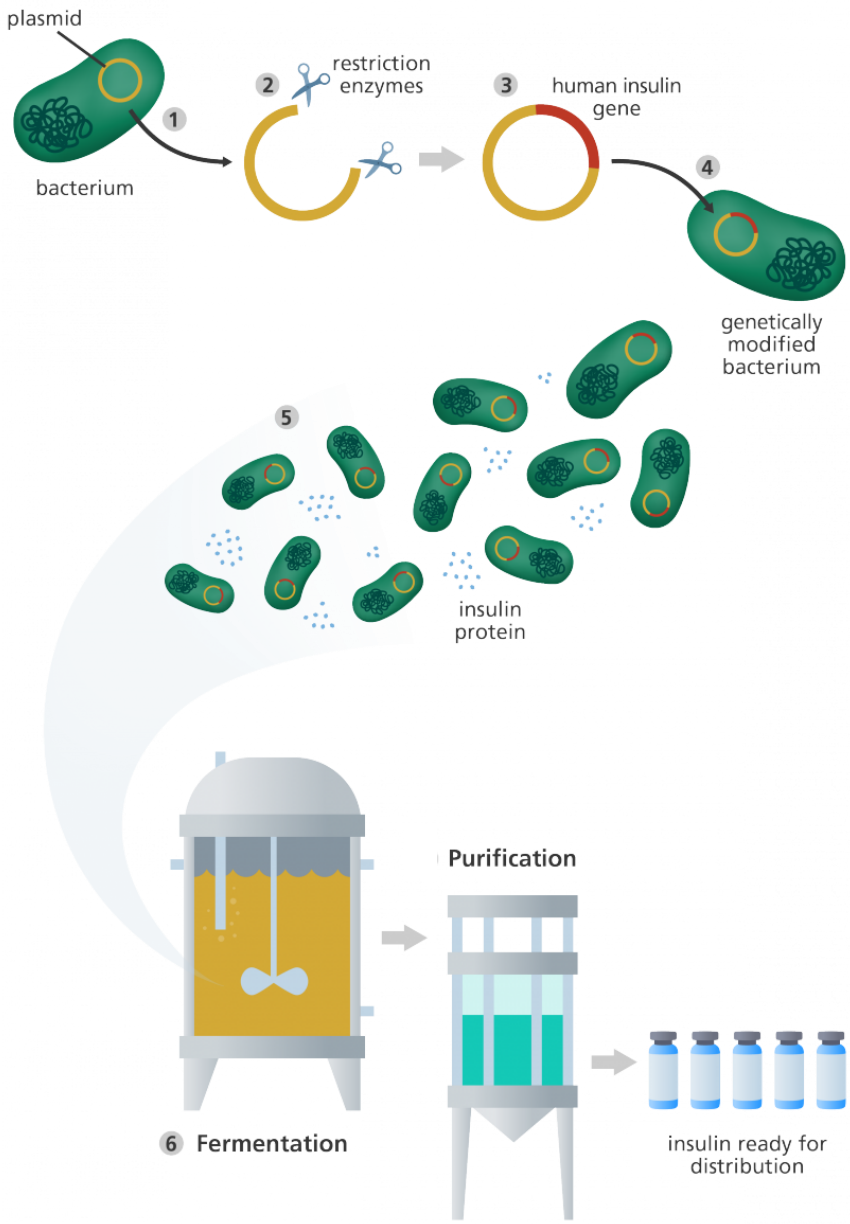
Experiment to purify DNA from fruit

Step 1: Mash up the fruit of your choice in a bowl. Bananas, kiwis and strawberries all work well. (Remove the skin of the bananas and kiwi, we just want the insides!)
Step 2: In a separate bowl, mix the washing up liquid, salt and tap water. Stir gently trying to avoid making too many bubbles in the mixture. This is your extraction buffer.
Step 3: Add the fruit to the extraction buffer and mix again. Mash your fruit sample as much as you can, but again, try to avoid making too many bubbles.
Step 4: Make a water bath with a temperature of about 60 °C. (A large washing up bowl works well for this.) Leave the fruit extraction mixture to incubate for 15 minutes.
Step 5: After 15 minutes, filter your fruit mixture through a fine sieve or coffee filter. This will remove all the solid material that you don't want. You should be left with a clear(ish) liquid.
Step 6: Take the ice cold alcohol and very slowly, drop by drop, pour it down the inside of the container with your fruit mixture. What you want to do is produce a layer of the alcohol floating on top of the fruit mixture.
Step 7: At the interface between the alcohol and the fruit mixture, you should see a white cloud-like substance forming. Use a hook (a bent paperclip would work) to slowly draw the DNA up and out of the solution.

Questions to consider

1. Look at each step of the protocol. What are the different steps and reagents (washing-up liquid, salt, water, alcohol) used for in the experiment?
2. How are you able to see the DNA?
3. Do you think that the sample you have prepared is "pure DNA"?

Appendix 5 – Stages in Producing Transgenic Bacteria



Notes

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