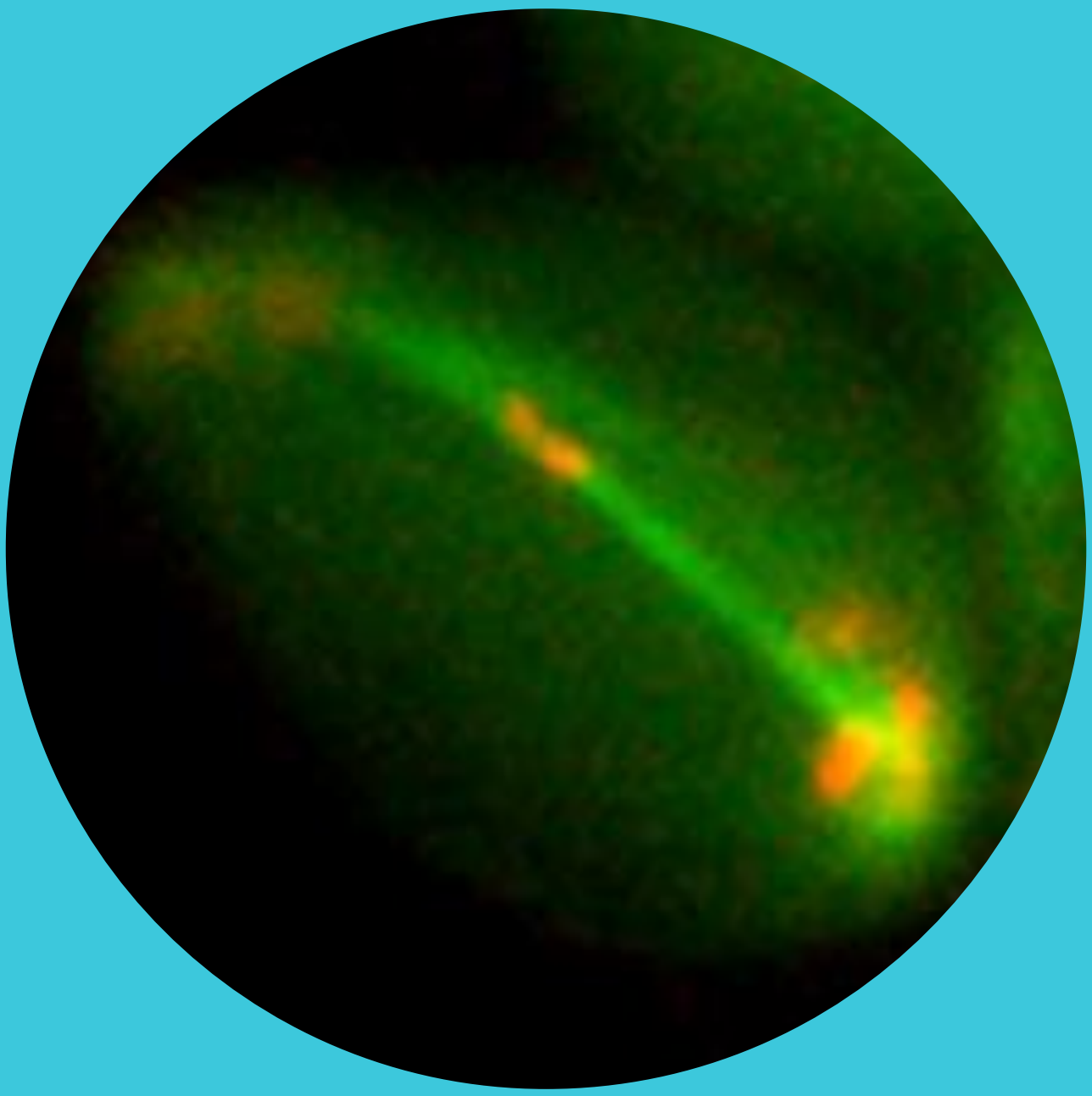
Researchers in Schools



Don't drop the chromosome! How mutant cells are losing it.

Key Stage 4 Programme

Pupil Name

Coursebook Designed by Dr Emre

Contents

Uni Pathways launch event 1
Introduction to Uni Pathways 1
Pupils' experience of Uni Pathways 2
Virtual campus tours 2
Meet university students! 3
Reflection 3
Timetable and Assignment Submission 5
Timetable – Tutorials 5
Timetable – Homework Assignments 5
Assignment Submission – Lateness and Plagiarism 5
Course Rationale 6
Uni Pathways Mark Scheme 2020 7
Baseline Assignment: Pupil Feedback Report 9
Final Assignment: Pupil Feedback Report 10
Subject Vocabulary 11
Tutorial 1 – Cell division without mistake 13
What is the Purpose of Tutorial 1? 13
Activity 1 - Cell cycle 14
Activity 2 - Stages of mitosis 15
Activity 3 – Problems during mitosis 16
Homework - Baseline assignment 17
Tutorial 2 – How to build a protein that works 21
What is the Purpose of Tutorial 2? 21
Starter activity 22
Activity 1 - A gene codes for a protein 23
Activity 2 – Genes and the structure of DNA 24
Activity 3 – Genetic mutations 24
Activity 4 – Mutant mice 25
Homework – Genes to build proteins 25
Tutorial 3 – Let's get technical 28
What is the Purpose of Tutorial 3? 28
Starter activity 29
Activity 1 – By the light of the microscope 29
Activity 2 – Using GFP to look at Mad2 protein in mitosis 31
Activity 3 – Looking at two signals at the same time 32
Activity 4 – Whom are you calling mutant? 34
Homework - Use of biological tools by scientists 35
Tutorial 4 – Order, order! Wait for the attachment of chromosomes before separating them 38
What is the Purpose of Tutorial 4? 38
Starter activity 39
Activity 1 – A wait signal delays mitosis 39

Activity 2 – Testing for the mitotic checkpoint 40
Activity 3 - Comparing the behaviour of two checkpoint proteins: Mad2 and Rod 41
Activity 4 – Quantifying two signals 42
Activity 5 - *mad2* and *rod* mutants: how does removing one affect the other? 43
Tutorial 5 – I have a proposal for you 48
What is the Purpose of Tutorial 5? 48
Activity 1 – Mad1, a new checkpoint protein has been identified 49
Activity 2 – Writing a research proposal 49
Homework - Final assignment: 52
Part 1 – Problem set 52
Part 2 – Written task 57
Tutorial 6 – Feedback tutorial 58
What is the Purpose of Tutorial 6? 58
Final assignment feedback from your Uni Pathways Teacher 58
Tutorial 7 – Final tutorial 60
Appendix 1 – Referencing correctly 62
How do I reference? 63
Notes 64

Uni Pathways launch event

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

By the end of the video, you will have

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

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

Introduction to Uni Pathways

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

_____
_____
_____

2. Independent learning is

_____
_____
_____

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

_____
_____
_____
_____

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

_____
_____
_____
_____
_____

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

_____
_____
_____
_____
_____

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

Pupils' experience of Uni Pathways

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

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

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

3. What were some challenges that the pupils met?

Virtual campus tours

You will now go on a virtual tour of some universities! Once you have seen some of the university campuses, respond to the questions below.
Note down something that you liked out of any of the campus tours you saw. It may be a particular building, space, city etc.

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

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

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

Meet university students!

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

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

Reflection

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

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

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

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

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

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

Timetable and Assignment Submission

Timetable – Tutorials

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

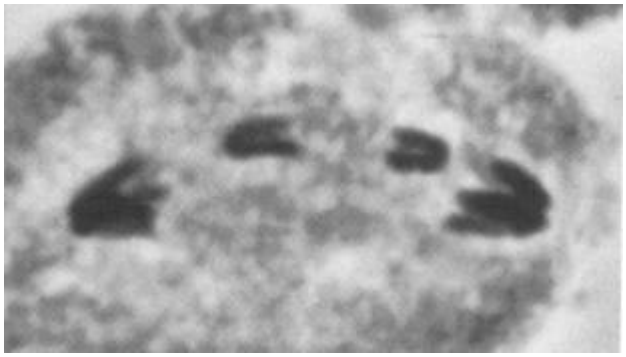
Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1	Baseline assignment	
Tutorial 2	Genes to build proteins	
Tutorial 3	Use of biological tools by scientists	
Tutorial 4	Experiments on mitosis	
Tutorial 5	Final assignment	

Assignment Submission – Lateness and Plagiarism

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

Course Rationale



Stem cells, skin cells, muscle cells… Cells divide all the time through a process called mitosis. Sometimes it goes wrong and a cell ends up with too many chromosomes. How does the cell avoid that situation?

A checkpoint ensures during mitosis that everything is correct before moving to the next stage: all chromosomes should be properly attached to microtubules (some kind of molecular rope) before the chromosomes are pulled apart and separated in two equal sets.

By creating genetic mutations, we can investigate the function of the genes involved in the checkpoint. We can also make proteins glow by adding fluorescent markers. And by combining the two, we obtain glow-in-the-dark mutants that allow us to follow chromosomes and checkpoint proteins in a cell in real time.

You will explore how to tackle biological questions and how to lead a research project through examples of experiments performed with mutated checkpoint genes and fluorescent proteins.

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. Does not yet apply this knowledge to build and support scientific arguments and explanations.	Beginning to analyse scientific evidence, arguments, and reasoning. Describes evidence and arguments, while not yet evaluating them.	The grammar, spelling, style, and structure of the work need improving in order to communicate ideas to the reader. Scientific language, key terms and

			references are not always used correctly. Limited, or no use of tables and graphs.

Baseline Assignment: Pupil Feedback Report

Name of Pupil	
Name of School	Harris City Academy Crystal Palace
Name of RIS teacher	Dr Emre
Title of Assignment	Events of the cell cycle

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

Problem Set	
Comment	*mark*

Final Assignment: Pupil Feedback Report

Name of Pupil	
Name of School	Harris City Academy Crystal Palace
Name of RIS teacher	Dr Emre
Title of Assignment	Write a research proposal to investigate the role of Mad1 in the mitotic checkpoint

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

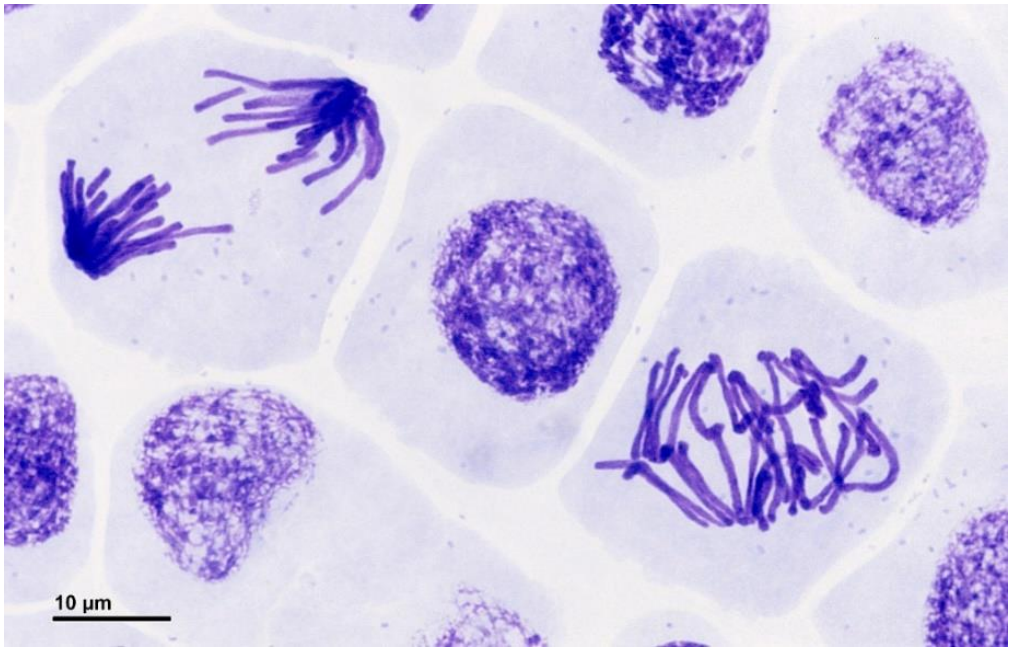
Subject knowledge	
	mark
Critical thinking	
	mark
Written communication	
	mark
Problem Set	
Comment	*mark*

Subject Vocabulary

Word	Definition	In a sentence
DNA	A molecule found in the nucleus of cells that contains the genetic information necessary to build a living being.	
Gene	Small section of DNA that carries the information to make a particular protein. It determines the characteristics of an individual.	
Chromosome	A long piece of DNA which contains many genes. Visible in the nucleus of the cell when compacted.	
Protein	A molecule that does most of the work in a cell. It is coded by a gene. It has a specific function; for instance: enzyme, transport, structure, signaling.	
Mitosis	The process of a cell dividing in two daughter cells. Both new cells have the same genetic information as the original cell.	
Aneuploidy	When a cell has an incorrect number of chromosomes.	
Kinetochore	Platform made of protein that assembles on chromosomes. It is where microtubules will attach.	
Microtubule	A long tubular protein structure used to move objects inside the cell. For instance, microtubules pull the chromosomes during mitosis.	
Checkpoint	Mechanism that checks if everything is correct before letting the cell progress in the cell cycle.	
Mutation	Modification of the DNA sequence in a gene.	
Mutant	Organism that has a mutation in one gene.	

Fluorescent marker	Protein that emits light after it has taken some energy from a light source.	

Tutorial 1 – Cell division without mistake



What is the Purpose of Tutorial 1?

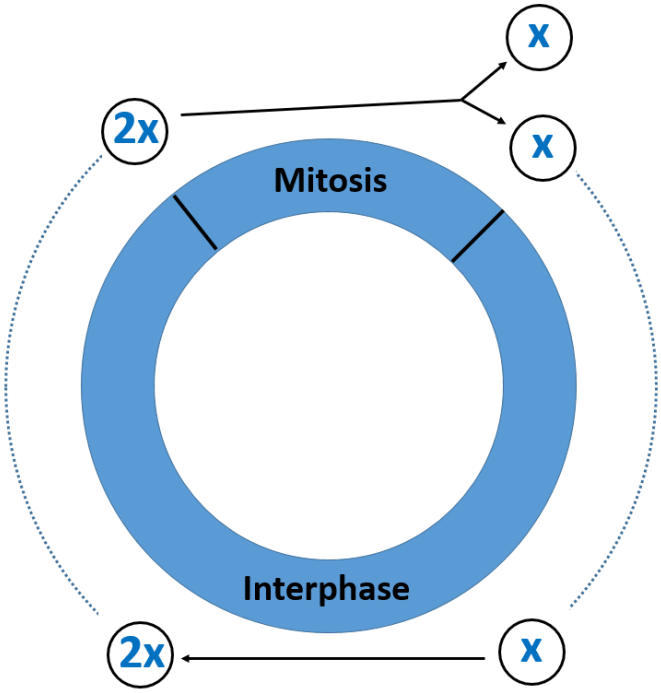
All living organisms are made of cells. Animals and plants are made of many cells and are called multicellular organisms. When one cell divides into two cells, it is called cell division or mitosis. This is the last stage of the cell cycle.

In this tutorial, you will learn to:

- Describe the events of the cell cycle and mitosis
- Understand why checkpoints are important
- Define key terms used in the tutorial: mitosis, interphase, chromosome, microtubule, aneuploidy, checkpoint

Activity 1 - Cell cycle

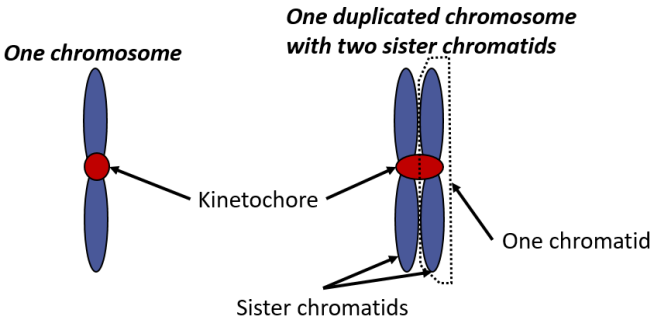
Write in the box the description of the main event of each of the two phases of the cell cycle as we go through them together.

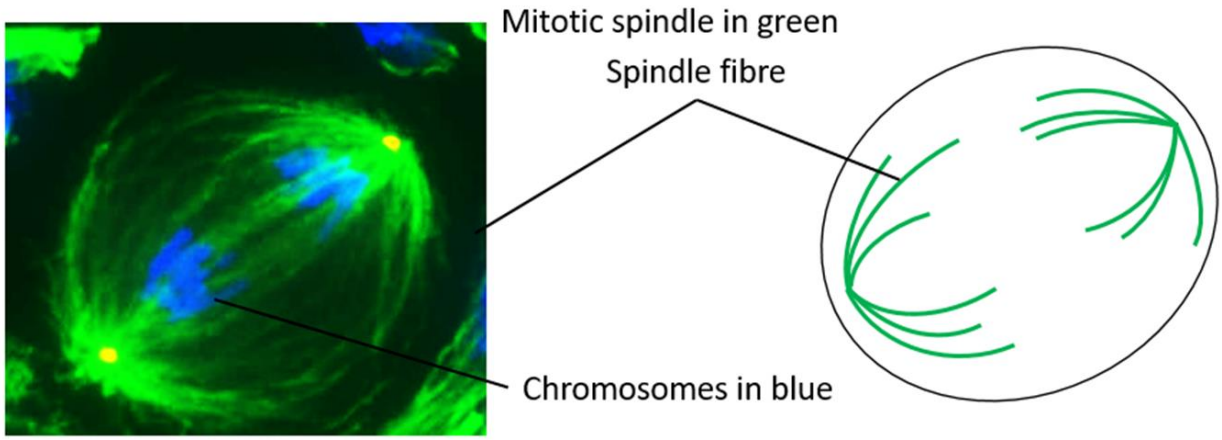


In mitosis,

In interphase,

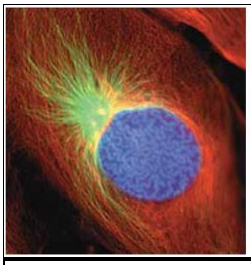
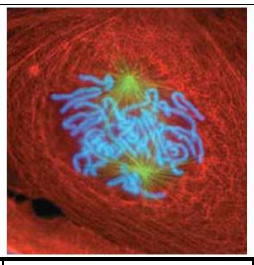
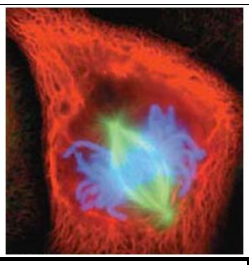
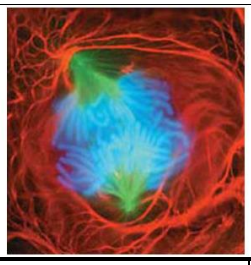
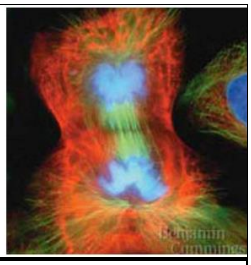
Key structures inside a cell





Activity 2 - Stages of mitosis

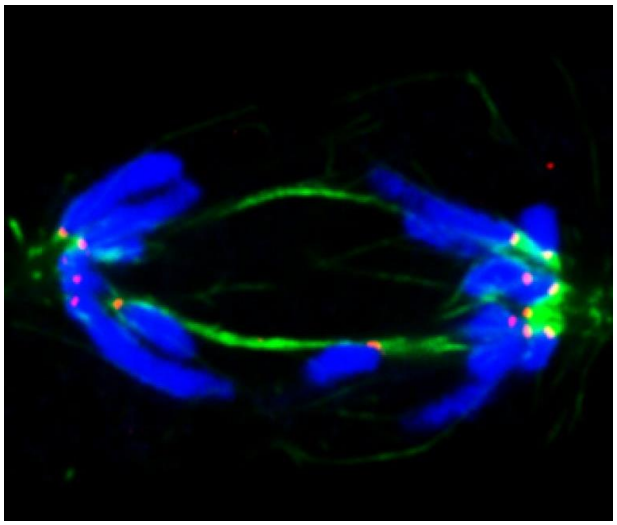
Match each stage of mitosis to its correct description

				
End of interphase	Prophase	Metaphase	Anaphase	Telophase

• Spindle fibres attach to chromosomes • Chromosomes line up at the equator (middle) of the cell	• Chromatids have reached opposite poles of the cell • Cytoplasm begins to divide	• Chromosomes condense • Mitotic spindle (microtubules) start to form	• Chromosomes have replicated • The cell prepares to enter mitosis	• Spindle fibres pull on the chromosomes • Chromosomes separate at the same time • Spindle fibres pull the chromatids to opposite poles of the cell

Activity 3 – Problems during mitosis

This mitosis has gone wrong. Can you tell why? Discuss in pairs and write your answer below the image. What could be the consequences for the two new cells and for the whole organism?



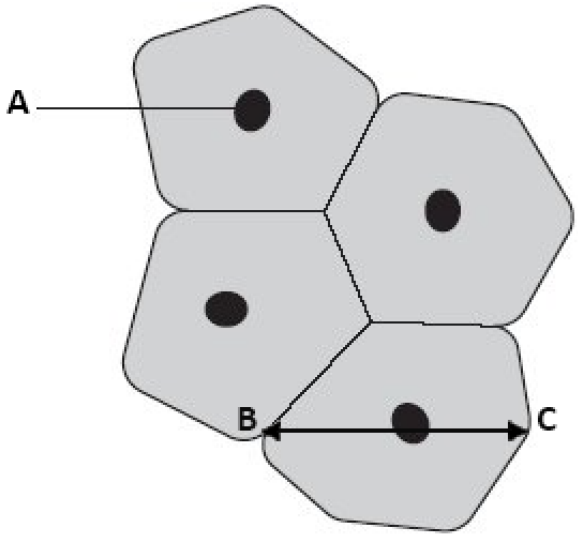
Homework - Baseline assignment

New cells are continuously made to replace old ones or repair damaged tissue. How does a cell divide and why is it important that a cell divides without mistake?

You have two tasks:

Task 1 - Complete the problem set.

The diagram shows a group of cells.



a) Give the name of part A

_____ (1)

b) Give the function of part A

_____ (1)

c) The cells are magnified 350 times. The width of a cell is shown by the line B to C.

Calculate the width of the cell in micrometres (µm) by completing the following steps.

- Measure the width of the cell using a ruler _____ mm (1)
- Use the equation to work out the real width of the cell in mm:
  real size = image size ÷ magnification
  _____ mm (1)
- Convert mm into µm _____ µm (1)

d) Name the type of cell division that produces new cells

_____ (1)

e) Explain why it is important for cells to be able to divide

_____ (1)

f) Describe what must happen to the genetic material before a cell can divide

_____ (1)

Task 2 – Written report - Describe in approximately 250 words the events that occur during the cell cycle by detailing the following:

- Phases of the cell cycle
- What happens during mitosis
- Why regulation of mitosis is important

Success criteria

- Knowledge is used to build and support highly effective scientific arguments and explanations.

- Identifies and critically evaluates key scientific arguments and evidence.

- Include key words from the glossary and demonstrate that you understand them by explaining what they mean and how they relate to the topic.

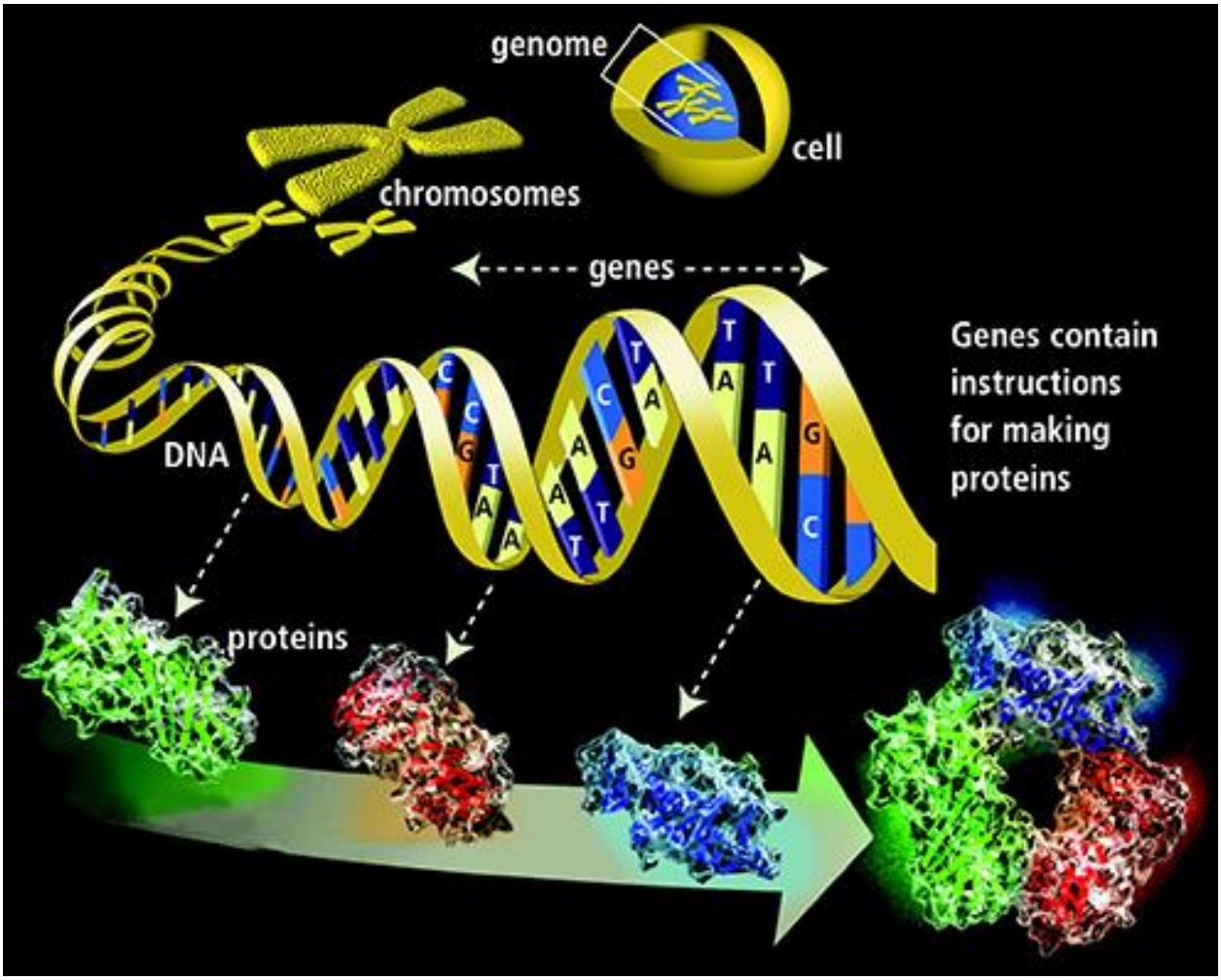
- Consistent referencing.

- Organise your ideas in paragraphs with a logical structure.

- There are no, or very few, errors in spelling or grammar.

Additional notes

Tutorial 2 – How to build a protein that works



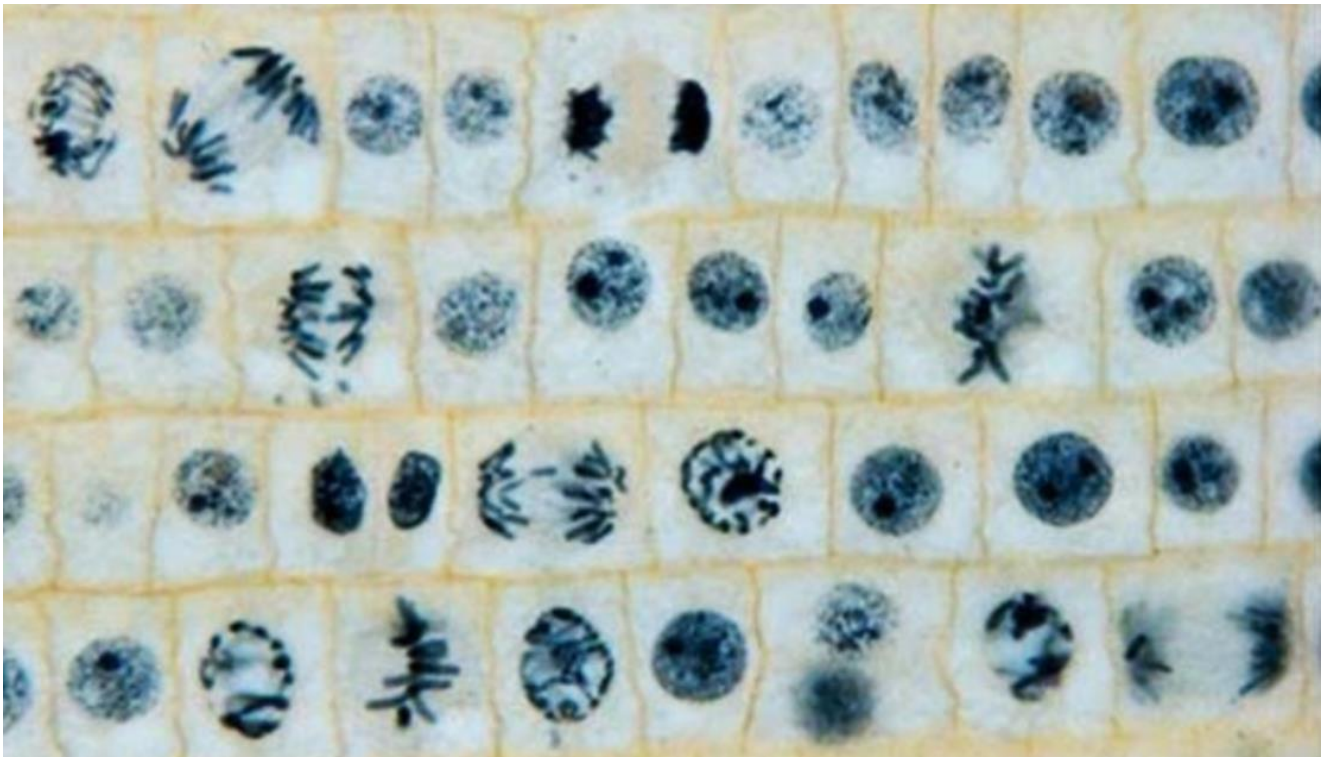
What is the Purpose of Tutorial 2?

Proteins are one of the main molecules found in cells and they perform many cellular functions. It is important to understand their role and how genes contain the information to build them.

Sometimes proteins have a defect, and they don't function properly. Imagine a car without wheels, it is still a car, but it wouldn't go very far.
We are going to look into how genes make proteins and how sometimes faulty proteins are produced. In this tutorial, you will learn to:

- Describe the link between a gene and a protein
- Define what a gene is
- Explain how genetic mutations affect proteins

Starter activity



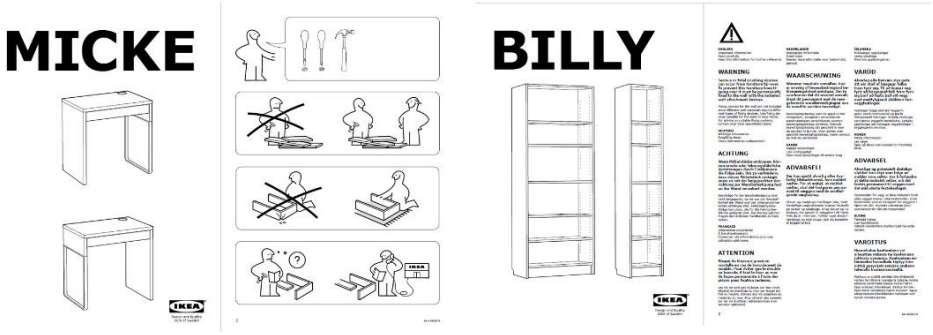
Name the phase of the cell cycle when cells divide.

In the picture above, circle the cells in metaphase. How many are there?

Draw a square around the cells in anaphase. Describe the cell encountering a problem.

From genes to proteins

Genes are the **instruction manuals…**



… to **build proteins**. The same way one instruction manual allows you to build one particular piece of furniture.

In this example, even though the desk and the bookshelf are made from the same material, they have different functions. But the instruction manual remains similar: it's a piece of paper with instructions.

There are thousands of different types of proteins in human cells. Some proteins are involved in the transport of molecules between the inside and the outside of the cell; some proteins have a structural role: they maintain the shape of the cell; some are enzymes and can cause biochemical reactions.

Activity 1 - A gene codes for a protein

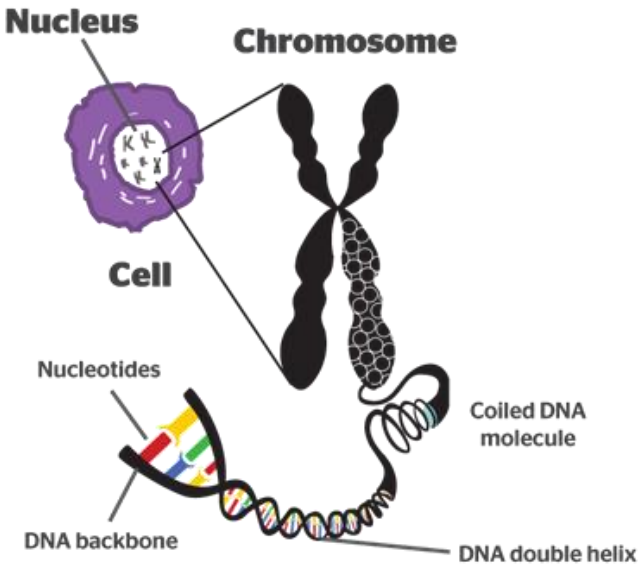
- Complete the sentences below using the following words:
  protein; genetic information; function; DNA; gene

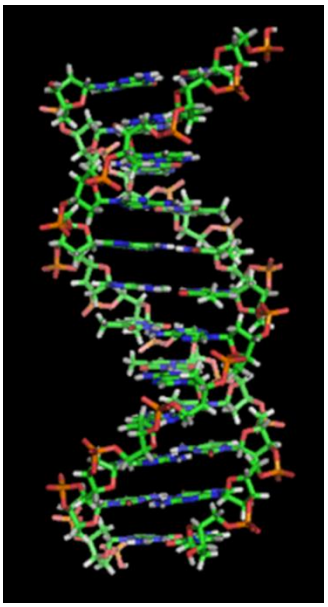
In the cell, a gene is made of _____ and is located on chromosomes. A _____ codes for a _____. It means a gene carries the _____ _____ to make a protein.

Different genes code for different proteins and each protein has a different _____.

- Draw a diagram summarising the ideas of the paragraph above.

Activity 2 – Genes and the structure of DNA





What is the name of the structure of DNA?

How many bases form the alphabet of DNA?

What is the name of a long sequence of bases and what does it code for?

Activity 3 – Genetic mutations

Spot the difference! The sequences of DNA below code for proteins. Circle any difference in the base sequence of DNA or in the amino acid sequence of the protein.

- **Original**
  ATG CAT AGA TCC TTG GAT GGT CAA
  ↓
  Met-His-Arg-Ser-Leu-Asp-Gly-Gln
- **Variation 1**
  ATG CAT AGA TCC TTA GAT GGT CAA
  ↓
  Met-His-Arg-Ser-Leu-Asp-Gly-Gln
- **Variation 2**
  ATG CAT AGA TCC TCG GAT GGT CAA
  ↓
  Met-His-Arg-Ser-Ser-Asp-Gly-Gln
- **Variation 3**
  ATG CAT AGA TCC TTG TTG GAT GGT CAA
  ↓
  Met-His-Arg-Ser-Leu-Leu-Asp-Gly-Gln

Activity 4 – Mutant mice

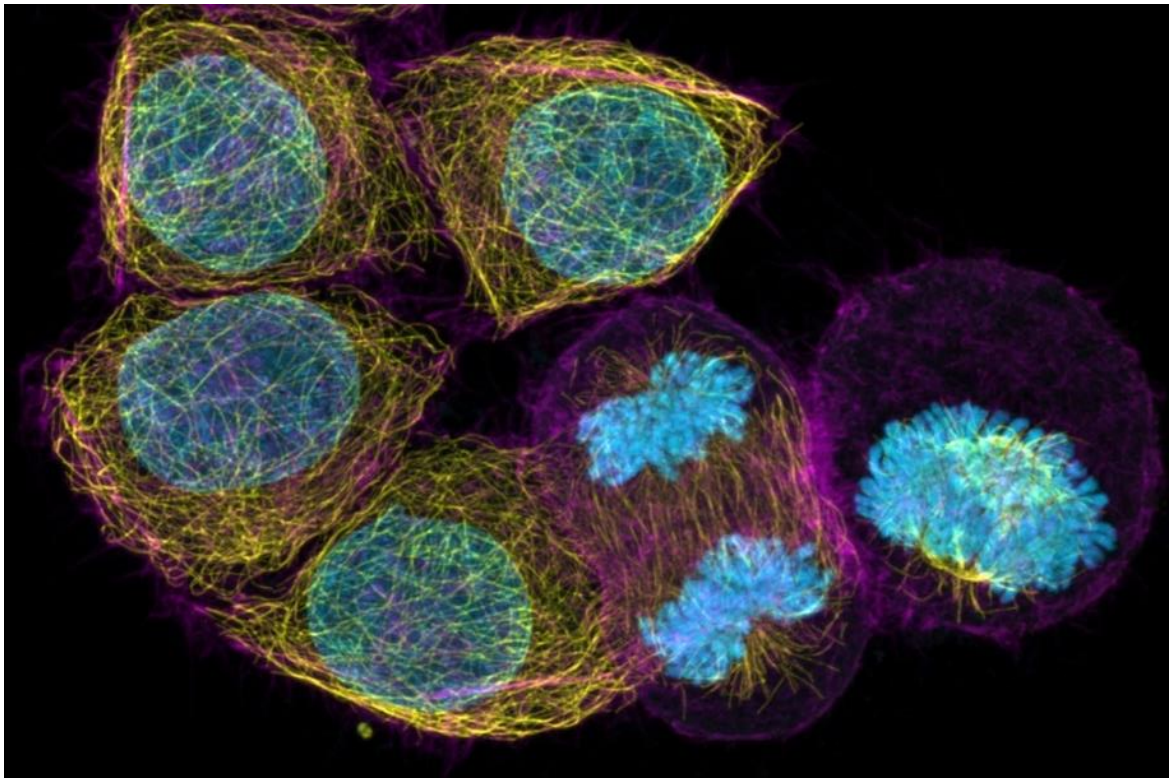
- The colour of skin and hair is determined by a pigment called melanin. The mice in the picture have different fur colours.
  Discuss in pairs why these mice have different fur colours and write your ideas below.

Homework – Genes to build proteins

- Describe the link between a gene and a protein.
- Explain how a mutation can lead to a modified protein.
- Identify and briefly describe a disease caused by a problem in mitosis or in the cell cycle.

Success criteria
- Write 150-250 words.
- Reference your sources of information (see Appendix 1).
- Knowledge is used to build and support highly effective scientific arguments and explanations.
- Identifies and critically evaluates key scientific arguments and evidence.
- Include key words from the glossary and demonstrate that you understand them by explaining what they mean and how they relate to the topic.
- Organise your ideas in paragraphs with a logical structure.
- There are no, or very few, errors in spelling or grammar.

Tutorial 3 – Let's get technical



What is the Purpose of Tutorial 3?

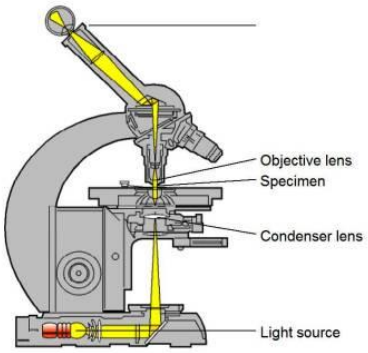
To study mitosis, researchers have several biological techniques available: fluorescent microscopy to obtain beautiful and useful images of cells, and genetic tools to analyse the role of genes and proteins. We are going to understand how these techniques are used.

- Describe common tools used in research (fluorescent proteins and mutations)
- Explain how to use these tools to perform experiments in cell biology

Starter activity

Draw a diagram of how a mutation in a gene can lead to the modification of a protein.

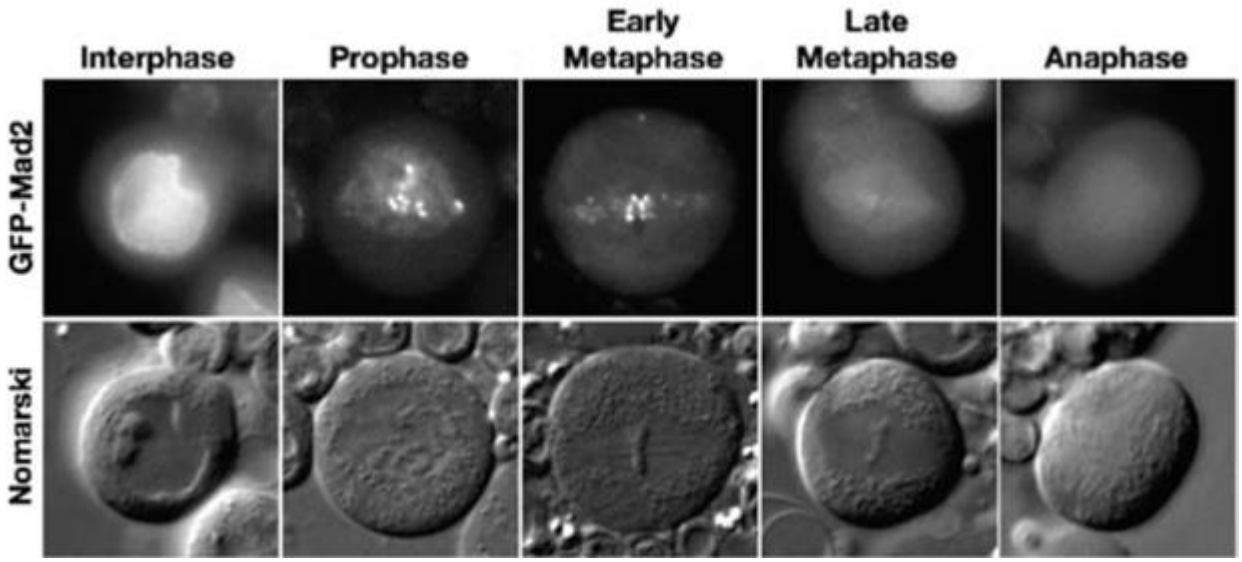
Activity 1 – By the light of the microscope



- What does GFP allow researchers to do?

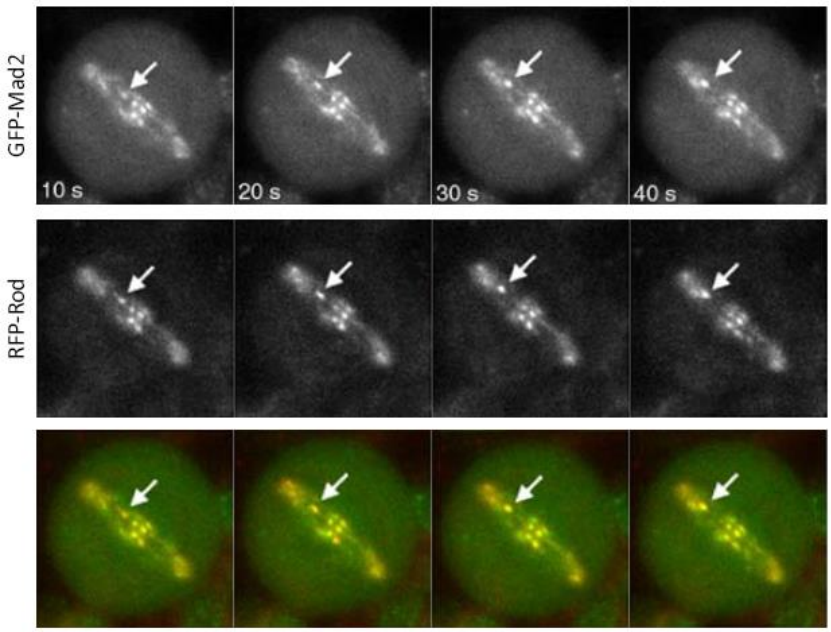
- Draw a diagram of how the GFP gene can be inserted in the DNA to make a fluorescently labelled protein

Activity 2 – Using GFP to look at Mad2 protein in mitosis



Using the video and the picture above, describe the behaviour of Mad2 protein. Use bullet points for each stage of mitosis.

Activity 3 – Looking at two signals at the same time



Two proteins can be labelled with two different fluorescent tags in the same cell.
First, compare the general localisation of the proteins Mad2 and Rod. Second, compare Mad2 and Rod at the level of the particle indicated by the arrow.

Activity 4 – Whom are you calling mutant?

Spot the differences between the two pictures below

- What piece of furniture is missing in the picture on the right?

- Based on these pictures, what is the function of the missing object? How can you tell?

- Scientists want to track the movement of the blue bag across the room. What tool could they use? Describe what you would do if the blue bag were a protein coded by a gene.

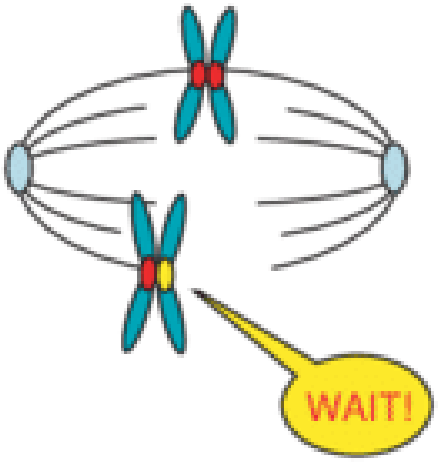
Key point:
By looking at what happens when an object is missing, we can deduce its function. The same principal applies to genetics. If a gene/protein is removed from a cell, we can determine its role by analysing the consequences of its absence.

Homework - Use of biological tools by scientists

Explain how scientists can use fluorescent markers and mutations to do research in biology. To answer this question, first describe what fluorescent markers and mutations are. Second, illustrate the use of these biological tools.

Success criteria
- Write 150-250 words.
- Reference your sources of information (see Appendix 1).
- Knowledge is used to build and support highly effective scientific arguments and explanations.
- Identifies and critically evaluates key scientific arguments and evidence.
- Include key words from the glossary and demonstrate that you understand them by explaining what they mean and how they relate to the topic.
- Organise your ideas in paragraphs with a logical structure.
- There are no, or very few, errors in spelling or grammar.

Tutorial 4 – Order, order! Wait for the attachment of chromosomes before separating them



What is the Purpose of Tutorial 4?

To avoid an incorrect number of chromosomes after cell division, chromosomes need to separate only after they have properly attached to the mitotic spindle. Otherwise, a chromosome might end up lost in the middle.

The mitotic checkpoint (also called spindle checkpoint) delays the separation of chromosomes with a wait signal until all the chromosomes are properly attachment to the mitotic spindle.

During this tutorial, you will understand how the cell sends this wait signal and what the proteins of the mitotic checkpoint are.

- Describe how the mitotic checkpoint works from a molecular point of view
- Analyse the consequences on the cell of mutations in checkpoint genes

Starter activity

Define the term mutant in genetics. Then explain how scientists can use that tool to do research.

Activity 1 – A wait signal delays mitosis

Draw a diagram of a cell undergoing normal mitosis on the left, and a cell without a mitotic checkpoint on the right.

Activity 2 – Testing for the mitotic checkpoint

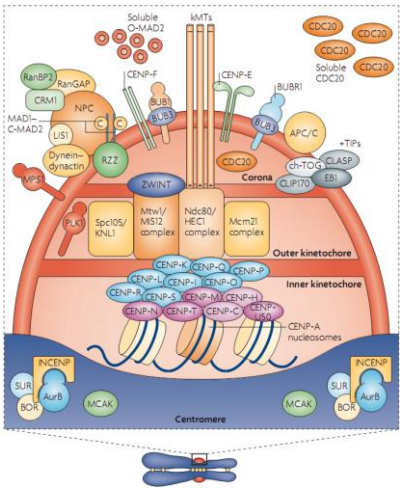
A drug called colchicine can disrupt the mitotic spindle. When there is a problem with the mitotic spindle, the checkpoint will block the cells in mitosis.

Scientists have counted the percentage of cells in mitosis (mitotic index) before and after giving the drug. The results for normal cells and mutant cells are given in the table below.

Type of cell	Time in colchicine (min)	Mitotic index
Normal cells	0	3.1
	60	9.2
rod mutant	0	2.6
	60	1.9
mad2 mutant	0	3.7
	60	3.1

First, compare the results obtained with and without the drug in normal cells. Second, analyse the effect of the drug in *rod* and *mad2* mutant cells.

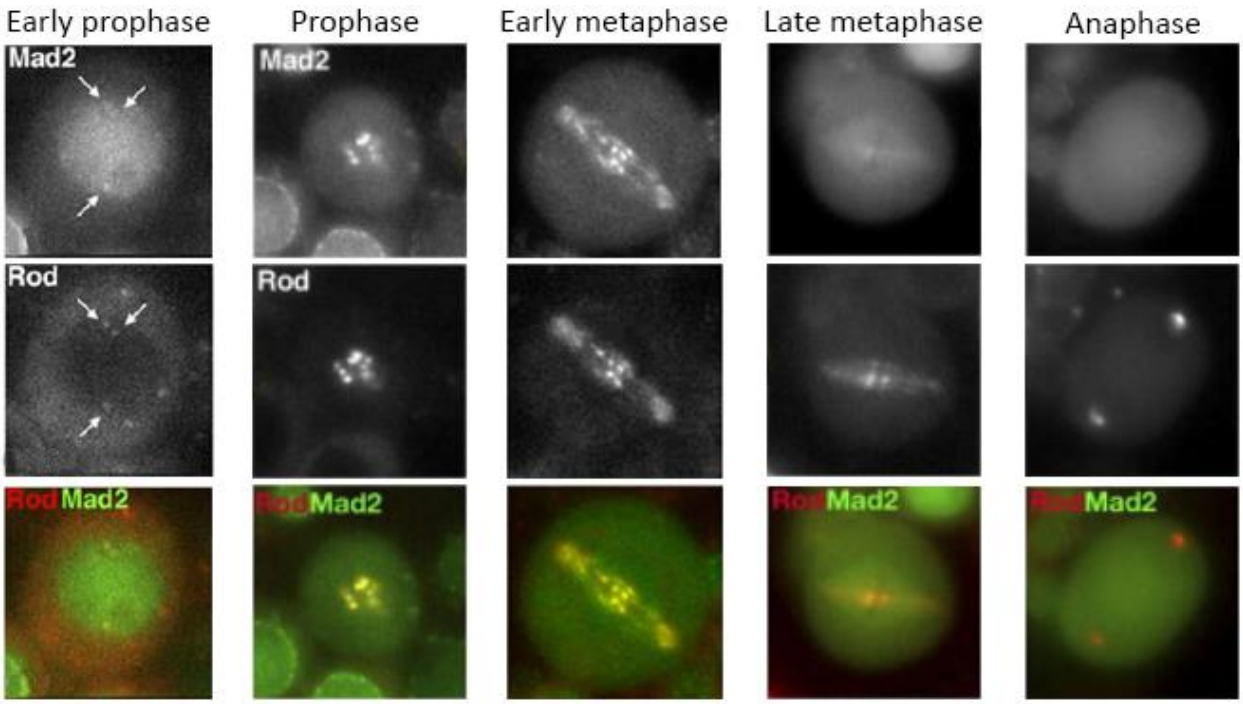
Protein scaffolding



To build a scaffolding around a house, you have to do it in order. First the base, then the top. Protein scaffolding at the kinetochore is build the same way. Proteins are gathered on top of each other.

We are going to look at scientific results and analyse how the mitotic checkpoint is assembled.

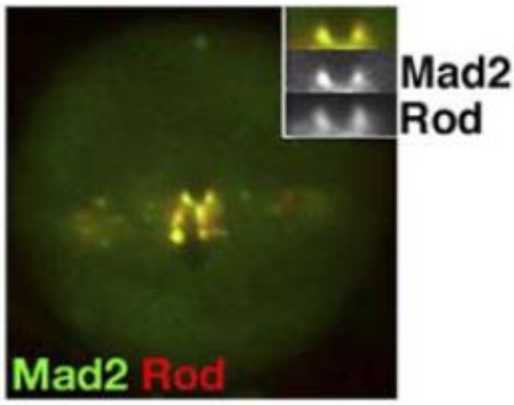
Activity 3 - Comparing the behaviour of two checkpoint proteins: Mad2 and Rod

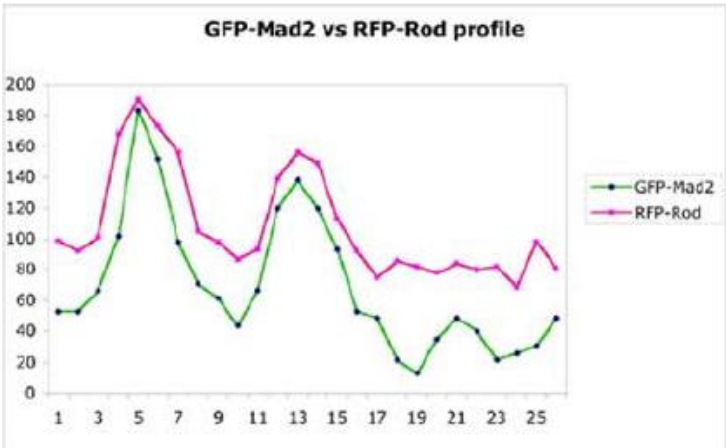


Mad2 and Rod during mitosis in normal cells.

Describe the similarities and differences in the behaviour of Mad2 and Rod proteins for each stage of mitosis.

Activity 4 – Quantifying two signals





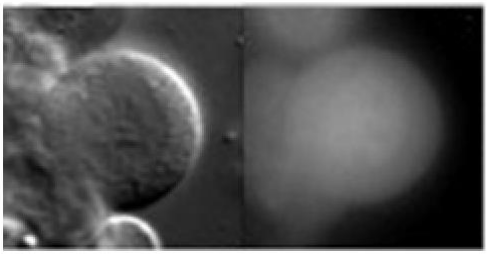
Counting the intensity of pixels.

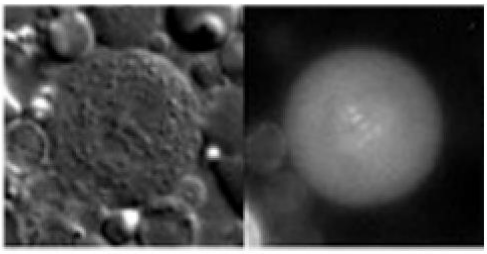
A single line of pixels was drawn through the centre of kinetochore images (top-right of the image on the left). A plot was obtained reflecting the intensity of the pixels.

Compare the profile of pixel intensity between Mad2 and Rod, in particular the shape of the peaks of intensity.

Activity 5 - *mad2* and *rod* mutants: how does removing one affect the other?

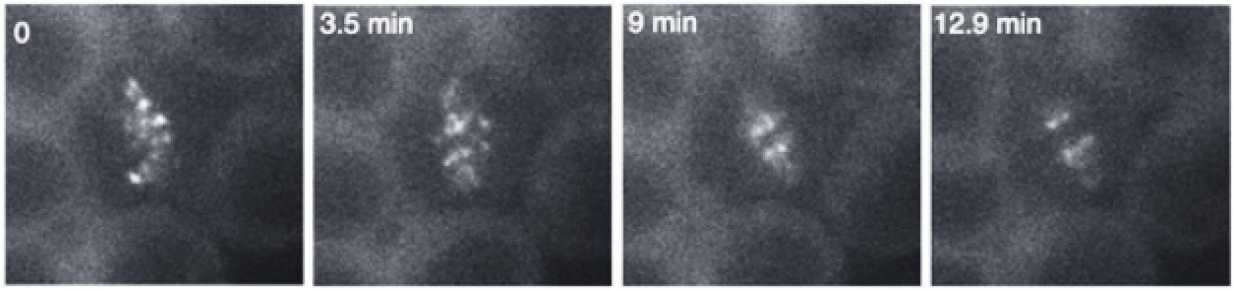
GFP-Mad2 in *rod* mutant





After watching the video, compare the localisation of Mad2 protein in normal cells and in *rod* mutant cells.

GFP-Rod in *mad2* mutant



Compare the localisation and behaviour of Rod protein in normal cells and in *mad2* mutant cells.

Homework – Experiments on mitosis
Summarise the main points of today's experiments. What can you conclude regarding the scaffolding of checkpoint proteins between Mad2 and Rod?

Success criteria
- Write 150-200 words.
- Reference your sources of information (see Appendix 1).
- Knowledge is used to build and support highly effective scientific arguments and explanations.
- Identifies and critically evaluates key scientific arguments and evidence.
- Include key words from the glossary and demonstrate that you understand them by explaining what they mean and how they relate to the topic.
- Organise your ideas in paragraphs with a logical structure.
- There are no, or very few, errors in spelling or grammar.

Additional notes

Tutorial 5 – I have a proposal for you

What is the Purpose of Tutorial 5?

Now that you are an expert on mitosis and its checkpoint, we are going to explore how to ask scientific questions.

- Formulate a hypothesis on the function of a new checkpoint protein
- Propose experiments based on the ones you know to test a hypothesis
- Understand how to structure a research proposal

Activity 1 – Mad1, a new checkpoint protein has been identified

Write down any information discussed regarding Mad1.

Activity 2 – Writing a research proposal

A research proposal is a structured way of saying 'this is what we know and this is what I would like to research'. If you wanted to investigate why the sky is blue, you would first state what you know about visible light and colours, and then you would offer a set of experiments to test why the sky is blue.

Sometimes it is hard to know where to start! Having a clear structure for your text will help you.

The final assignment is as follows:

> Write a research proposal to investigate the role of Mad1 in the mitotic checkpoint.

The main parts of a research proposal are:

1. Title
2. Background and context
3. Research question
4. Research methods
5. References

Let's look in detail at each part and see how it can be applied to the final assignment.

1. Title

The title should be one line that will summarise the rest of the text. Try to write one that is clear and precise. You can help yourself with the title of the final assignment.

2. Background and context

What do we know? This part contains all the information the reader needs in order to understand the topic. This includes general concepts in cell biology and genetics, and more specific information on the mitotic checkpoint proteins.

Look back at all the tutorials and write down what information you think is essential to include. You can write them as bullet points.

3. Research question

What are you trying to test? This part should explain what experiments you want to perform and why you want to do them. Look at the experiments we have analysed together and write down if any similar experiments could be done to investigate the role of Mad1 in the mitotic checkpoint.

4. Research methods

How are you going to do the experiments? This part should include the techniques you plan to use for the experiments. Look back at the tutorials and write down the main techniques that have been used.

5. References

The proposal should include a list of your references. See Appendix 1 for more details.

The structure of the proposal can also be simplified as:

- Introduction
- What I know on the topic
- What I plan to do
- Why I plan to do it
- How I plan to do it

Homework - Final assignment:

The final assignment is in two parts.

- The first part is a problem set. You will have to use the knowledge and the skills you acquired to analyse some scientific experiments.

- The second part of the final assignment is a written research question that builds on everything we have done so far.

Part 1 – Problem set

The problem set has four questions for a total of 16 marks.

Question 1 – Effect of colchicine treatment in normal cells and in mutant cells. (3 marks)

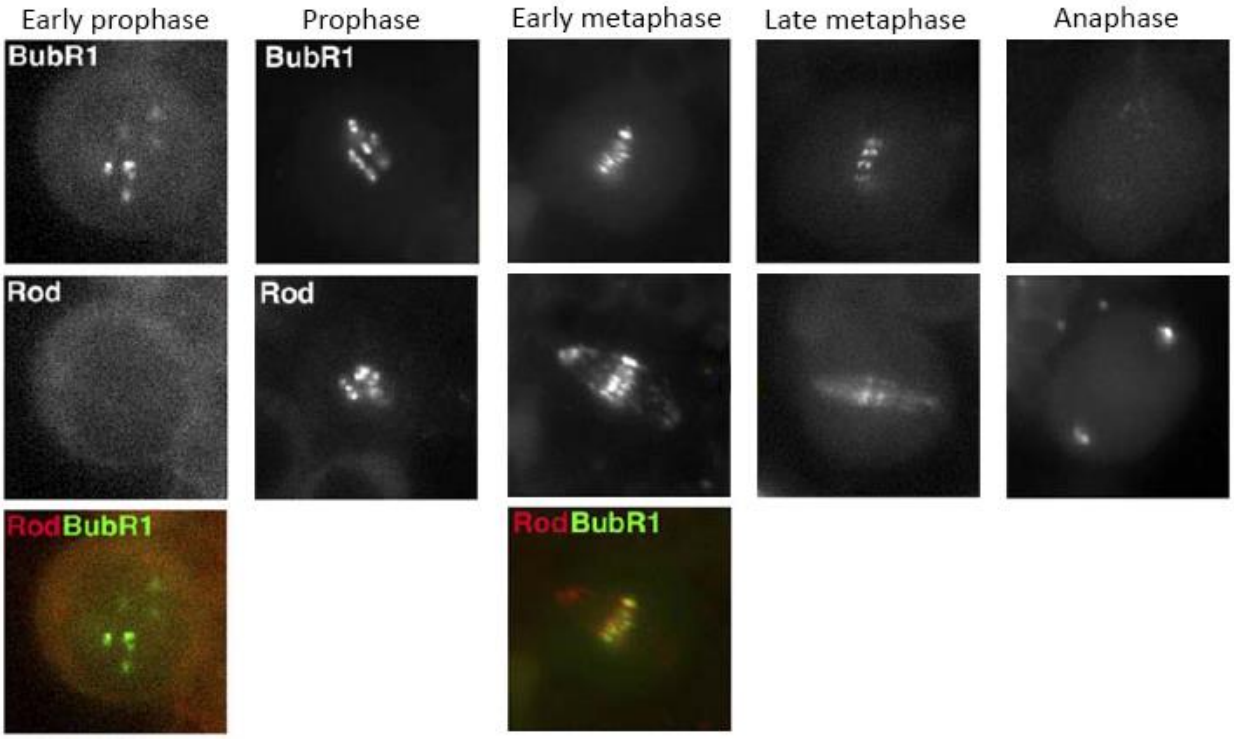
Type of cell	Time in colchicine (min)	Mitotic index
Normal cells	0	3.1
	60	9.2
rod mutant	0	2.6
	60	1.9
bubR1 mutant	0	2.0
	60	1.6

State the effect of colchicine on the mitotic spindle. (1)

Explain why the mitotic index is increasing in normal cells after a treatment of 60 minutes in colchicine. (1)

Explain why the mitotic index is not increasing in *rod* and *bubR1* mutant cells after a treatment of 60 minutes in colchicine. (1)

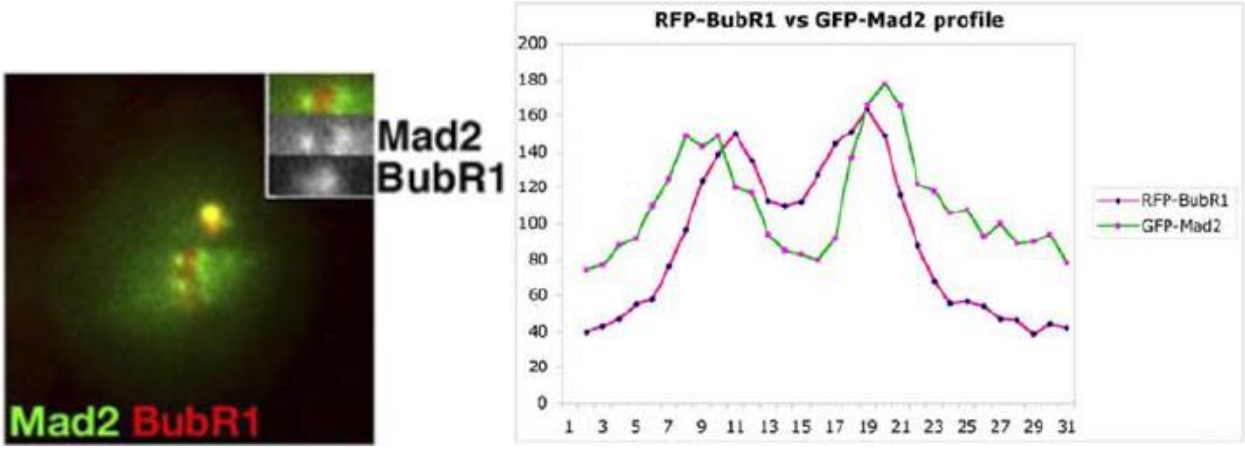
Question 2 – Behaviour of BubR1 and Rod proteins during mitosis in normal cells. (5 marks)

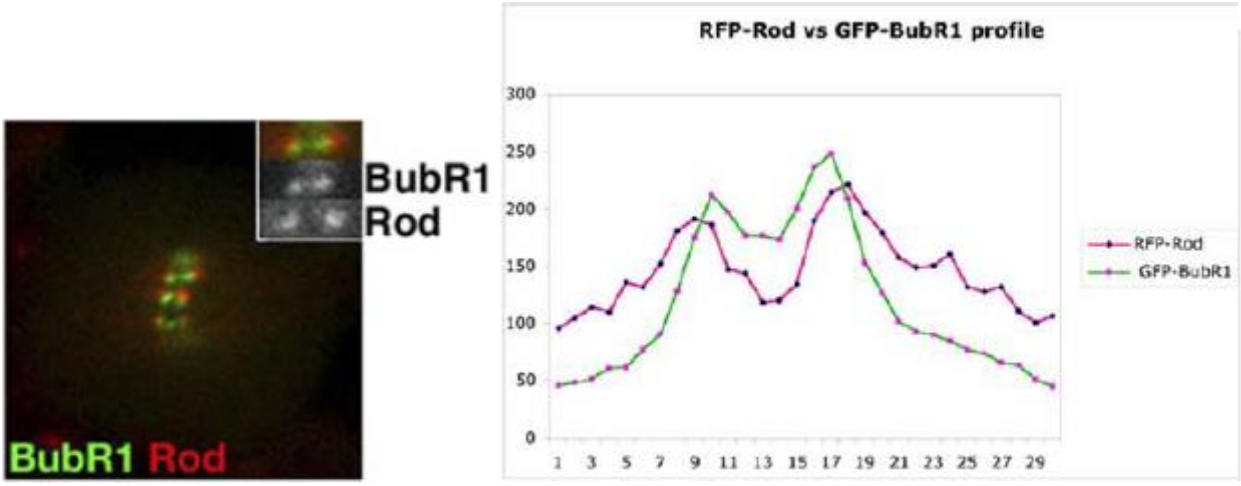


Describe the similarities and differences in the behaviour of the BubR1 and Rod proteins for each stage of mitosis. (5)

Question 3 - Profile of signal intensity at the kinetochore for Mad2, bubR1 and Rod proteins in normal cells. (5 marks)

A single line of pixels was drawn through the centre of kinetochore images (top-right of each image on the left). A plot was obtained reflecting the intensity of the pixels.



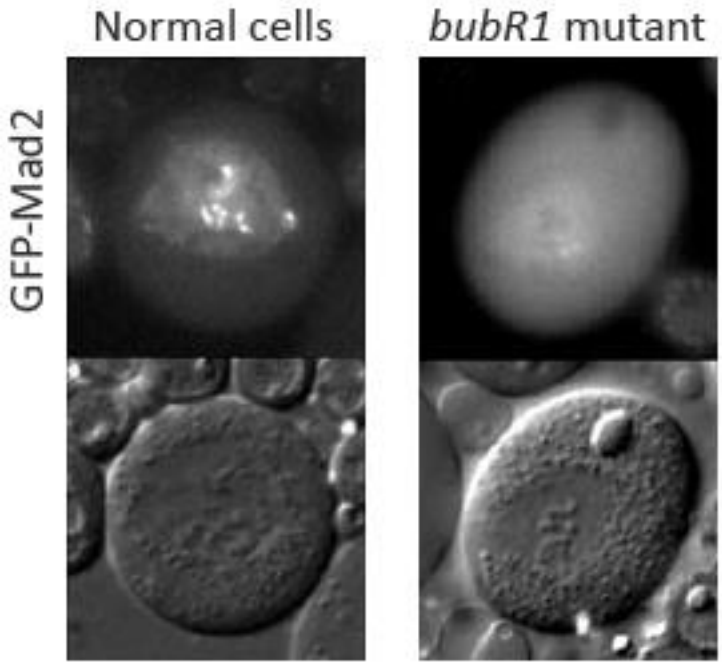


Compare the localisation and the profiles of pixel intensity of Mad2 and BubR1. (2)

Compare the localisation and the profiles of pixel intensity of Rod and BubR1. (2)

What can you conclude regarding the localisation of BubR1 at the kinetochores? (1)

Question 4 – Localisation of Mad2 protein in prophase of normal and bubR1 mutant cells. (3 marks)



Compare the localisation of Mad2 protein in prophase of normal and *bubR1* mutant cells. (1)

What can you conclude regarding the scaffolding of BubR1 and Mad2 at the kinetochore? (2)

Part 2 – Written task

Write a research proposal to investigate the role of Mad1 in the mitotic checkpoint.

Details:

Your research lab has made some exciting new discoveries. Mad1 is a newly identified mitotic checkpoint protein. It is time to plan the future by proposing experiments.

Your task is to write a research proposal of approximately 1000 words to investigate the role of Mad1 in the mitotic checkpoint.

In your proposal, you must include:

- An introduction to mitosis

- How mitosis is regulated by the mitotic checkpoint

- Why studying the mitotic checkpoint is important

- The relationship between a gene and a protein

- The biological tools available to do research

- Propose one set of experiments to investigate the Mad1 and the mitotic checkpoint. Base the experiments on the ones analysed during the tutorials. You can also use the experiments of part 1 of the final assignment. Detail the purpose of the experiments and any expected results.

Success criteria:

- Use the new mitotic checkpoint protein Mad1 described in activity 1 of this tutorial as a target for your experiments.

- Structure the research proposal with a clear introduction, main part and conclusion.

- Include the key words from the glossary and demonstrate that you understand them by explaining what they mean and how they relate to the topic.

- Figures should be clearly labelled.

- Any references and sources of information should be properly referenced (see Appendix 1).

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 you use a reference?

You should use a reference when you:

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

How do I reference?

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

1. **A marker in your assignment**: After you have used a reference in your assignment (you have read something and included it in your work as a quote, or re-written it your own words) you should mark this is in your text with a number, e.g. [1]. The next time you use a reference you should use the next number, e.g. [2].
2. **Bibliography**: This is just a list of the references you have used in your assignment. In the bibliography, you list your references by the numbers you have used, and include as much information as you have about the reference. The list below gives what should be included for different sources.

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

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

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

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

    c. **Articles** – 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

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