TEACHER'S NOTES

WHAT'S THE LINK?

OVERVIEW

Aimed at key stage 4 pupils.

In this activity the pupils will learn about the relationship between Sickle Cell Anaemia and malaria.

LEARNING OBJECTIVES

- Learn about malaria and how this disease affects our bodies
- Understand the relationship between malaria and Sickle Cell Anaemia
- Appreciate that having the sickle cell trait gives a person some protection against malaria
- Understand that in areas where malaria is common natural selection favours people with the sickle cell trait

CURRICULUM LINKS

- KS4: The ways in which organisms function are related to the genes in their cells
- KS4: Human health is affected by a range of environmental and inherited factors, by the use and misuse of drugs and by medical treatments
- KS4: Organisms are interdependent and adapted to their environments

YOU WILL NEED

- Student worksheets

Activity

- Watch the film **Pamela's story**
- Students can complete the activities on this sheet individually or in pairs
- Discuss the pattern of inheritance for Sickle Cell Anaemia
- Before students complete question 4, explain that there are some countries around the world where there is limited access to treatments for malaria and Sickle Cell Anaemia. In these places not everyone is able to access treatment and this makes a significant difference to the outlook for these patients
- Question 4 asks students to imagine three different people – one with no sickle cell alleles, one with sickle cell trait and one with Sickle Cell Anaemia living in different countries. Students have to complete the table by saying what they think the life expectancy or state of health would be for each person in each country. You may want to tell students that the three answers they can choose from are:
  - Above average life expectancy
  - Average life expectancy
  - Below average life expectancy
- Question 5 asks students to consider natural selection and the sickle cell trait

ANSWERS

1. What relationship can you see between the number of cases of malaria in an area and the number of babies born with Sickle Cell Anaemia there?

The students should note that Africa has the highest number of people infected with malaria and it also has the greatest number of babies born each year with Sickle Cell Anaemia. In comparison, the table shows that no-one has been infected with malaria in England and this area has a lower number of babies born each year with Sickle Cell Anaemia than Africa. This suggests that in areas where malaria is common, Sickle Cell Anaemia is more common.

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ANSWERS

continued

2. Which of the following inheritance patterns describes the way Sickle Cell Anaemia is passed between generations?

b) Recessive pattern of inheritance.

3. How many copies of the sickle cell allele would someone have if they were affected with Sickle Cell Anaemia?

They would have two copies of the sickle cell allele.

Sickle Cell Anaemia and Malaria – the Link

4. Fill in the gaps in the table; some have been done for you.

	No sickle cell alleles	Sickle cell trait	Sickle Cell Anaemia
Do they have protection against malaria?	NO	**YES**	**NO**
What would happen if they lived in country with high levels of malaria and very limited treatments for malaria and Sickle Cell Anaemia? (eg. Kenya)	**Average life expectancy**	**Above average life expectancy**	Below average life expectancy
What would happen if they lived in country with low levels of malaria and high standards of treatment for malaria and Sickle Cell Anaemia? (eg. UK)	**Average life expectancy**	Average life expectancy	**Below average life expectancy**

Natural Selection

5. Imagine if malaria suddenly became very rare in Africa - what do you think would happen to the frequency of the sickle cell alleles over time? Explain your answer

If malaria became very rare then we would expect that the frequency of the sickle cell alleles would decrease over time. If malaria is no longer common then it is not an advantage to have the sickle cell trait, natural selection would no longer favour people with these alleles. We would therefore expect the frequency of the sickle cell allele in the population to decrease.

6. Imagine if malaria suddenly became common in England – what do you think would happen to the frequency of the sickle cell alleles over time? Explain your answer

If malaria became common in England, then we would expect the frequency of the sickle cell alleles to increase over time. People with the sickle cell trait are more likely to survive if they get malaria, so where malaria is common natural selection favours people with sickle cell trait. This would mean that people with this trait are more likely to go on and have children and pass on their genes including the sickle cell allele. Over time this would increase the frequency of the sickle cell allele in the population.

FURTHER information

See Pamela's Story Teacher Factsheet on Sickle Cell Anaemia for basic information.
For more detailed information, link to the patient support group: **www.sicklecellsociety.org**

For further information about malaria and Sickle Cell Anaemia and research being carried out in this area visit the Wellcome Trust website: **http://malaria.wellcome.ac.uk/**

The World Health Organisation website can also provide further information about malaria and work taking place globally to tackle this disease:**http://www.who.int/topics/malaria/en**

WHAT'S THE LINK?

PUPIL WORKSHEET

There is a link between Sickle Cell Anaemia and malaria. One connection is that they both affect red blood cells but you will discover that there are other links too.

You have heard from Pamela who has Sickle Cell Anaemia. People have known for hundreds of years that there is a link between Sickle Cell Anaemia and malaria. Use the table below to try and identify this link.

WHAT IS MALARIA?

Malaria is an infectious disease that is caused by a parasite that damages red blood cells. Each year more than 300 million people are infected with malaria, and 2 million people are killed every year. A single-celled parasite causes malaria and this parasite is spread by a blood-sucking mosquito.

When the mosquito bites, it injects the parasite into your bloodstream. The parasite travels first to your liver, where it reproduces and then it invades your red blood cells. In your body the parasite spends most of its time inside your red blood cells, feeding on your haemoglobin.

Area	Number of people who are infected with malaria in that area (each year)	Number of babies born every year with Sickle Cell Anaemia (approximately)
Africa	212 million	200,000
England	1,300	350

1. What relationship can you see between the number of cases of malaria in an area and the number of babies born with Sickle Cell Anaemia there?

2. Which of the following inheritance patterns describes the way Sickle Cell Anaemia is passed between generations?

   a) Dominant pattern of inheritance

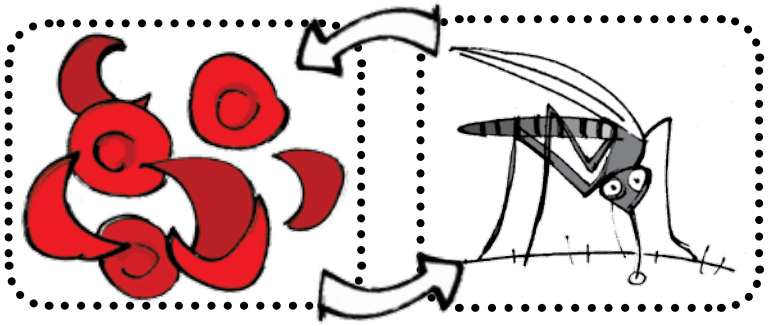
   b) Recessive pattern of inheritance

   c) X-linked pattern of inheritance

3. How many copies of the sickle cell allele would someone have if they were affected with Sickle Cell Anaemia?

MALARIA & SICKLE CELL ANAEMIA: THE LINK

If people with Sickle Cell Anaemia do not receive treatment then many of them would sadly die young. You therefore might think that the sickle cell allele wouldn't occur very often – it would have a low frequency in the population. However we have seen that in areas where malaria is common, Sickle Cell Anaemia is more common.



WHAT'S THE LINK?

When scientists investigated this relationship they made some interesting discoveries. People with one copy of the sickle cell allele are said to have sickle cell trait (this is also known as being a carrier of sickle cell). They have some 'sickle-shaped' red blood cells but lots of normal ones, and they generally do not experience any symptoms of Sickle Cell Anaemia. It has been found that people with the sickle cell trait have some protection against malaria. They are more likely to survive a malaria infection than people with no 'sickle-shaped' red blood cells.

You may expect that this would mean that people with Sickle Cell Anaemia also have some protection against malaria. However this is not the case and if people with Sickle Cell Anaemia are infected with malaria and don't receive treatment, they are unlikely to survive the infection.

In many countries around the world there is limited access to treatments for malaria and Sickle Cell Anaemia. This obviously makes a significant difference to the outlook for patients.

The table below asks you to imagine three different people, one with no sickle cell alleles, one with sickle cell trait and one with Sickle Cell Anaemia.

4 ***Fill in the gaps in the table; some have been done for you.***

	No sickle cell alleles	Sickle cell trait	Sickle Cell Anaemia
Do they have protection against malaria?	NO		
What would happen if they lived in country with high levels of malaria and very limited treatments for malaria and Sickle Cell Anaemia? (eg. Kenya)			Below average life expectancy
What would happen if they lived in country with low levels of malaria and high standards of treatment for malaria and Sickle Cell Anaemia? (eg. UK)		Average life expectancy	

NATURAL SELECTION

You can see from the table that in areas where malaria is common it is an advantage to have the sickle cell trait. This is because it means that you are more likely to survive if you get malaria. So where there is a high level of malaria, natural selection favours people with the sickle cell trait.

People with sickle cell trait are more likely to go on and have children and pass on their genes, including the sickle cell allele. This is why Sickle Cell Anaemia is more common in areas where there is lots of malaria.

In areas where malaria isn't present, it is not an advantage to have the sickle cell trait and so sickle cell disease is less common.

5 ***Imagine if malaria suddenly became very rare in Africa - what do you think would happen to the frequency of the sickle cell alleles over time? Explain your answer***

6 ***Imagine if malaria suddenly became common in England – what do you think would happen to the frequency of the sickle cell alleles over time? Explain your answer***