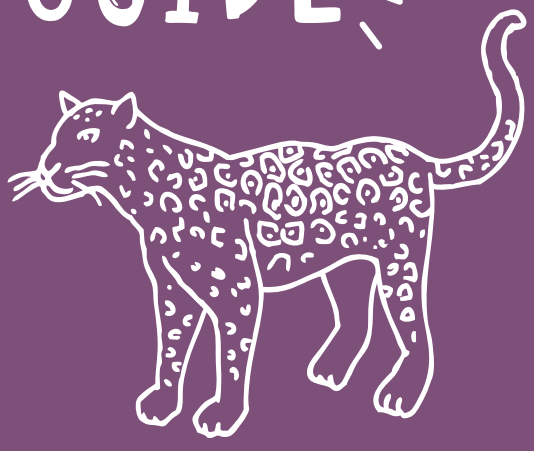
LEARN AT CHESTER ZOO

JAGUAR MELANISM CASE STUDY TEACHER'S GUIDE



The aim of this online resource is to provide context for your students' classroom learning, by using the fascinating case study of our two Jaguars here at Chester Zoo! We'll focus on phenotypic variation in Jaguars and explore the genetic conditions under which melanism (black fur coat) occurs.

NOTE: This case study is designed to complement your teaching sessions, so a base knowledge of heredity and familiarity with genetic terminology is required. Think of it as a fun alternative to the textbook peppered moth examples!

Needed: Case Study PDF
Student Worksheets: If Goshi is... and Punnet Squares
KS4 Conservation Genetics Glossary (optional)

This step by step guide will take you through how to deliver the accompanying PDF to your students. We've even referenced which bits of information match each page.

Pages 2-3

JAGUARS

Just to start you off, we have a little background information on Jaguars:

Jaguars are the only members of the scientific genus *Panthera* (aka the 'Big Cat' group) to live in the new world. The term 'black panther' can be used to describe any member of this Panthera genus that's born with a black coat – most commonly black Jaguars and Leopards.

They are the apex predators in their native regions, feeding on a variety of prey species including Tapir, Capybara and Caiman.

The Jaguar is well adapted for rainforest habitats. These adaptations may be behavioural or physical.

The patterned coats of all Jaguars help them to camouflage and may assist in predation.

While the Jaguar has no natural predators in the wild, their numbers are still declining in many areas of Central and South America.

They are under major threat from deforestation, habitat fragmentation and poaching. They are also implicated in human-wildlife conflict, as they are known to be killed by farmers as retribution for lost livestock.

Because of these problems, they have been classified as Near Threatened on the IUCN Red List.

GENETICS RECAP

Page 4

After a quick recap of some genetic terminology, it's time to explore how melanism (black coat) in Jaguars is inherited.

INHERITANCE IN JAGUARS

Page 5

Melanism refers to the phenotypic expression of a darker coat colour on an animal. There are two coat phenotypes in Jaguars – all black (melanistic) and yellow/black. Whilst we refer to the yellow/black colouration as being 'spotted' in this resource, black Jaguars also have a black rosette spot pattern - it's just a lot harder to see!

Melanism is caused by a 15 base pair deletion mutation on the MC1R gene. This gene codes for a pigment signalling receptor protein found in cell membranes. The mutation causes a change in the shape of the receptor protein which lies in the cell membrane. When the shape is altered, the pigment producing signalling is amplified and an abundance of pigment is created, resulting in the dark coat.

As this is a dominant mutation, if one copy of DNA from one parent contains the deletion then the offspring will have the mutant phenotype. In this case, if one set of the genes has the 15 base pair deletion on the MC1R gene, the Jaguar will have a black coat.

Page 6

So the genotype of yellow/black spotted Jaguar is always homozygous recessive (bb), but the genotype of black Jaguars could potentially be either homozygous dominant (BB) or heterozygous (Bb).

PUNNET SQUARES

Page 7

We can map out the potential genotypes of Jaguar cubs by exploring different parental genotype combinations; for this, we use Punnett squares! In this case study, the allelic composition for coat colours are bb, BB or Bb.

Page 8

We've given you an example of two heterozygous individuals, which are predicted to result in three black phenotypes and one spotted phenotype. Using the student worksheets, how many combinations can your students come up with…?
(Answer – there are 9 possible combinations!)

As expected, more offspring are predicted to be born with the dominant melanistic phenotype. The only instance in which all offspring are predicted to be born with the recessive spotted phenotype is when two spotted (bb) individuals breed.

CHESTER ZOO JAGUARS

Page 9

Now we've covered the theory behind melanism and inheritance, let's look at Chester Zoo's pair of Jaguars: Napo (male) and Goshi (female). This young pair has been selected to breed as part of the European Studbook recommendations for the species; so Chester Zoo could hear the pitter patter of tiny Jaguar paws in the future!

Page 10

We know Napo and Goshi's phenotypes, but not their genotypes; but we can use the information we've learned so far to predict what their potential offspring would look like!

Page 11

Since we don't know whether our female Goshi is heterozygous or homozygous dominant, there are two possible Punnett squares to complete. Using the student worksheets, map out the predicted offspring from both scenarios.

Page 12

If Goshi is heterozygous (meaning she has a copy of the dominant mutation, as well as the recessive allele) then the offspring will follow the pattern shown in the Punnett square on the left. If she is homozygous dominant (meaning she has two copies of the dominant gene) then all of her offspring will be melanistic with black coats, as shown in the Punnett square on the right.

So if they do breed, and any of her cubs are born spotted, then we'll know for sure that her genotype is heterozygous!

NATURAL SELECTION

Page 13

In the wild however, most Jaguars are not melanistic. In fact, less than 10% of all Jaguars have black coats. So why might the dominant trait not be passed from generation to generation?

Sometimes environmental factors can contribute to which phenotypes are passed down. Under the theory of evolution through natural selection, individuals with beneficial traits are more likely to survive and pass on these traits to the next generation. Applying this theory to Jaguars, we can hypothesise that Jaguars with the recessive spotted coats reproduce more successfully than Jaguars with the dominant melanistic colour.

It is thought that spotted coats may assist the Jaguars in ambush predation. As most prey species in the rainforest see in black and white, the dark spots on the light coat may help the Jaguars to camouflage more successfully than the more uniformly coloured melanistic individuals.

If the spotted phenotype results in more recessive trait holders surviving to breeding age, and consequently breed with other Jaguars with the recessive gene, it seems valid that the majority of Jaguars exhibit this adaptive trait.

Brainstorm with your students – if more than 90% of wild Jaguars are the spotted phenotype, which of the Punnett squares that we created earlier would show their genotypes?

This is a good opportunity to discuss allele fixation in a population. If the spotted alleles continue to be overrepresented in the wild community, eventually they may become fixed and the mutated melanistic allele, despite being dominant, may be lost.

FOLLOW UP

Why not follow up your classroom learning with a visit to see our Jaguars in the flesh? Check out the learning pages of our website for more information on organising a school trip:
chesterzoo.org/education/booking-your-visit

Whilst you're here, book onto our 75 minute Post-16 Conservation Genetics workshop, where we explore how modern scientific techniques help to protect Tigers and Leopards in Nepal:
chesterzoo.org/education/post-16/workshops/conservation-genetics

We also have lots of other fun free online learning resources for you to download:
chesterzoo.org/education/learning-resources

Got further questions? Feel free to Tweet us! @LearnatCZ

Curriculum Links: (Science)

KS3

Working scientifically:
- make predictions using scientific knowledge and understanding

Genetics and evolution
Inheritance, chromosomes, DNA and genes:
- Heredity as the process by which genetic information is transmitted from one generation to the next

- The variation between species and between individuals of the same species means some organisms compete more successfully, which can drive natural selection

- Changes in the environment may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction

KS4

Working scientifically:
- The development of scientific thinking using a variety of concepts and models to develop scientific explanations and understanding

- Experimental skills and strategies using scientific theories and explanations to develop hypotheses

- Analysis and evaluation, interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions

Evolution, inheritance and variation:
- Single gene inheritance and single gene crosses with dominant and recessive phenotypes

- Genetic variation in populations of a species

- The process of natural selection leading to evolution