Genetics: The Foundation of Animal Agriculture

Teacher Guide

Grade: 12

Subject: Biology

Unit: Understanding Biological Inheritance

SLO

B12-1-03 Distinguish between genotype and phenotype, use the terms appropriately when discussing outcomes of genetic inheritance

B12-1-04 Use punnet squares to solve a variety of autosomal inheritance problems and justify results using appropriate terminology

B12-1-05 Describe examples of and solve problems involving the inheritance of phenotype traits that do not follow a dominant-recessive pattern

B12-1-07 Describe examples of and solve problems involving sex-linked genes

B12-1-08 Use pedigree charts to illustrate the inheritance of genetically determined traits in a family tree and determine probability of certain offspring having particular traits

Pre-knowledge/new knowledge

- Students should have already learned the Specific Learning Objectives stated above
- Students will be introduced to new examples of the above Specific Learning Objectives
- Students will solve real world genetics problems relating to inheritance in animal agriculture

Genetics: the Foundation of Animal Agriculture

Since the beginning of agriculture 10,000 years ago, farmers have selected their best, most productive animals to breed with other high quality animals to improve the overall quality of their livestock. Long before genetics became a recognized scientific discipline in the mid 1800's, farmers were essentially using genetics to improve the productivity of their herd as well as create different breeds with unique traits that best suited their use and environment.

Today's livestock producers, whether they choose to focus on purebred animals or on crossing different breeds to produce animals that offer a combination of desirable traits, use the most up to date science of genetics to continually improve the production of their animals.

As a result, Canadian animal genetics are among the best in the world and much in demand. In fact, in 2012, Canada exported over $236 million in animal genetics including semen, embryos, breeding animals and hatching eggs.)

1. In cattle breeds such as Herefords, the ability to grow horns is a dominant trait (H), whereas polled (ie cannot grow horns) is recessive (h). Cattle without horns cause less injuries to other cattle and are safer to handle so many farmers prefer animals which are polled. If the farmer crosses a heterozygous female and homozygous polled male, create a punnet square to determine the likelihood that the offspring will be horned. How could the farmer ensure future generations of his cattle do not have horns?

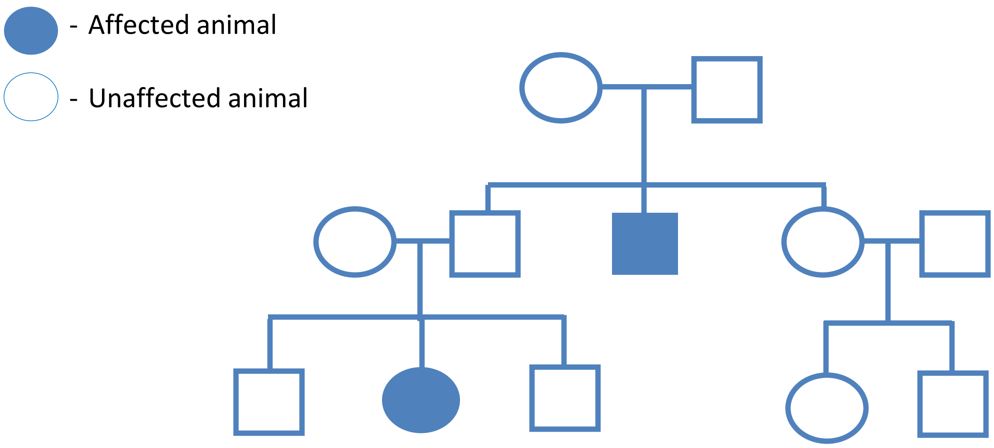
	h	**h**
H	Hh	Hh
h	hh	hh

50% of the offspring would have horns.

The farmer could stop breeding any cattle that have horns, as polled cattle is a recessive trait the farmer could only be sure the offspring would be polled if both parents were as well.

2. Syndactyly or mulefoot in cattle is a genetic anomaly causing a fused hoof, as seen on the right side of the picture shown here, though this is the most obvious symptom, the effected cattle are also very susceptible to heat stroke and rarely live long enough to reproduce. Based on the following pedigree, would you conclude that mulefoot is a recessive or dominant trait? How would you recommend the farmer reduce the likelihood of this disease in his herd? Recessive trait, the farmer should not use the F_1 generation or any of the offspring as breeding stock.

Left hoof is normal
Right hoof is syndactyly



Male 'slow feathering' genotype shown left, female 'fast feathering' genotype shown right.

3. In chickens a sex-linked gene for speed of feathering is used to determine gender in breeding stock, this technique is known as 'feather sexing'. Chickens are unique from mammals because the females are heterozygous (WX) and the males are homozygous (XX), as opposed to in mammals where males have XY sex chromosomes and females have XX sex chromosomes.

When hens carry a recessive WX^f genotype their wing feathers grow more quickly which is obvious at birth (see picture on left).

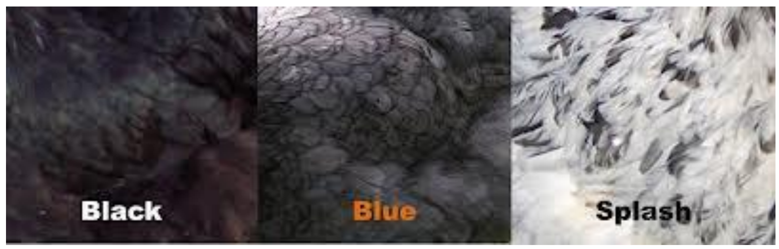
a) Which parent determines the feathering phenotype in female chicks?

b) What would the male and female parent flocks' genotypes be if the hatchery wanted to be sure they could differentiate between male and female offspring?

The roosters determine the phenotype in female chicks.

The roosters must be fast feathering homozygous (X^fX^f) and the females must be slow feathering homozygous X^FW.

4. In certain breeds of chickens crossing a black (BB) chicken with a 'splash' (bb) chicken produces a blue (Bb) chicken. What is the phenotype ratio when you cross two blue colored chickens?



	B	b
B	BB	Bb
b	Bb	Bb

1 black:2 blue:1 splash

5. Most genetic traits are *polygenetic*, meaning they are determined by multiple genes and cannot simply be described as recessive/dominant.
   In agriculture, Expected Progeny Differences (EPDs) are used to predict how the future offspring of an animal are likely to perform. A set of EPDs are associated with one specific animal, when choosing to use a bull for breeding, the farmer can use EPDs to decide which bull would best suit their needs and breeding program. *Each trait is in comparison to other bulls*, generally, the more calves a bull has sired, the more accurate the EPD value will be.

   The table below compares three EPD traits of three bulls in comparison to the average EPDs for that breed of cattle. The traits being described are:
   Weaning Weight: Gives farmers an idea of how heavy a calf might be they are weaned from their mothers, expressed in pounds
   Calving Ease: How easily a *heifer*, or first time mother cow, would give birth to the calf and is based on the percent of unassisted births
   Maternal Milk: The milk production and maternal abilities of a bull's daughters in comparison to the daughters of other bulls

	Calving Ease	Maternal Milk	Weaning Weight
Breed Average	+8	+24	+40
Bull A	+5	+30	+60
Bull B	+9	+26	+45
Bull C	+12	+20	+28

   Please use the above table to answer the following questions:
   a) Which bull has the best calving ease score? The lowest?
      Bull C has the best calving score, Bull A the lowest
   b) Which bull has the best weaning weight score? The lowest?
      Bull A has the best weaning weight score, Bull C the lowest
   c) Based on your answers above, how might weaning weight be related to calving ease?
      Calves with higher weaning weights tend to be bigger at birth, this means calving ease is lower because they may be more difficult to give birth to

   d) Why would the farmer be concerned with maternal milk values? What would they be planning to use the offspring for?
      A farmer might want to keep the offspring as 'replacement heifers' or sell them for other farmers to use for breeding.

Additional Resources:

Rick Mercer Report: Rick at Agribition video
May be found via search on Youtube or through the AITC-M Resources page.

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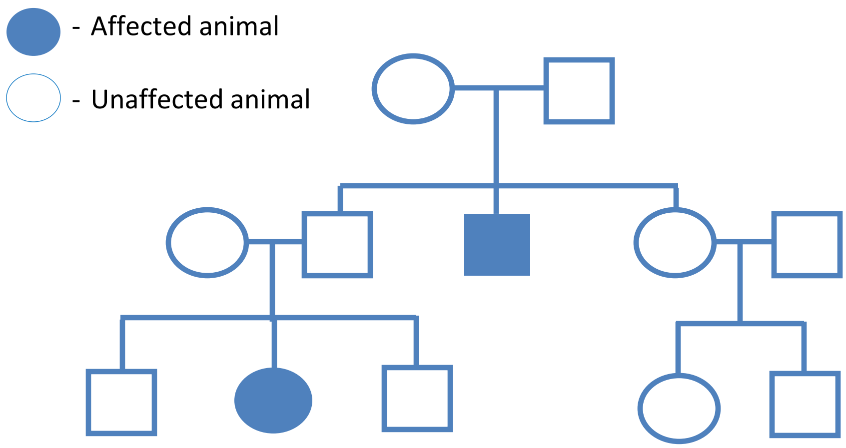

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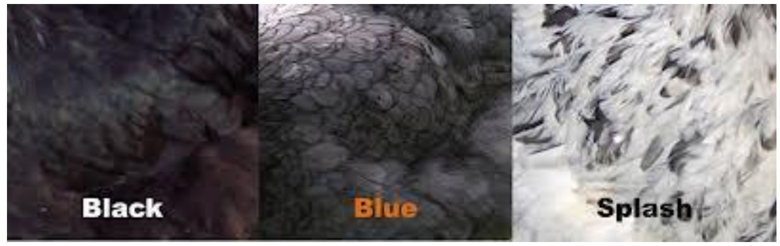

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