

GENETICS & GENETIC ENGINEERING

27 FEBRUARY 2013

Lesson Description

In this lesson, we:

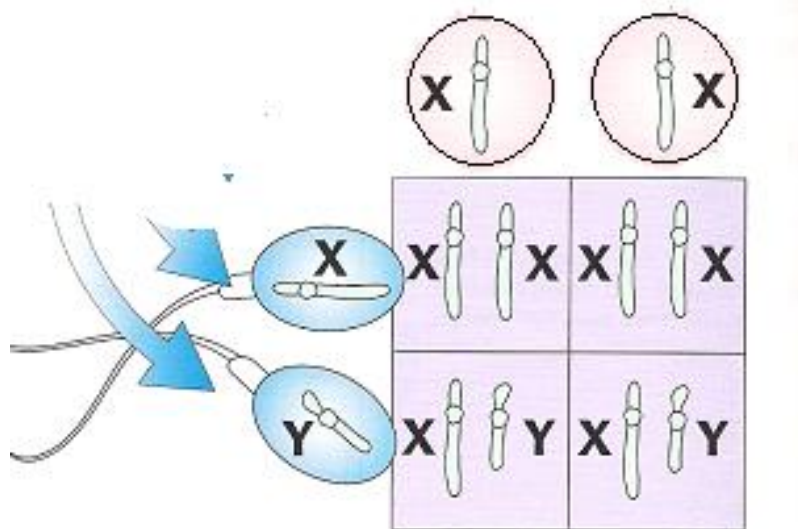
- Discuss inheritance of sex
- Cover inheritance of haemophilia and colour blindness as sex-linked characteristics
- Look at the interpretation of pedigree diagrams
- Look at the importance of genetic engineering:
 - In medicine (Production of e.g. hormones such as insulin, production of vaccines)
 - In agriculture (Production of genetically modified crops which may be pest-resistant, drought-resistant, improved quality, etc.)
- Discuss ethics & legislation around:
 - Genetic testing and genetic counselling
 - Genetic engineering (including selective breeding)
 - Cloning
- Consider beliefs, attitudes and values concerning genetic diseases

Key Concepts

How is Sex Determined in Humans?



Is it a boy or a girl?



XX = girl

XY = boy

Sex-linked Traits in Humans

- Sex-linked genes are genes on the sex chromosomes.
- Certain human disorders, like haemophilia, are caused by **sex-linked** genes.
- Y chromosome - much shorter than the X chromosome, only the X, and not the Y chromosome, carries the genes for these disorders.
- If a male inherits the recessive allele on an X chromosome from his mother, he will have haemophilia.

- If a female inherits the recessive allele, she would not have the disorder as long as her other X chromosome carried the normal, dominant allele of the gene.

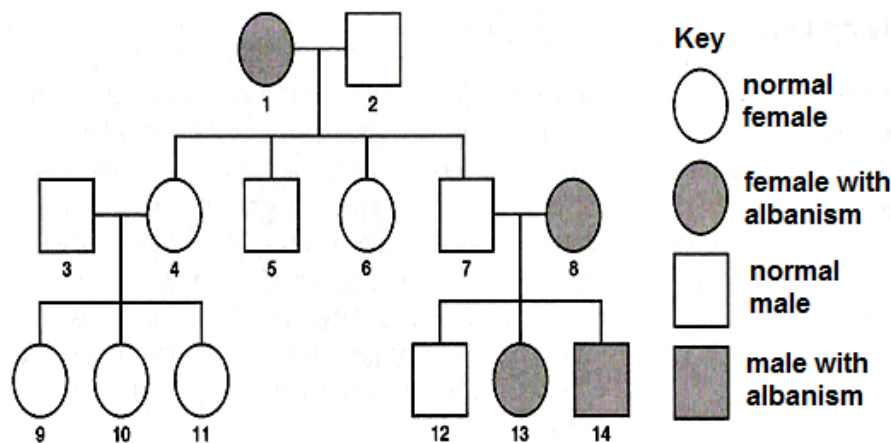
Genotypes	Description of phenotype
X^HY	Male with normal blood clotting time
X^hY	Male with haemophilia
X^HX^H	Homozygous female with normal blood clotting time
X^HX^h	Heterozygous female with normal blood clotting time, but carries the recessive allele
X^hX^h	Homozygous female with haemophilia

(From Life Sciences for All, Grade 12, Pg. 258)

Other mutations are autosomal – some are recessive while others are dominant.

What is a Pedigree Diagram?

- Pedigree diagrams/charts are a way of graphically illustrating inheritance patterns over a number of generations
- Usually used to study the inheritance of genetic disorders



What is the difference between selective breeding and genetic engineering?

- Selective Breeding involves choosing **two** organisms of the **same** species and **mating** them with the hope of getting the **best qualities** of each parent to show up in the offspring.
- Genetic Engineering involves identifying certain genes and **moving** them from one organism to another – even to a different species or removing the gene entirely!
- Both activities are **controversial**.



Brahman Cattle
 Good resistance to heat, but poor beef.



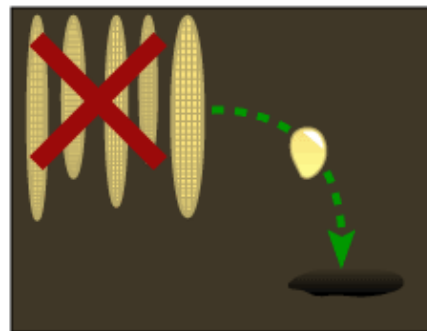
English Shorthorn Cattle
 Good beef but poor heat resistance



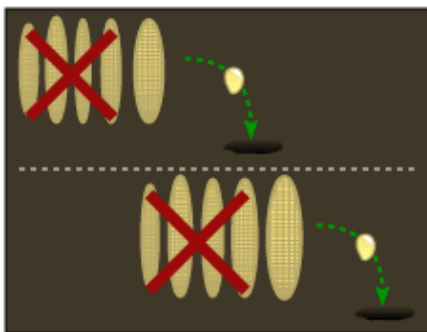
Santa Gertrudis Cattle
 (Cross of 2 breeds)
 RESULT = good beef and resistant to heat.



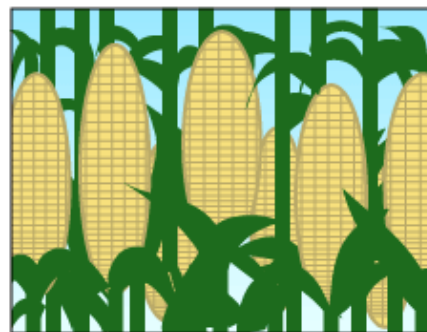
1. Natural variation occurs in the wild population.



2. Seeds for the next generation are chosen only from individuals with the most desirable traits.



3. Repeat this process for several generations.



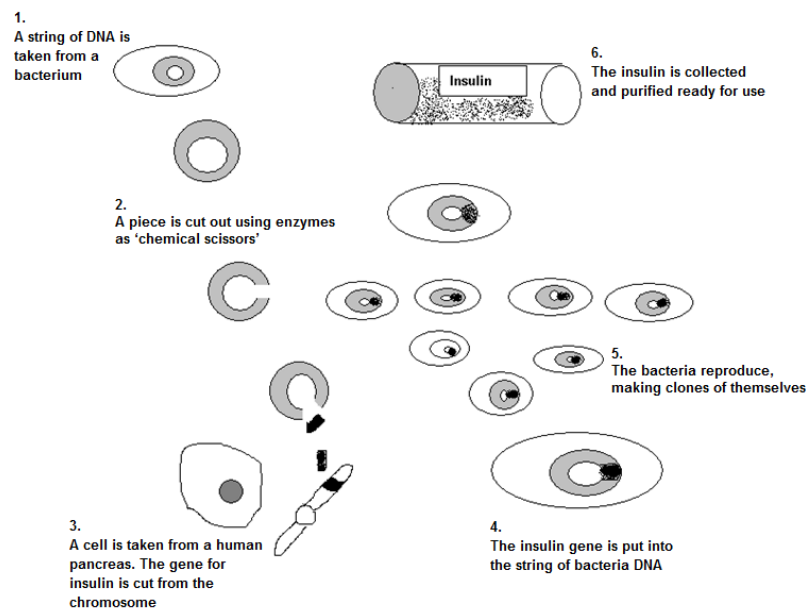
4. Over time, the quality of the crop increases.

Advantages of Selective Breeding

- Might get **improved** organisms
- **Don't** need any special tools or lab
- Can be performed **easily** by farmers & breeders
- Undesirable traits from both parents may appear in the offspring
- Disease can accumulate in the population
- Remember the deaf Dalmatians, boxers with heart disease, labs with hip problems, etc.?

Genetic Engineering

How is it carried out?



Scientists engineered chickens to be featherless by **REMOVING** the gene in chicken DNA that causes them to grow feathers



Cabbage plant + scorpion venom = bug-proof veggies



Placing the “anti-freeze gene” from a fish in tomatoes so the tomatoes can still grow in cold weather.



Scientists used a bioluminescent gene from a jellyfish to create “glowing” green mice!

Cloning – production of a genetically identical individual from an existing one.

Genetic Disorders

This is a condition that may be inherited and that results in disturbance of a person’s normal body functioning. Mutations of genes or chromosomes may cause a person to have a genetic disorder. The greatest benefits of the Human Genome Project have allowed scientists to locate the genes responsible for thousands of genetic disorders. Examples of FOUR genetic disorders to be studied are: Down’s syndrome, Sickle cell anaemia, Haemophilia and Albinism.

GENETIC DISORDER	NATURE	CAUSES	SYMPTOMS
Down’s Syndrome	If non-disjunction (chromosomes do not separate during meiosis) happens in chromosome 21 during gamete formation, a zygote with 47 chromosomes is produced.	It is caused by faulty meiotic division during the production of gametes.	• Mental retardation because the brain has not developed properly. • Hearing, heart and eyes defects • Depressed nasal bridge • Small hands and fingers
Sickle Cell Anaemia	Sickle-cell anaemia causes the red blood corpuscles to become sickle shaped and this causes blockage in the small blood vessels.	It is caused by a single mutated gene on chromosome number 11.	• Spleen enlargement • Fatigue • Damage to parts of the brain leading to stroke

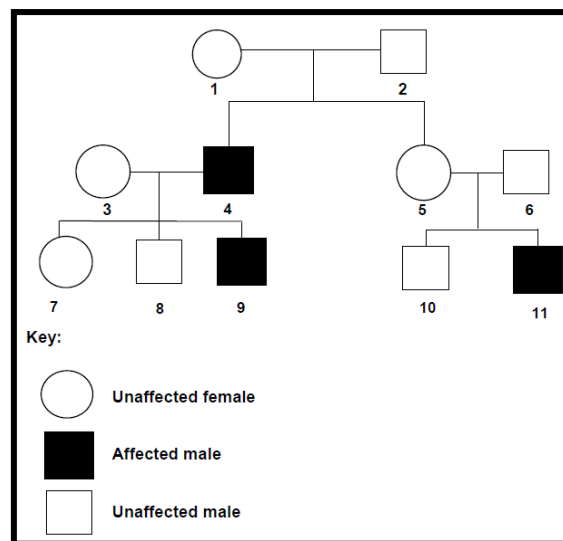
Haemophilia	Bleeding caused by the lack of essential blood clotting factors.	Caused by two genes. Both Haemophilia A and B are caused by X- linked recessive genes.	- Abnormal bleeding - Bleeding in the muscles and joints causes pain and severe swelling - Muscle-atrophy – muscles simply waste away.
Albinism	Refers to a group of genetic disorders all of which are characterised by a lack of the pigment melanin.	Caused by a single pair of recessive alleles and will only show in the homozygous state.	- Poor vision. - Sunburn can result in blisters, sores and eventually skin cancer.

Questions

Question 1

(Adapted from Nov 2012, DOE, Paper 1, Question 3.1)

The pedigree diagram below traces the inheritance of haemophilia in a family



- How many family members not affected by haemophilia are carriers? (1)
- Explain why this disorder affects mostly males in this family. (3)
- Use the possible alleles XH, Xh and Y to determine the genotype of the following:
 - Individual 1
 - Individual 4
 (2)
- What are the chances of individual 10 and his wife, who is a carrier (not shown in the pedigree), having a son who is affected? (2)
- Give TWO reasons why individual 9 and his partner should undergo genetic counselling before starting a family. (2)

Question 2

(Adapted from Nov 2012, DOE, Paper 1, Question 3.3)

Genetically modified organisms (GMO) bring new hope for medical cures, promise to increase yields in agriculture and have the potential to help solve the world's pollution and resource crisis. There are also many objections to GMO, some stating that they are expensive and a threat to our biodiversity.

- a.) Give TWO reasons why:
 - i. The initial cost of production of GMO is high (2)
 - ii. GMO are considered a threat to biodiversity (2)
- a.) Apart from those in the text, state THREE objections that some people have against the production of GMO. (3)
- b.) Provide THREE arguments for GMO's. (3)