Types of Variation

A Level

Organisms within a population are not identical - they display variation. There are two main types of variation: discontinuous and continuous.

Part A Definitions

Discontinuous variation is variation [ ]. Traits that display discontinuous variation are usually controlled by [ ] genes.

Continuous variation is variation [ ]. Traits that display continuous variation are usually controlled by [ ] genes.

Items:

many **along a range** **one or a few** **across discrete categories**

Part B Discontinuous variation examples

Which of the following traits display discontinuous variation in humans?

- [ ] height
- [ ] sex
- [ ] skin colour
- [ ] blood type
- [ ] weight
- [ ] foot length

Part C Continuous variation examples

Which of the following traits display continuous variation in humans?

- [ ] height
- [ ] sex
- [ ] skin colour
- [ ] blood type
- [ ] weight
- [ ] foot length

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Variation: Causes and Heritability

A Level

Part A Parent and offspring

Which of the following **could** lead to phenotypic variation between a human parent and their offspring?

- [ ] their genomes
- [ ] time spent in sunlight
- [ ] their diets

Part B Bacterial clones

Which of the following **could** lead to phenotypic variation between two clones in a bacterial population?

- [ ] their genomes
- [ ] nutrient availability
- [ ] exposure to toxins

Part C Heritable variation

Which of the following phenotypes may be inherited by a person's offspring?

- [ ] XY genotype
- [ ] green eyes
- [ ] a broken bone
- [ ] A+ blood group
- [ ] tattoos
- [ ] body fat percentage of 30%

Adapted with permission from NSAA 2020 Section 1 Q61

Gameboard:

STEM SMART Biology Week 24 - Variation

Sexual Reproduction & Genetic Variation

A Level

There are two forms of reproduction: asexual and sexual.

In asexual reproduction, an individual's genome is replicated to produce an individual that is genetically identical to the parent. This is the most common form of reproduction in unicellular organisms, but also occurs in some multicellular organisms (e.g. vegetative propagation in plants).

In sexual reproduction, half of an individual's genome is combined with half of another individual's genome to produce an individual that is genetically distinct from both parents. One of the main evolutionary advantages of sexual reproduction is that it increases the amount of genetic variation among the offspring.

Part A Asexual reproduction

Parthenogenesis is a form of asexual reproduction in which an unfertilised egg cell develops into an adult. This form of asexual reproduction occurs in some insects and some vertebrates.

Suppose that humans reproduced by parthenogenesis. How many possible genomes could be found in the offspring of one human if no mutations occurred?

Part B Sexual reproduction: meiosis processes

There are two processes, both of which occur during meiosis, that produce genetic variation among gametes (and therefore among offspring).

Name the process, which occurs during meiosis, that ensures each **gamete** can receive a combination of both maternal and paternal **chromosomes**.

Name the process, which occurs during meiosis, that ensures each **chromosome** can receive a combination of both maternal and paternal **alleles**.

Part C Sexual reproduction: without meiosis processes

Suppose that humans reproduced by a form of sexual reproduction in which independent assortment and crossing over did **not** occur during meiosis. How many possible genomes could be found in the offspring of a pair of humans (male and female) if no mutations occurred?

Part D Sexual reproduction: with meiosis processes

Suppose that humans reproduced by a form of sexual reproduction in which independent assortment **did** occur but crossing over did **not** occur during meiosis. How many possible genomes could be found in the offspring of a pair of humans (male and female) if no mutations occurred?

Give your answer to 1 s.f.

Taking into account both independent assortment **and** crossing over, how many possible genomes could be found in the offspring of a pair of humans (male and female) if no mutations occurred?

Assume that, for each chromosome, crossing over always produces the same result. Therefore, there are two possible versions of each chromosome: a recombinant version (when crossing over occurs) and a non-recombinant version (when crossing over does not occur).

Give your answer to 1 s.f.

Part E Sources of genetic variation

Which of the following statements about genetic variation are correct? Select all that apply.

- [ ] mutations can produce new alleles of a gene
- [ ] sexual reproduction can produce new alleles of a gene
- [ ] a new allele of a gene may be **more** beneficial to the organism than the original allele
- [ ] a new allele of a gene may be **less** beneficial to the organism than the original allele
- [ ] sexual reproduction can create new combinations of alleles of different genes
- [ ] if one individual reproduces asexually to form a population, there cannot be any genetic variation among the individuals in the population
- [ ] sexual reproduction ensures that multicellular organisms adapt to their environments much faster than bacteria do

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Gameboard:

STEM SMART Biology Week 24 - Variation

Seedling Variation

A Level

A gardener wants to plant some new plants in their garden. They plant seeds from the same parent plant in separate pots. After a few weeks, the gardener notices some variation among the seedlings. The gardener measures the heights of 20 of the seedlings (to the nearest cm). The results are shown in **Figure 1**.

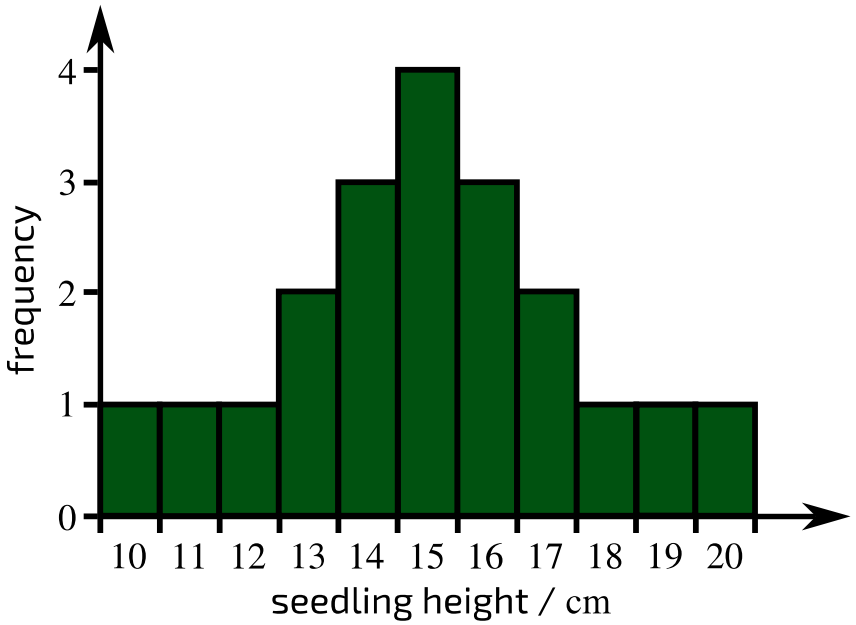

Figure 1: Frequency histogram of seedling height.

Part A Seedling statements

Which of the following statements about the seedling height are correct? Select all that apply.

- [ ] the variation could be partly due to epigenetic differences
- [ ] the variation could be partly due to environmental differences
- [ ] seedling height is most likely controlled by many genes
- [ ] this is continuous variation
- [ ] this is discontinuous variation
- [ ] seedling height is most likely controlled by one gene

Part B Mean seedling height

Calculate the mean seedling height.

Part C Standard deviation

Calculate an unbiased estimate of standard deviation in seedling height. Give your answer to 3 decimal places.

The formula is given below.

$$S = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

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Allele Population Frequencies

A Level

A recessive condition is found within a human population. There were 5000 births in this population within one year. Of these births, 8% had the condition and 32% were homozygous dominant.

One healthy cheek cell is analysed from each person born in this year.

Part A Recessive allele numbers

How many recessive alleles are present in the sample?

Part B Dominant allele numbers

How many dominant alleles are present in the sample?

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Populations and Allele Combinations

A Level

Four populations of the same diploid species each have the same gene (gene A) in the same position on a chromosome.

Each population has a different number of alleles for gene A as shown in the table.

Population	Number of alleles for gene A
P	3
Q	4
R	5
S	6

Each genotype produces a discrete phenotype. Assume that in the heterozygous state, the genotype is the same whether an allele is inherited from the mother or the father.

Part A Type of variation

What type of variation is this?

Part B **Population P**

How many homozygous genotypes are theoretically possible in population P?

How many heterozygous genotypes are theoretically possible in population P?

Part C **Population Q**

How many homozygous genotypes are theoretically possible in population Q?

How many heterozygous genotypes are theoretically possible in population Q?

Part D **Population R**

How many homozygous genotypes are theoretically possible in population R?

How many heterozygous genotypes are theoretically possible in population R?

Part E Population S

How many homozygous genotypes are theoretically possible in population S?

How many heterozygous genotypes are theoretically possible in population S?

Part F n alleles

In a population with n alleles, how many **total** genotypes are theoretically possible?

The following symbols may be useful: n

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