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STEM SMART Biology Week 28 - Variation

Types of Variation

Subject & topics

Biology | Evolution | Variation

Status

Not started

Stage & difficulty

A Level Practice 2

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, and are more likely to be affected by environmental factors.

Items:

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

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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STEM SMART Biology Week 28 - Variation

Variation: Causes and Heritability

Subject & topics

Biology | Evolution | Variation

Status

Not started

Stage & difficulty

A Level Practice 2

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?

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

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STEM SMART Biology Week 28 - Variation

The Basis of Phenotypic Variation

Subject & topics

Biology | Evolution | Variation

Status

Not started

Stage & difficulty

A Level Practice 3

Phenotypic variation within a population is partly due to genetic variation, and partly due to environmental variation. In order to understand how genetic variation affects phenotypic variation, we need to understand the different ways in which mutations can affect a phenotype.

A gene is a section of DNA that codes for a protein. However, only one part of a gene (the coding region) is transcribed to produce an mRNA transcript. The other part of the gene (the regulatory region) controls when and where the gene is transcribed, by containing binding sites for proteins called transcription factors.

Part A

Coding vs regulatory changes

Which of the following statements are correct for multicellular organisms? Select all that apply.

- [ ] A mutation in the **coding region** of a gene **will always** change the protein's structure and function.
- [ ] A mutation in the **coding region** of a gene **may** change the protein's structure and function.
- [ ] A mutation in the **coding region** of a gene may result in the protein being non-functional.
- [ ] A mutation in the **regulatory region** of a gene may change the protein's structure and function.
- [ ] A mutation in the **regulatory region** of a gene may change the amount of protein produced.
- [ ] A mutation in the **regulatory region** of a gene may change the cell types that produce the protein.
- [ ] A mutation in the **regulatory region** of a gene may change the timing of protein production.

Part B

Variation types

Phenotypic variation can be split into two categories: continuous variation and discontinuous variation.

Which type of mutation is more likely to result in continuous variation among individuals?

- coding region mutations
- regulatory region mutations

Part C

Height variation

Which of the following statements most likely explain the variation in height among humans? Select all that apply.

- [ ] Humans have different alleles of genes that code for growth hormones due to coding region differences. This means that tall people produce different growth hormones than short people do.
- [ ] Humans produce different amounts of the same growth hormones due to regulatory region differences. This means that tall people and short people produce the same growth hormones, but tall people produce them in higher amounts.
- [ ] Differences in diet enable some people to grow more than others.
- [ ] Regular stretching and exercise cause some people to grow more than others.

Part D

ABO blood type variation

The four ABO blood types in humans (A, B, AB, and O) are based on the type of self-antigens present on red blood cells (only type A, only type B, both type A and type B, or neither).

Which of the following statements most likely explain the variation in ABO blood type among humans? Select all that apply.

- [ ] Differences in exposure to sunlight cause different self-antigens to be produced.
- [ ] Differences in exposure to blood-borne pathogens (e.g. HIV) cause different self-antigens to be produced.
- [ ] Humans have different alleles of a gene involved in self-antigen-production due to coding region differences. This means that individuals with different blood types produce different proteins from this gene.
- [ ] Humans produce different amounts of the same self-antigens due to regulatory region differences. This means that type O individuals produced the same self-antigens as type AB individuals but in smaller amounts.

Part E

Eye colour variation

Human eye colour is determined by two main types of melanin: eumelanin (a brown/black pigment) and pheomelanin (a yellow/red pigment). If very little of these pigments are produced, the iris is blue due to light scattering. If mainly pheomelanin is present, the iris is green. If mainly eumelanin is present, the iris is brown.

Which of the following statements most likely explain the variation in eye colour among humans? Select all that apply.

- [ ] Humans have different alleles of a gene involved in melanin production due to coding differences, which means that some individuals produce only eumelanin, some produce only pheomelanin, some produce both, and some produce neither.
- [ ] Humans produce different amounts of eumelanin and pheomelanin due to regulatory region differences, but the structure of eumelanin and pheomelanin is the same across individuals.
- [ ] Differences in diet cause different pigments to be produced in the iris.
- [ ] Differences in environmental temperature cause different pigments to be produced in the iris.

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Question deck:

STEM SMART Biology Week 28 - Variation

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Sexual Reproduction & Genetic Variation

Subject & topics

Biology | Evolution | Variation

Status

Not started

Stage & difficulty

A Level Challenge 2

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

Suppose that humans reproduced by asexual reproduction. 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 sf.

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 sf.

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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Question deck:
STEM SMART Biology Week 28 - Variation

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Seedling Variation

Subject & topics

Biology | Evolution | Variation

Status

Not started

Stage & difficulty

A Level Practice 2

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**.

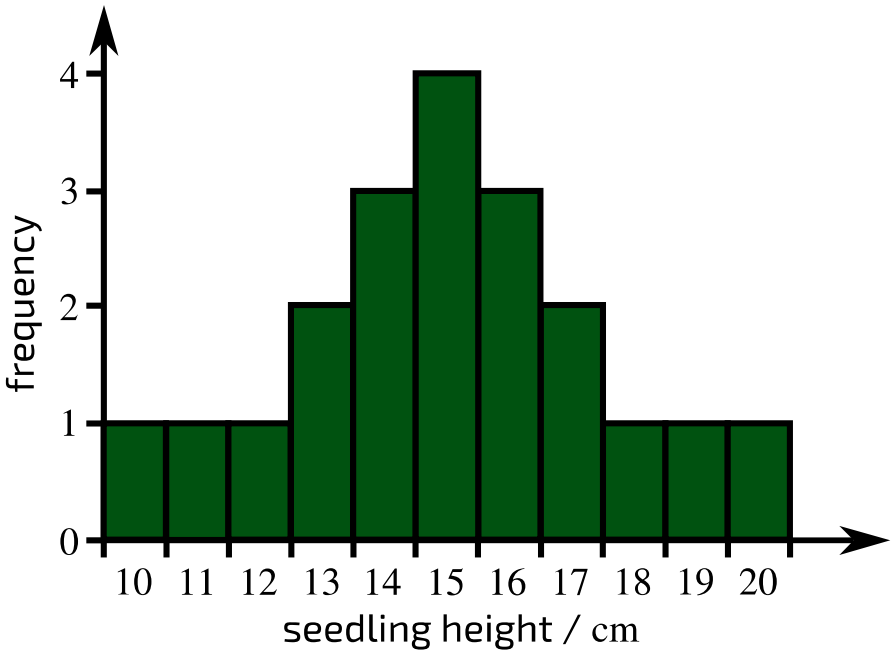

Figure 1: Frequency histogram of seedling height.

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

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

Subject & topics

Biology | Evolution | Variation

Status

Not started

Stage & difficulty

A Level Practice 2

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?

Adapted with permission from NSAA 2020 Section 2 Q44

Question deck:

STEM SMART Biology Week 28 - Variation

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STEM SMART Biology Week 28 - Variation

Populations and Allele Combinations

Subject & topics

Biology | Evolution | Variation

Status

Not started

Stage & difficulty

A Level Challenge 2

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 of a particular gene, how many **total** genotypes are theoretically possible for this gene?

The following symbols may be useful: n

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