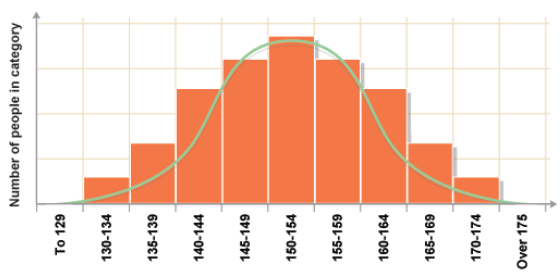
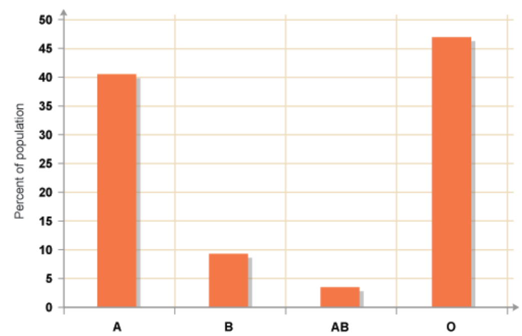
17(a) Describe the difference between continuous and discontinuous variation and give examples of each

Variation

Genetic variations are differences in phenotypes between individuals of the same species.

There are two types of variations

1. continuous variations
2. discontinuous variations

<table>
<tr><th>Continuous variations</th><th>Discontinuous variations</th></tr>
<tr><td>A range of intermediate characters</td><td>Few clear cut different characters</td></tr>
<tr><td>Normal distribution</td><td>Data not normally distributed</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Environment influences</td><td>No influence of environment</td></tr>
<tr><td>Controlled by many genes</td><td>Controlled by many alleles(single gene)</td></tr>
<tr><td>Height, body mass, IQ-level</td><td>Gender, blood group, eye color</td></tr>
</table>

Question 279

Farmers crossed two breeds of cattle, the Jersey from Europe and the Sahiwal from Africa. For many generations, the farmers picked out the offspring with the highest milk yields to breed the next generation.

Which phrase best describes this process?

A artificial selection

B discontinuous variation

C evolution

D natural selection

Question 280

Which two characteristics both show continuous variation?

A eye colour and height

B gender and eye colour

C height and weight

D weight and blood group

Question 281

A couple have three children. The table shows some of the children's characteristics.

child	sex	blood group	sickle-cell / normal
1	male	B	sickle-cell
2	female	AB	normal
3	male	O	normal

What do the characteristics show?

A continuous variation only

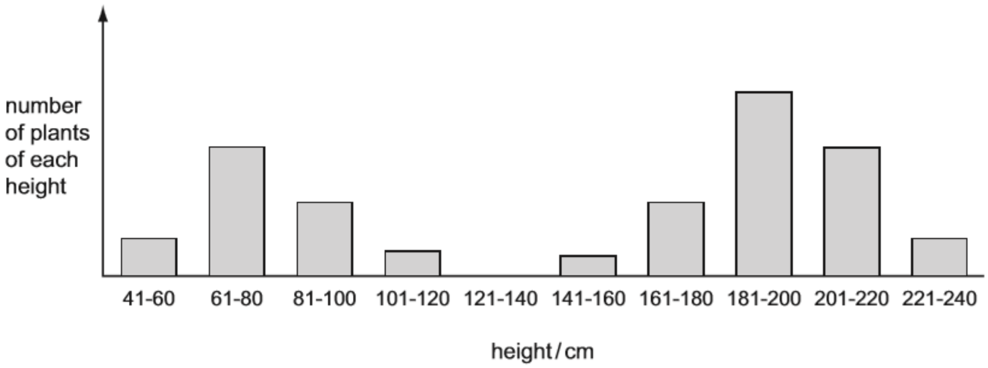
B discontinuous variation only

C both continuous and discontinuous variation

D neither continuous nor discontinuous variation

Question 282

40 The heights of 500 pea plants of the same age were measured to the nearest 20 cm. The results are shown in the chart below.



Variation in height of these pea plants shows

A continuous variation only.

B discontinuous variation only.

C both continuous and discontinuous variation.

D neither continuous nor discontinuous variation.

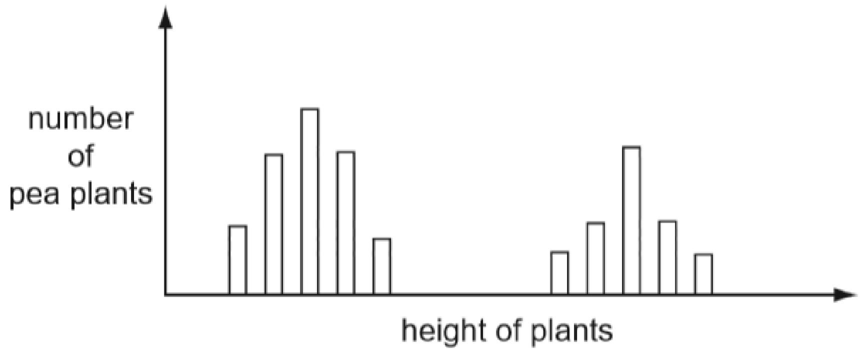
Question 283

What is the effect of environment on discontinuous variation, and what is an example of this type of variation in humans?

	environmental effect	example
A	large	ABO blood group system
B	large	height
C	small	ABO blood group system
D	small	height

Question 284

The bar chart shows the heights of pea plants grown from 500 pea seeds.



What variation do the plants show?

A continuous variation only

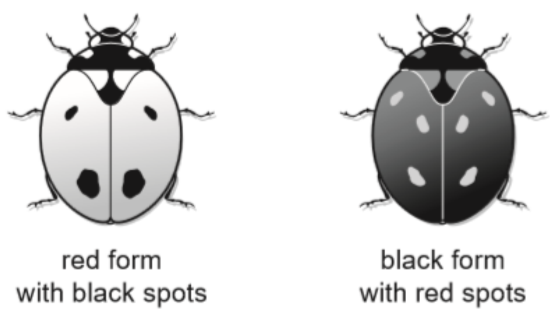
B discontinuous variation only

C both continuous variation and discontinuous variation

D neither continuous variation nor discontinuous variation

Question 285

The diagram shows two distinct forms of beetle. The difference between them is controlled by a single gene. The allele for the black form is dominant to the allele for red.



What kind of variation is shown by the beetle and why?

A continuous variation because it is controlled by genes

B continuous variation because there are two forms

C discontinuous variation because it is controlled by genes

D discontinuous variation because the two forms are distinct

17(b) State that a chromosome includes a long molecule of DNA

Chromosomes

Thick threads

Visible when a cell dividing

Number of chromosomes specific for each species

Each individual receives one chromosome from one and the other from the other parent

Chromosomes in pairs in a an organism/cell called Diploid

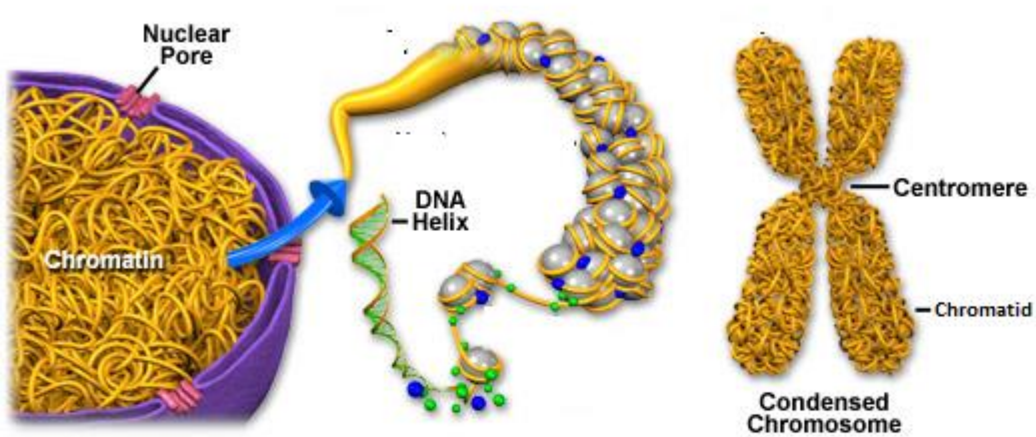
Games have one of each paire of chromosomes and are Haploid

Chromosome, includes a long molecule of DNA.

DNA is divided into sections called genes.

Genes may be copied and passed out next generation

Chromatin and Condensed Chromosome Structure



Question 286

Which statement about chromosomes is correct?

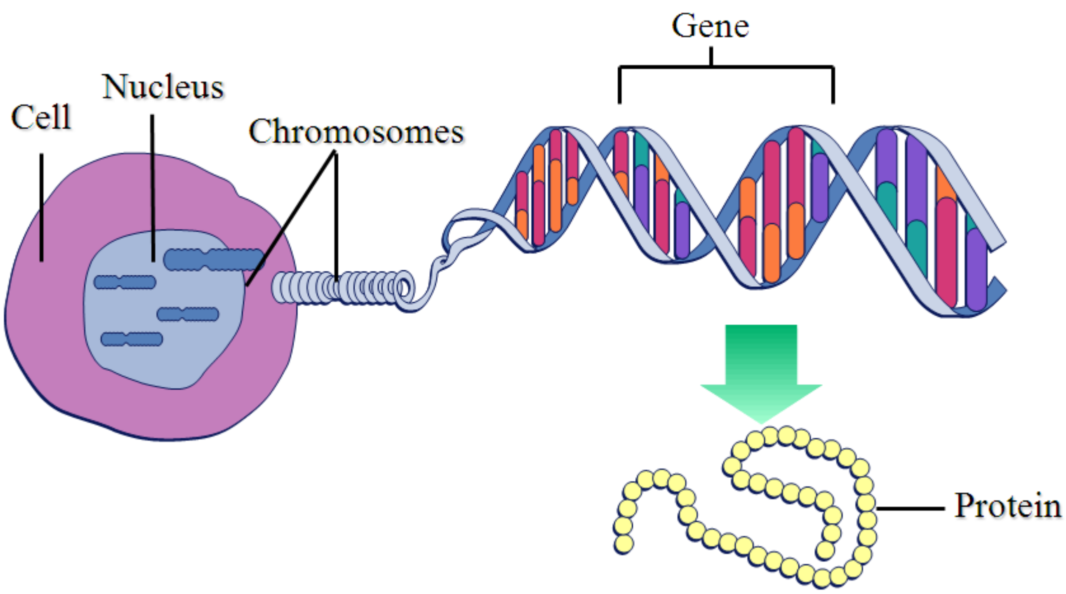
A Chromosomes are long DNA molecules called genes which are divided into sections.

B Chromosomes include a long molecule of DNA divided into sections called genes.

C Chromosomes include genes which are divided into sections called DNA molecules.

D Genes include long DNA molecules called chromosomes.

17(c) State that DNA is divided up into sections called genes



Question 289

What is the primary function of DNA?

A controls the absorption of nutrients

B controls the production of protein

C controls the rate of reproduction

D controls the rate of mutation

17(d) Explain that genes may be copied and passed on to the next generation

Before cell divides DNA is duplicated so that the DNA is equally divided to the daughter cells during Mitosis

Question 290

Which statement is evidence that genes are copied and passed on to the next generation?

A Asexual reproduction produces genetically identical offspring.

B Different alleles of a gene can produce variation in phenotype.

C Each species of a plant or animal has a fixed number of chromosomes.

D Sexual reproduction produces genetically different offspring.

17(e) Define a gene as a unit of inheritance and distinguish clearly between the terms gene and allele

Question 291

Which statements describe an allele?

	an alternative form of a gene	copied during cell division	part of a DNA molecule
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

key

✓ = yes

✗ = no

17(f) Describe complete dominance using the terms dominant, recessive, phenotype and genotype

Question 292

A recessive homozygote is crossed with a heterozygote of the same gene.

What will be the phenotypes of the F_1 generation?

A all dominant

B 75 % dominant 25 % recessive

C 50 % dominant 50 % recessive

D 25 % dominant 50 % heterozygous 25 % recessive

Question 293

One gene has two codominant alleles, A^E and A^F, and one recessive allele, A^G.

How many different genotypes and phenotypes are possible?

	genotypes	phenotypes
A	3	3
B	4	6
C	6	4
D	6	6

Question 294

Which statement about the genotypes of organisms is correct?

A Dominant alleles are only found in homozygotes.

B One recessive allele always causes a recessive phenotype.

C Recessive phenotypes must be homozygous.

D The dominant phenotype must be heterozygous.

Question 295

The table shows the genotypes and phenotypes for hair colour for the members of a family, but **one** phenotype is shown incorrectly.

	genotype		phenotype
family member	allele 1	allele 2	hair colour
mother	a	A	brown
father	A	A	brown
son 1	a	A	blonde
daughter 1	a	a	blonde
son 2	A	A	brown
daughter 2	A	a	brown

Which family member has the **incorrect** phenotype?

A daughter 1

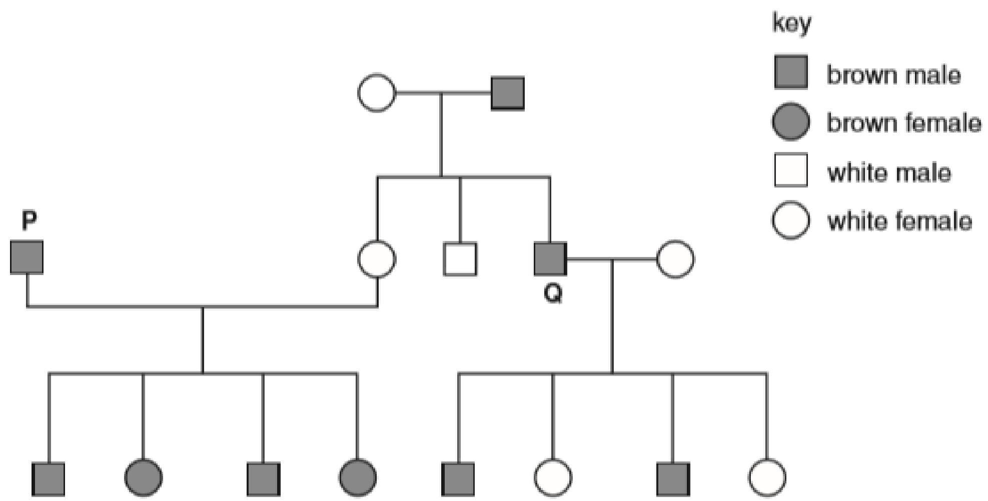
B daughter 2

C son 1

D son 2

Question 296

0 The chart shows the inheritance of coat colour in mice. The allele for brown coat, B, is dominant to the allele for white coat, b.

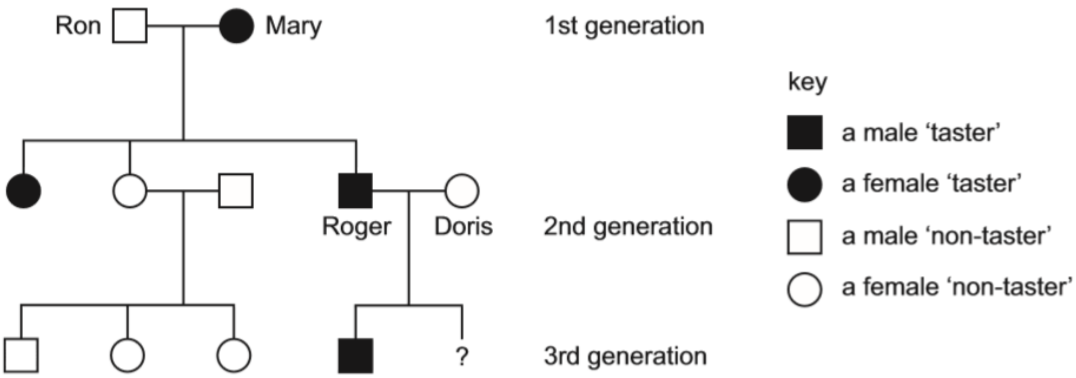


What are the most likely genotypes of the individuals P and Q?

	P	Q
A	BB	BB
B	BB	Bb
C	Bb	BB
D	Bb	Bb

Question 297

Below is a family tree showing the inheritance of the ability to taste a certain substance. The allele for the ability to taste this substance is dominant to the allele for the inability to taste it.



What is the probability of the second child of Roger and Doris being a 'non-taster'?

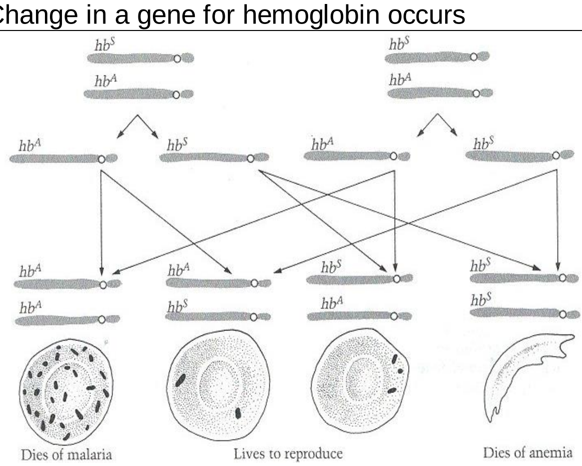
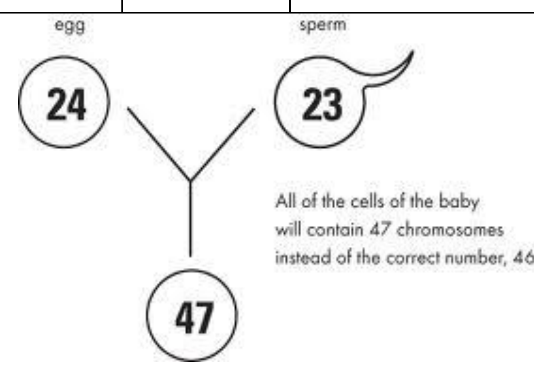
A 0.25 **B** 0.34 **C** 0.5 **D** 1.00

17(g) Describe mutation as a change in the structure of a gene (sickle cell anaemia) or in the chromosome number (e.g. 47 in Down's syndrome instead of 46)

Mutation

An unpredicted change in the DNA or chromosomes

Two types

<table>
<tr><th>Gene mutation</th><th colspan="3">chromosomal mutation</th></tr>
<tr><td>Sickle cell anemia</td><td colspan="3">Down's syndrome</td></tr>
<tr><td>Change in a gene for hemoglobin occurs</td><td colspan="3">Chromosome number is 47 instead of 46</td></tr>
<tr><td rowspan="2">
</td><td>Female
46</td><td>X</td><td>Male
46</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td>Distorted haemoglobin
RBC's Sickle shaped</td><td colspan="3">Down syndrome
Mental retarded</td></tr>
</table>

Oxygen carrying capacity reduces RBC's block in blood capillaries RBC's broken down, anemia	Sexually sterile

Question 298

How many chromosomes are there in a zygote which develops into a Down's syndrome baby?

A 23

B 24

C 46

D 47

Question 299

Down's syndrome and sickle cell anaemia are both genetic diseases.

How are they caused?

	Down's syndrome	sickle cell anaemia
A	chromosomal mutation	chromosomal mutation
B	chromosomal mutation	gene mutation
C	gene mutation	chromosomal mutation
D	gene mutation	gene mutation

Question 300

A person with Down's syndrome is born with 47 chromosomes in each of his/her cells, instead of 46.

What could cause this?

A A mutation happened during the production of the egg cell.

B More than one sperm fused with the egg at fertilisation.

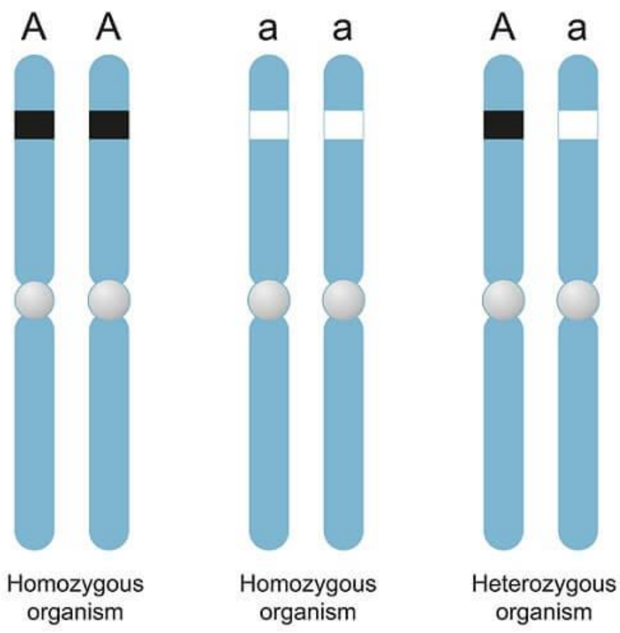
C Radiation caused a change in structure of a gene in the father's sperm.

D The mother was exposed to harmful chemicals while she was pregnant.

17(h) Name radiation and chemicals as factors that may increase the rate of mutation

17(i) Predict the results of simple crosses with expected ratios of 3:1 and 1:1, using the terms homozygous, heterozygous, F_1 generation and F_2 generation

Gene
unit of inheritance.
Allele
Different forms of a gene
Dominant Allele: the one that shows its effect in the heterozygous state
Recessive Allele: Only shows its effects in homozygous state
Phenotype: Physical features.
Genotype: Genetic make up.
Homozygous genotype: Both alleles of same kind, TT or tt
Heterozygous genotype: both alleles are different, Tt



Question 301

In rabbits the allele for black hair is dominant. A heterozygous black-haired rabbit is crossed with a heterozygous black-haired rabbit.

Which phenotypic ratio would result?

A 1 : 1 **B** 1 : 2 : 1 **C** 3 : 1 **D** all similar

17(j) Explain why observed ratios often differ from expected ratios, especially when there are small numbers of progeny

Expected ratios are obtained from genetic crosses that only tell us the chance of occurrence of a character.

Question 302

Flower colour is controlled by a single pair of alleles. The allele for red flowers is dominant to the allele for white flowers.

A plant homozygous for red flowers is crossed with a plant homozygous for white flowers. All the resulting plants have red flowers (F_1 generation).

When the F_1 generation are crossed with each other, 18 plants are obtained. 12 plants have red flowers and 6 have white flowers (F_2 generation).

What ratio is expected in the F_2 generation and what ratio has been obtained?

	expected ratio red to white	obtained ratio red to white
A	1 : 1	2 : 1
B	1 : 1	3 : 1
C	3 : 1	2 : 1
D	3 : 1	3 : 1

17(k) Explain codominance by reference to the inheritance of the ABO blood group phenotypes (A, B, AB, O, gene alleles I^A I^B and I^o)

Codiminance

Both parental characters express themselves in F1 generation i.e in heterozygous condition

	Complete dominance		**Co-dominance**	
Parent 1 phenotype	**Black X**	**Brown**	**Group A**	**X Group B**
Genotype	**BB**	**bb**	I^AI^A	I^BI^B

Gamete	B b	I^A I^B
F1 Genotype	Bb	I^AI^B
F1 Phenotype	Black	Group AB
Selfing of F1	Black X Black	Group AB X Group AB
Parents 2	Bb Bb	I^AI^B I^AI^B
Gametes	B, b B, b	I^A , I^B I^A,I^B
F2 genotype ratio	BB, Bb, Bb, bb	I^AI^A, I^AI^B, I^AI^B, I^BI^B
F2 Phenotype ratio	3Black ,1Brown	1 group A: 2group AB: 1 group B

Question 303

A man of blood group A, and his wife of blood group O, had two children, both of blood group A. The man concluded that he must be homozygous for the allele I^A, since he thought half his children would be of group O if he were heterozygous.

Why was his conclusion unsound?

A Blood group mutations are common.

B Genetic ratios are unreliable for small numbers.

C His wife might have been heterozygous.

D The expected ratio for a heterozygous father and group O mother is 3 group A: 1 group O.

Question 304

Some genotypes that occur in blood groups are given.

Which genotype results in a phenotype that shows co-dominance?

A $I^A I^A$

B $I^A I^B$

C $I^B I^O$

D $I^O I^O$

Question 305

A study was made of children whose mothers were blood group O (genotype $I^O I^O$) and whose fathers were blood group AB (genotype $I^A I^B$).

Which statement about their children is correct?

A All will have the same blood group.

B 50% will have the same blood group as their mother.

C 50% will have the same blood group as their father.

D None will have the same blood group as either parent.

17(l) Describe the determination of sex in humans (XX and XY chromosomes)

Determination of Sex in Humans

Phenotype: Female x Male

Karyotype: X X x X Y

Fertilisations

	X	Y
X	XX	XY

Offspring Karyotype XX or XY

Offspring Phenotypic ratio Male: Female

1:1

Male has XY chromosomes
Produces two types of sperms
Half carrying X and other half Carrying Y
Female produces all eggs carrying X
A sperm fertilizes an egg
The chance of boy baby to be born is ½
50 %
Sperm determines the gender of the baby
At the time of fertilization

Question 306

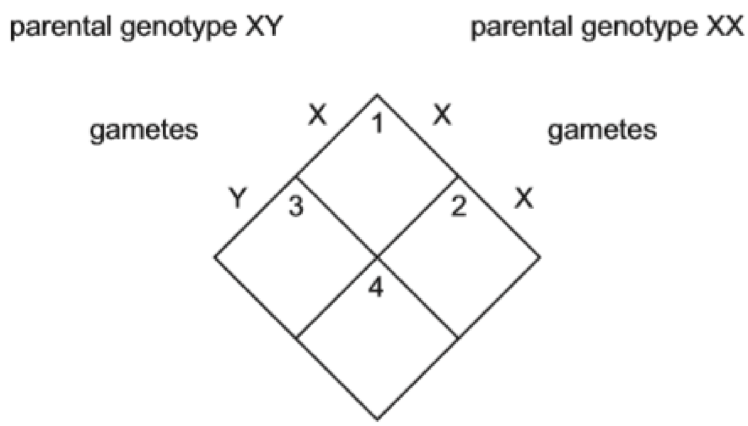
Sex in humans is determined by **X** and **Y** chromosomes inherited from parents.

Which shows the chromosome inherited from the father and from the mother?

	sex of child	chromosome from father	chromosome from mother
A	male	**X**	**Y**
B	male	**Y**	**X**
C	female	**X**	**Y**
D	female	**Y**	**X**

Question 307

The diagram shows the inheritance of sex in humans.



Which sex are the offspring in boxes 1, 2, 3 and 4?

	1	2	3	4
A	boy	girl	boy	girl
B	boy	girl	girl	boy
C	girl	boy	girl	boy
D	girl	girl	boy	boy

17(m) Describe variation and state that competition leads to differential survival of organisms, and reproduction by those organisms best fitted to the environment

Question 308

What is essential for natural selection to occur?

	competition	variation
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key
✓ = yes
✗ = no

17(n) Assess the importance of natural selection as a possible mechanism for evolution

Natural Selection:

Variation is present amongst organism.

There is a change in the environment.

Some organism better adapted to this change.

These survive.

These pass on their genes to their offsprings.

Others die become extinct.

Genes eliminated from population

This results in Evolution.

Examples

Antibiotic resistance in bacteria

Pesticide resistance in insects

Antibiotic resistance in bacteria

Two variations of bacteria

A non-resistant to antibiotic

And resistant to antibiotic bacteria

Produced by mutation

antibiotic given

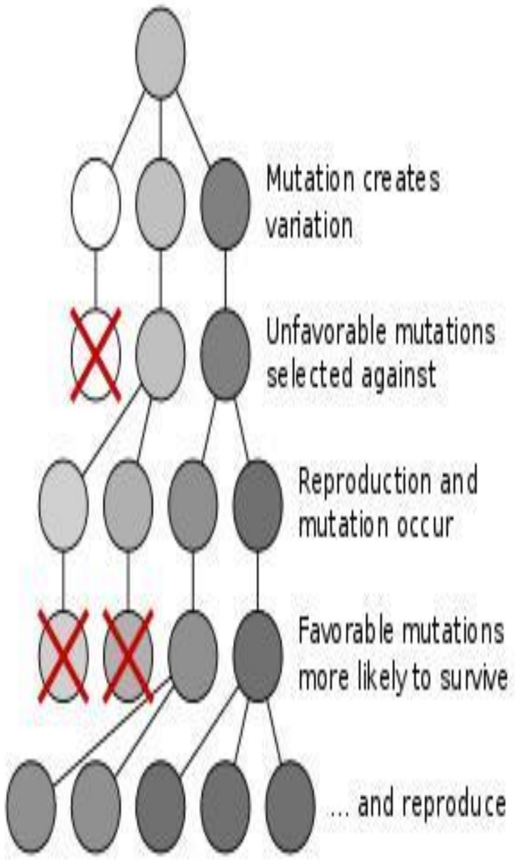
kills non-resistant bacteria

resistant bacteria survive

and multiply and increase

spread to the other people

same antibiotic given has no affect



Question 310

Which statement is correct?

A Evolution is natural selection.

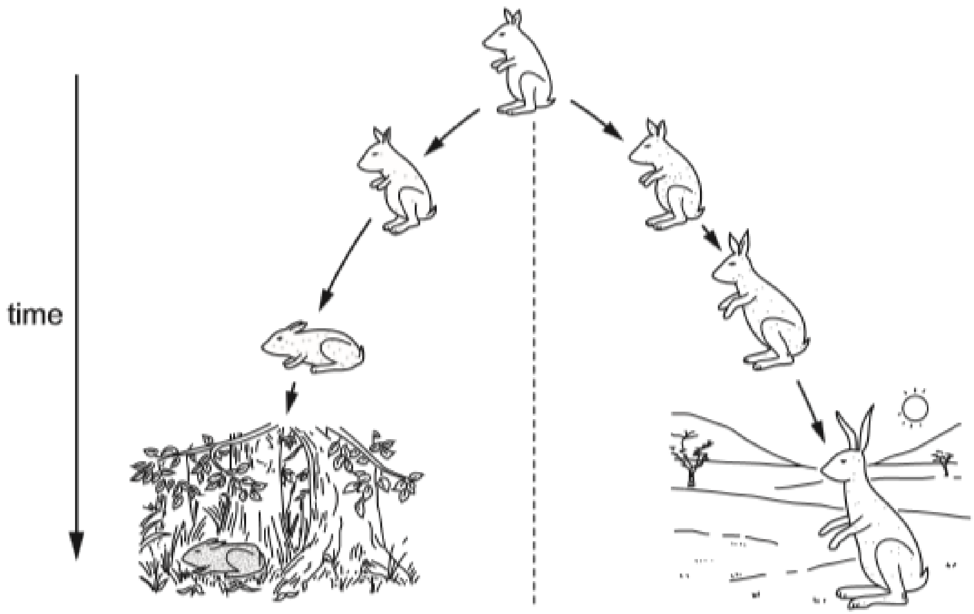
B Evolution results in natural selection.

C Natural selection and evolution are independent of each other.

D Natural selection results in evolution.

Question 311

The diagram shows a species becoming modified to survive in two different habitats.



Which process is responsible for these modifications?

A artificial selection

B conservation

C genetic engineering

D natural selection

Question 312

Which term describes reproduction between those members of a species that are best fitted to their environment?

A discontinuous variation

B gene mutation

C natural selection

D survival of the fittest

Question 313

What is a result of natural selection?

A cattle that produce large quantities of milk

B crop plants that are resistant to disease

C grapes that develop no seeds

D mosquitoes that are resistant to insecticides

17(o) Describe the role of artificial selection in the production of economically important plants and animals

Artificial Selection:

Human benefit

- E.g. high yield
- Disease resistance in crops
- Short stem in wheat
- Better wool in sheep

Select the desired organism with desired characteristics.

Cross them.

Repeat over many generations.

The desired organism obtained.

Asexually reproduce or

Self cross

Question 314

Which statement describes an example of artificial selection?

A It has been found that some strains of bacteria produce antibiotics.

B It is common practice to mate bulls with cows that produce the most milk.

C It is possible to control caterpillars on food crops by releasing small wasps which lay their eggs in caterpillars and kill them.

D Mosquitoes have developed strains that are resistant to insecticides.

Question 315

Which outcomes might farmers want to achieve by using artificial selection?

	increased	decreased
A	fertiliser use	pesticide use
B	growth rate	yield
C	pesticide use	growth rate
D	yield	fertiliser use

Question 316

Farmers crossed two breeds of cattle, the Jersey from Europe and the Sahiwal from Africa. For many generations, the farmers picked out the offspring with the highest milk yields to breed the next generation.

Which phrase best describes this process?

A artificial selection

B discontinuous variation

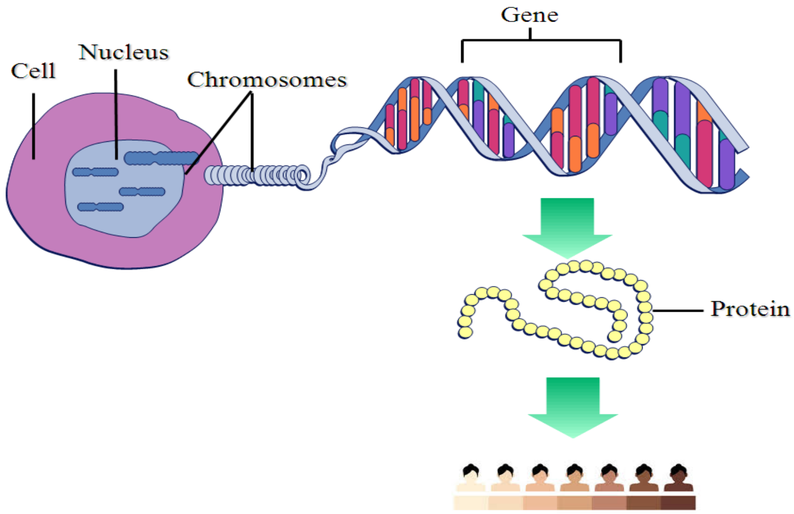
C evolution

D natural selection

17(p) Explain that DNA controls the production of proteins

From DNA to phenotype

1. A gene is a single unit of hereditary information consisting of a specific nucleotide sequence located on the chromosome. Each gene contains information for the production of a single polypeptide.
2. These gene products are responsible for every aspect of a living organism e.g. appearance, resistance to specific diseases, biochemical processes necessary for life etc. For example, a gene can affect skin colour by coding for an enzyme involved in the production of a pigment melanin.



Question 317

What is the primary function of DNA?

A controls the absorption of nutrients

B controls the production of protein

C controls the rate of reproduction

D controls the rate of mutation

17(q) State that each gene controls the production of one protein

Question 318

A textbook states that because human insulin is a single …X…, its production is controlled by a single …Y… .

What are X and Y?

	X	Y
A	carbohydrate	DNA molecule
B	carbohydrate	gene
C	protein	DNA molecule
D	protein	gene

17(r) Explain that genes may be transferred between cells (reference should be made to transfer between organisms of the same or different species)

Cystic fibrosis gene therapy

GM crop production

Gene Transfer between cells

A copy of normal gene is obtained from human DNA

It is attached with a vector and transferred in epithelial cells of trachea

It helps to overcome symptoms of cystic fibrosis

Treatment of genetic disorder by transfer of normal genes is called Gene Therapy

Cystic Fibrosis

A genetic disorder due to recessive allele

A person homozygous recessive for CFTR proteins produces faulty proteins

This faulty protein can not remove chloride ions out of epithelia cells

So water does not move out of epithelial cells

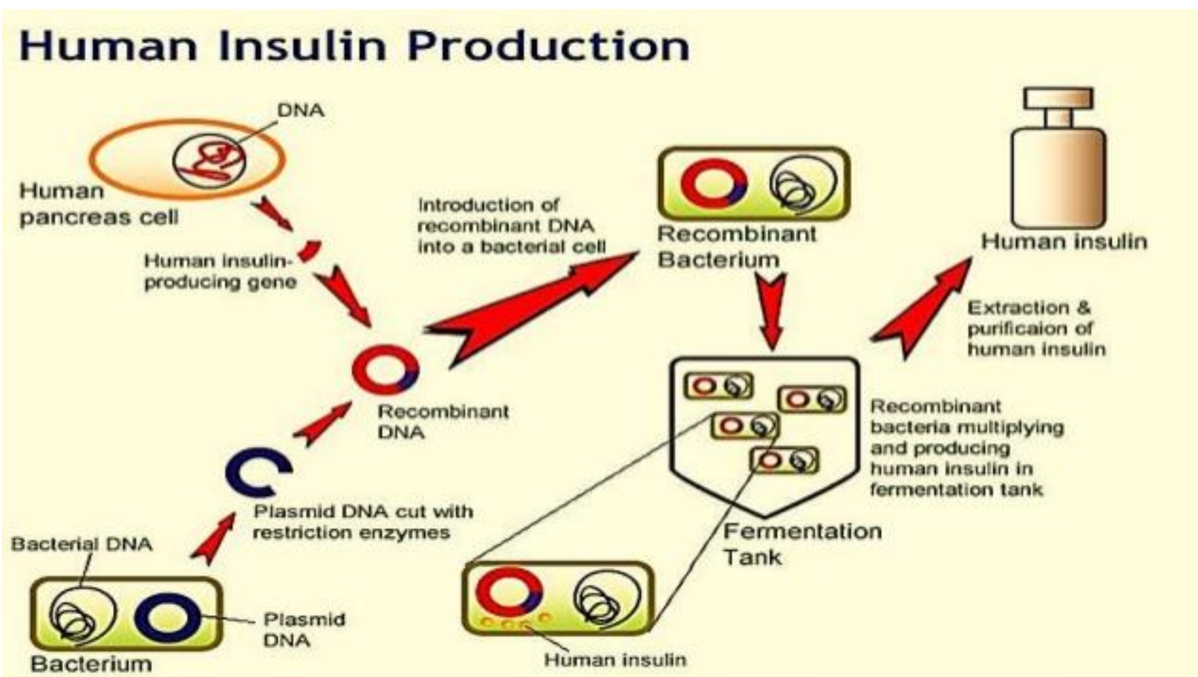
As a consequence thick mucus accumulates in air passages

It causes breathing difficult and reduces life expectancy

17(s) Explain that the gene that controls the production of human insulin can be inserted into bacterial DNA

Production of human insulin

1. People suffering from type 1 diabetes mellitus require insulin injections.
2. Genetic engineering is used to produce human insulin from the bacteria Escherichia coli.
3. The human insulin gene is first obtained from a human chromosome by cutting it with a restriction enzyme.
4. The plasmid vector is cut with the same restriction enzyme.
5. When the plasmids are mixed with the DNA fragments, they are able to bind as the enzyme cuts both in the same way, generating 'sticky ends' that can join together. DNA ligase is added to the mixture, allowing the cut ends of the DNA to join to form a continuous double strand.
6. The recombinant plasmids are mixed with E. coli. Heat shock is applied to the bacteria, opening up pores on the membrane of the bacteria so plasmids enter the bacteria. This process is known as transformation.
7. The bacteria are placed in large steel tanks called fermenters under optimal conditions for growth and reproduction. Features of a fermenter include a nutrient broth containing glucose water and salts, 37°C temperature maintained by a temperature probe, optimal pH maintained by a pH probe, air supply for aeration and a stirrer to mix substances evenly.
8. At the end of fermentation, the bacteria cells are lysed open. Insulin is extracted and purified by crystallisation.



Question 319

Which statements about genetic engineering to produce human insulin are correct?

1. The human insulin gene is cut out of human DNA.
2. The insulin gene is inserted into bacterial DNA.
3. The genetically engineered bacteria are cultured in large numbers.
4. These cultured bacteria are used in injections for diabetics.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1, 2 and 4 only

D 2, 3 and 4 only

Question 320

In the commercial manufacture of insulin, a human gene is inserted into which of these?

A a chromosome of a human cell

B a protein molecule in a yeast cell

C the DNA of a bacterium

D the nucleic acid in a virus

17(t) Understand that such genetically engineered bacteria can be used to produce human insulin on a commercial scale

Question 321

Which method could **not** be used to produce human insulin from genetically engineered bacteria?

A Bacteria are ground up and used as a source of insulin.

B Insulin is extracted from gases given off from the fermenter in which bacteria are grown.

C Insulin is extracted from homogenised bacteria.

D Insulin is extracted from the nutrient medium from a fermenter in which bacteria have been grown.

17(u) Discuss potential advantages and dangers of genetic engineering
Balanced arguments for and against GM foods:

Advantages of Genetic Engineering:

Do not need to use animals insulin.
Animal insulin causes allergies.
Animal insulin could transmit diseases like Mad cow disease.
People developed tolerance to animal insulin.
Genetically engineered insulin was exactly likes human insulin so did not cause any side effects.

Dangers:

Fear of the genetically engineered bacteria escaping in the wild.
The recombinant DNA could be transferred to other bacteria.
What if genes transferred to disease causing bacteria would cause serious effects.

Applications of genetic engineering

1. Genetic engineering has relevance to biological research e.g. genetically- modified (GM) mice are used to study the function of genes.
2. Low-cost, high-yield production of pharmaceutical drugs e.g. insulin, clotting factors for haemophiliacs, human growth hormone.
3. Agriculture, where traits conferred through genetic modification include:
(a) Survivability in harsh environmental conditions. Areas previously considered unsuitable can be used to grow crops. Crops are also more likely to survive bad weather such as drought.
(b) Reduced maturation time. Multiple harvests a year translates into increased supply of food.
(c) Resistance to pests, diseases and herbicides. Crops are less likely to succumb to diseases; farmers are able to use pesticides to remove pests and herbicides to remove weeds without killing the crops.
(d) Production of toxins that kill pests (bioinsecticides). Farmers save money on pesticides.
(e) Enhanced nutritional value. Genes coding for vitamin or nutrient production can be inserted into a crop species to yield a more nutritious product.

Benefits include:

(a) Lowered cost for farmers since fewer pesticides are used as plants can produce their own. This translates to lower consumer costs and increased accessibility to certain types of food.
(b) Higher yield since fewer crops are lost to disease or poor environmental conditions.
(c) GM foods with enhanced nutritional value can be used to supply nutrients to people living in areas without access to certain nutrients in their regular diet.

4. Animal husbandry and aquaculture – GM fish are designed to overproduce growth hormone, resulting in faster growth. This reduces fishing pressure on wild stock.
5. Gene therapy – Gene therapy is the insertion of genes into a person's cells or tissues in order to treat a disease.

Social and ethical implications of genetic engineering

1. Potential health concerns including allergen transfer, transfer of antiobiotic resistance, unknown health effects.
2. Environmental impact including transfer of genes to wild plants or weed varieties through cross-pollination, loss of biodiversity, reduced effectiveness of pesticides.

(a) Genes conferring herbicide tolerance might be transferred to weed varieties, causing the development of herbicide-resistant 'superweeds'.
(b) Pesticide-producing GM plants produce pesticides that might indiscriminately kill insects around them, even harmless insects such as butterflies. Such genes crossing over into wild varieties and ending up in a natural environment would have serious ecological implications. This results in a loss of biodiversity and affects the ecological balance.
(c) There is a concern that insects might build up resistance to pesticides.
3. Economic impact
(a) World food production would be controlled by a few biotechnology companies.
(b) Increased dependence of developing countries on industrialised countries carrying out genetic research.
(c) Technology modifying GM plants to produce sterile seeds to minimise the spread of genes into unintended plants and combat patent infringement would result in farmers having to purchase new seeds every year – not financially feasible for farmers in developing countries.
4. Ethical objections
(a) Limitations of modern science to adequately understand the negative effects of GMOs
(b) Unnatural to mix genes across species, tampering with nature, not respecting natural organisms' intrinsic values
(c) Concerns about welfare of GM animals
(d) GM food labelling is not mandatory in some countries. Consumers might be unaware that they are purchasing and consuming GM products.
(e) GM food might not have been adequately tested
(f) Further GM developments might be skewed towards private interests and profit instead of the public welfare

Question 322

Bacteria can be genetically engineered to produce human insulin by adding a human insulin gene to the bacterial DNA.

What is an advantage of this procedure?

A The bacteria do not need a source of glucose.

B The bacteria grow faster than before being engineered.

C The insulin does not need to be purified before being injected into a patient.

D The insulin is unlikely to cause an immune response when injected into a patient.

Question 323

Bacteria can be genetically engineered to produce human insulin.

Before this method was developed, the only insulin available was that from cattle or pigs. It was obtained from extracts of animal pancreas.

Which statements about the two methods are correct?

W Large numbers of bacteria can be cultured in a small space.

X Bacteria reproduce very quickly and make insulin quickly.

Y People sometimes develop diseases from insulin taken from cows or pigs.

Z The insulin produced in bacteria is not the same as that produced in the human pancreas.

A W, X and Y **B** W, X and Z **C** W, Y and Z **D** X, Y and Z

Question 324

What is a potential danger of growing genetically engineered crops?

A changing the genotypes of plants in nearby ecosystems

B producing cereals with different nutrient content

C producing greater yields within a shorter time

D reducing the amount of pesticides on crops