You and your genes

Answers

1  D

2  a  i  polymer
   ii  monomer
   iii  two, double

   b  The bases in two strands of DNA always pair up in the same way. A always pairs with T, and C always pairs with G.

   c  The two strands separate. Free bases pair up with the bases in each strand, to form two new strands. Each half of the split DNA molecule is completed with the new strands, making two identical DNA molecules.

   d  Each set of three bases in a gene make up the triplet code for one amino acid. The sequence of triplets in a gene describes the order of amino acids in a protein.

3  a  C
   b  A
   c  B

4  A mutation changes the sequence of bases in the DNA of the gene. This could change the sequence of amino acids in the protein made. This could affect the structure of the protein and its function. If the protein works differently or not at all, this could change the organism’s phenotype.

5  a  recessive
   b  i  D
      ii  A and C (B could also be a carrier, but we cannot be certain from the family tree)
      iii  She does not have cystic fibrosis, so she could be homozygous dominant (FF) or heterozygous (Ff). She would only be a carrier if she was heterozygous (Ff).

6  a

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>BB</td>
<td>Bb</td>
</tr>
<tr>
<td>b</td>
<td>Bb</td>
<td>bb</td>
</tr>
</tbody>
</table>

   b  C (75%)
   c  0.5 (or 50%)
   d  3:1
7  a  Genetic testing can provide information about whether or not people have harmful genetic variants. It can help people make informed decisions about family planning and healthcare. The results could cause distress/worry, and could affect job prospects and insurance.

b  Ethical issues: who should be told the results, what effect the results might have on people’s future decisions, whether genetic screening should be compulsory, and whether or not it is right to interfere. Different views: it’s wrong to interfere, we should give people all the information we can about their own health and the health of their fetus, so that they can make informed decisions.

8  Risks: unforeseen negative effects on health of humans who eat the rice; marker genes for antibiotic resistance could be transferred to pathogens; there could be protests/vandalism; golden rice may cost more than normal rice; customers may not like the yellow colour, so farmers would not be able to make a living from selling golden rice; farmers who do not grow golden rice may not be able to sell their normal rice if people regard it as inferior.

Benefits: health benefits of increased vitamin A in the diet; tests have shown that golden rice is safe to eat; tests have shown the risk of genes spreading from golden rice to wild crops is low.

9  a  altering the characteristics of an organism modifying its DNA

b  the plasmid

c  transfers human insulin gene (and marker genes) into the bacterium

d  Include a gene for antibiotic resistance (in the vector/plasmid). Grow the bacteria with the antibiotic; only bacteria that have taken up the new genes (and therefore become resistant to the antibiotic) will survive.
Keeping healthy

Answers

1. a influenza, ash dieback, HIV/AIDS, *Salmonella* food poisoning  
   b HIV/AIDS  
   c ash dieback  
   d *Salmonella* food poisoning

2. a Any two from: the skin, mucus in the respiratory and digestive systems, platelets in the blood.  
   b They are not made in response to a specific pathogen (are always present).

3. Many different pathogens cause colds, and memory cells from the first cold/infection cannot make antibodies against a different pathogen. Even if the first and second infections are with the same pathogen, the antigens on the pathogen may change (due to changes/mutations in their DNA), and memory cells will not recognise the changed antigens.

4. Regulating the movement of plant material, sourcing healthy plants and seeds, destroying infected plants, polyculture, crop rotation, chemical control, biological control.

5. DNA extracted from sample  
   ↓  
   gene probes joined to fluorescent substance  
   ↓  
   gene probes added to DNA  
   ↓  
   gene probes pair up with genetic variants in pathogen DNA  
   ↓  
   computer detects fluorescence

7. a Peter  
   b Ranjit  
   c Stella  
   d Jane and Ranjit

8. a African America  
   b Any four from: smoking, lack of exercise, diet high in fat/salt, body mass/BMI/obesity, high blood cholesterol, high blood pressure, family history/genetic variants, drinking alcohol, stress, diabetes.
c People in Africa get more exercise/have a better diet (lower salt/fat intake, eat fewer processed foods)/do not smoke or drink alcohol as much obesity is less common.

9 a Petri dish, agar, bacteria, antibiotic discs, ruler, gloves/personal protective equipment (students may also mention: wire loop/spreader, Bunsen burner, alcohol, ventilation cabinet, incubator).
b same size discs, same amount/concentration of antibiotic per disc, temperature
c diameter/radius of each clear zone
d Calculate diameter/radius/area (where area = πr²) of each clear zone.

10 Preclinical testing: A new medicine is first tested on human cells grown in a laboratory. If those tests show it is safe for cells, it is tested on animals. This test makes sure it is safe in whole animals. Finally it is tested in clinical trials.
Clinical testing: The medicine is tested on healthy human volunteers for safety, then on people with the disease for safety and effectiveness.
Double-blind trial: Neither the doctor nor the patient knows whether the patient has the new medicine. This is to ensure the reporting of effects is not biased.
Blind trial: The doctor knows whether the patient has the medicine, so they can look out for particular effects.
Open-label trial: Both doctor and patient know whether the patient has the treatment. This would be used when it could not be avoided (e.g., the patient is having a physical treatment such as physiotherapy) or when there is no other treatment and patients are so ill that they will not recover from the illness (so everybody in the trial is given the new treatment).

11 A placebo looks exactly like the real treatment, but does not have the medicine in it. A placebo may be given to the control group during clinical testing. A placebo should not be used if a current treatment is available, or if patients are so ill that they will not recover from the illness (so it would be wrong to withhold a potential new treatment).
Living together – food and ecosystems

Answers

1 a Completed table:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>light, water</td>
<td>oxygen, hydrogen</td>
</tr>
<tr>
<td>2</td>
<td>hydrogen, carbon dioxide</td>
<td>glucose</td>
</tr>
</tbody>
</table>

b Count the number of bubbles given off by a plant in a set period of time (e.g., 1 minute).

c Collect the bubbles of gas in the syringe. Record the volume of gas collected, instead of counting bubbles.

d amount of water, temperature, carbon dioxide concentration (or the amount of carbon dioxide) in the air

e Another factor (such as amount of water, temperature, or carbon dioxide concentration) is limiting the rate of photosynthesis.

2 B, C, E, (D)

3 a starch would be made more quickly

b starch would be made more slowly

4 Diffusion: The overall movement of molecules from a region of their higher concentration to a region of their lower concentration. It is a passive process (it does not need additional energy). For example, gases enter and leave plants by diffusion.

Osmosis: The overall movement of water from a dilute to a more concentrated solution through a partially permeable membrane. It is a special case of diffusion. It is a passive process (it does not need additional energy). For example, water enters plant roots by osmosis.

Active transport: The movement of molecules across a cell membrane by a carrier protein. Molecules can be moved from a region of the lower concentration to a region of their higher concentration (against a concentration gradient). It is an active process (it requires ATP/energy from respiration). For example, nitrate ions are absorbed by plant root hair cells by active transport.

5 a Xylem is made of dead cells that have no cytoplasm. They are joined end to end to form a hollow tube. This allows water and dissolved minerals to move through the xylem tube.

b Water and dissolved minerals are drawn through the xylem tube from the roots up the stem to leaves and flowers by transpiration.

6 a lettuce/rose

b greenfly/ladybird/caterpillar/robin/shrew/owl

c lettuce/rose → caterpillar → shrew/robin → owl, OR rose → greenfly → ladybird → robin → owl

d Greenfly population will decrease because they have no roses to eat. All populations of consumers higher in the food chain (i.e., ladybird, robin, and owl populations) may also decrease due to lack of food. Caterpillars will eat more lettuce, therefore lettuce population will decrease. If robins eat
more caterpillars (because ladybird population has decreased), lettuce population could increase and shrew population could decrease.

7  a  D  
    b  B, C, D

8  a  Diagram should show a pyramid of biomass similar to that shown in Student Book B3.3B Worked example, but based on data in question.  
    b  0.13%

9  Some bacteria are decomposers. They break down dead organisms. This process releases carbon dioxide into the atmosphere and into water such as the oceans. (The carbon dioxide can then be used by producers in photosynthesis, to build biomass.)

10  Use the capture-mark-recapture method. That is, collect a sample of puffins from the island. Mark each puffin (e.g., by putting a ring around its leg). Release the marked puffins. Later, collect a second sample of puffins from the island. Count how many puffins in the second sample are marked. Estimate the population size using the formula:

\[
\text{estimated population size} = \frac{\text{number of puffins given marks} \times \text{number of puffins recaptured}}{\text{number of recaptured puffins that have a mark}}
\]
Using food and controlling growth

Answers

1 a i When energy is required and (sufficient) oxygen cannot be supplied quickly enough for aerobic respiration (e.g., in muscle cells when sprinting to get away from a dangerous situation).
   ii If an organism lives in a low-oxygen environment (e.g., germinating seeds in soil, or bacteria in mud or a puncture wound).

   b Any suitable example, such as: bacteria used in cheese and yogurt production, yeast used in brewing and bread making, methane-producing bacteria used in biogas manufacturing.

2 a Any two from: aerobic respiration, anaerobic respiration, fermentation.

   b Nitrate ions are moved into root hair cells by active transport. This process requires energy from ATP (which is a chemical store of energy). Carbon dioxide molecules move through open stomata by diffusion, which is a passive process (does not require any more energy than the molecules already have). Therefore, no ATP is used in diffusion.

3 a To keep oxygen out to ensure cellular respiration is anaerobic.

   b To ensure that all carbon dioxide gas produced by respiring yeast is collected in the syringe (rather than escaping into the air).

   c To control the temperature, so that it does not affect the rate of respiration.

   d carbon dioxide gas

   e \[ \text{rate} = \frac{(70 - 30)}{400} = 0.1 \text{cm}^2 \text{ per second} \]

   f Any sensible suggestion, for example: line would start rising sooner, incline would be steeper, would reach maximum sooner, maximum would be higher. Any sensible explanation that links the predicted shape of the graph to more glucose/faster rate of respiration.

4 Ray and Jo

5 a Changes (mutations) in genes that control the cell cycle cause a cell to divide many times by mitosis. This can form a ball of cells called a tumour.

   b Any two from: carcinogens, ionising radiation, errors when DNA is copied.

   c Cells are leaving the tumour and moving around the body, and dividing uncontrollably to cause tumours elsewhere.

   d The tumour is made from the patient’s own cells. Therefore it is recognised as self by the patient’s white blood cells/immune system, and is not attacked.

6 a phototropism

   b C

7 a Bone marrow contains stem cells that divide and differentiate to make eight different kinds of blood cell. Leukaemia is a kind of cancer where the body makes too many white blood cells. Treatment involves killing the patient’s own bone marrow cells with radiation. New bone marrow from a donor, containing stem cells, can make healthy blood.
b Graft-versus-host disease can occur when the donated bone marrow makes white blood cells. The white blood cells from the new bone marrow recognise the patient’s body cells as non-self, and attack them.

c Any three from: infections, tumours, organ damage, immune rejection.

d Some people are worried about the ethical issues surrounding the use of human embryos as a source of embryonic stem cells. They say that these embryos could have grown into normal human beings under suitable conditions, and have the right to life. Some people believe that living things and human life are special, so research like this should never be allowed to take place. Other people believe that this research is only justified if it brings great benefits. Others may think the associated risks are too great.
The human body – staying alive

Answers

1  a  i  diffusion
  ii  diffusion
  iii  active transport
  b  water

2  As you breathe in, an oxygen molecule in the air travels through the nose and trachea into the lungs. In an alveolus it diffuses across partially permeable membranes into a capillary and then into a red blood cell, where it binds to haemoglobin.

3  Completed table:

<table>
<thead>
<tr>
<th>Blood component</th>
<th>Function</th>
<th>How the component is adapted to its function</th>
</tr>
</thead>
</table>
| red blood cells    | carry oxygen       | • packed with haemoglobin to bind oxygen  
|                    |                    | • no nucleus to allow more space for haemoglobin  
|                    |                    | • biconcave shape to increase surface area                                        |
| white blood cells  | fight infection    | • ability to make antibodies and ingest pathogens                                |
| platelets          | seal wounds        | • stick to edges of wound  
|                    |                    | • send out substances that cause blood to clot                                     |
| plasma             | carries dissolved substances | • acts as a solvent                                                                |

4  It would take too long for oxygen and other essential molecules to move from outside your body to all of the cells inside by diffusion/active transport. The distance is too great. The circulatory system carries these substances around your body quickly enough to keep all the cells alive and reduces the diffusion distance.

5  Like emails and letters, nerve impulses and hormones are used to send messages from one place to another, which may be a long way away. Nerve impulses are fast and the message is carried by electrical signals, like emails. Hormones are slower and the message is carried by physical substances, like letters.

6  Cells, enzymes, and life processes work best within a narrow range of conditions. For example, enzymes work at their best at an optimum temperature. In humans they have evolved to work best at core body temperature of around 37 °C. If conditions in the body change too much, you can become very unwell and even die.
7 When the concentration of the blood plasma is too high, this triggers the release of the hormone ADH from the pituitary gland. ADH travels in the blood to the kidneys. ADH increases the permeability of the kidney tubules, so more water is reabsorbed into the blood. When the concentration of the blood plasma returns to normal, ADH secretion stops.

8 The hot surroundings would warm the egg, which would eventually become the same temperature as its surroundings. Egg white is made of proteins. Proteins are denatured at high temperature, which changes their shape. This caused the egg white to turn solid. However, Sir Charles Blagden’s body would control his core temperature to keep it constant. He sweated, and his skin became vasodilated to control his core temperature. So his proteins were not denatured because his core body temperature did not rise to dangerous levels.

9 a

<table>
<thead>
<tr>
<th>uterus lining thickens</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>follicle breaks down, and uterus lining ready to receive fertilised ovum</td>
<td>D</td>
</tr>
<tr>
<td>uterus lining is shed</td>
<td>A</td>
</tr>
<tr>
<td>ovum released from follicle in ovary</td>
<td>C</td>
</tr>
</tbody>
</table>

b oestrogen
c LH (luteinising hormone)

10 a A: iris, B: cornea, C: lens, D: ciliary muscle, E: retina

b i and ii Diagrams should be based on the final figure in B5.6B of the Biology Student Book.

11 a

insulin

<table>
<thead>
<tr>
<th>glucose</th>
<th>carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>glucose</td>
<td></td>
</tr>
</tbody>
</table>

b i Type 2 diabetes, because it was late onset and she is obese which is a risk factor for type 2 diabetes.

ii controlled diet, careful exercise, and occasional insulin injections
Life on Earth – past, present, and future

Answers

1. a. i. extensive  
   ii. most  
   iii. a few  

b. A change in the DNA of an organism, which creates a genetic variant.  

c. Mutations happen at random, so different individuals in a species have different mutations, some of which may affect the individual’s phenotypes in different ways. This creates variation within a species.  

2. All individuals compete for resources (including water, space, light, pollinators, seed dispersers, shelter, and mates). Some individuals have helpful features caused by mutations in their DNA, which give them an advantage. These individuals compete more successfully, and are more likely to survive to reproduce. This is natural selection.  

3. a. Europe  
   b. i. A, D  
      ii. Homo sapiens  

4. The invention of the electron microscope meant biologists could see that animals, plants, fungi, and protists have a nucleus containing genetic material. It was suggested that these kingdoms could be put into a domain, the eukaryotes. DNA analysis has shown that the eukaryotes and the archaea are more closely related to each other than they are to the bacteria. The bacteria and the archaea are now classed as domains in their own right.  

5. Any three from: changing, damaging, and destroying habitats; removing or killing too many organisms; introducing organisms and pathogens that do not belong in an ecosystem; directly polluting and contaminating ecosystems; polluting the atmosphere, which contributes to global climate change.  

6. a. bioaccumulation  

b. Mercury is not broken down/digested/excreted, it is stored in the body/biomass of each organism. It is transferred to higher trophic levels / up the food chain when organisms are eaten. Each predator eats a large number of its prey, so receives many doses of mercury. There are fewer organisms in the higher trophic levels, so the amount of mercury per organism is greater (assuming the total amount of mercury per trophic level is the same).  

7. a. fully fished and underfished  

b. i. 40%  
   ii. 10%  
   iii. underfished  
   iv. The percentage of fish populations that are underfished has decreased. The percentage of fish populations that are fully fished has increased. The percentage of fish populations that are overfished has increased. (The percentage of fish populations fished sustainably has decreased.)
v Underfished populations could become overfished if fishing were not carefully controlled.

vi If climate change causes other sources of food (e.g., crops) to become more scarce, people could become more dependent on fish, leading to overfishing. If climate change causes fish to die out, fish population sizes will decrease and current levels of fishing will not be sustainable (will be classified as overfishing).