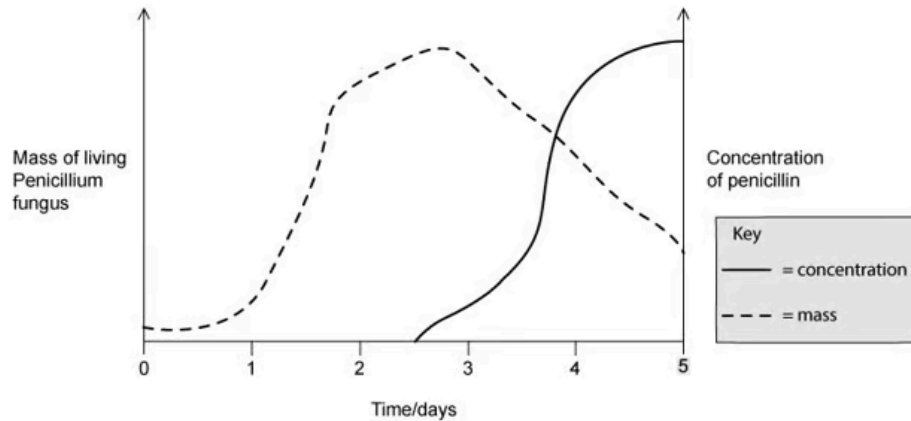


1.

Penicillin is produced in a fermenter by growing the fungus *Penicillium*.

The graph below shows how the mass of living *Penicillium* fungus, and the concentration of penicillin, changed over time.



Which day would be the best to harvest the penicillin at?

- A. 3 days
- B. 1.5 days
- C. 5 days
- D. 3.5 days

Answer: C

2. **State the name of an organism that can be used to make ethanol biofuel from sugars**  
Yeast

3. **State the process that this organism uses to make ethanol biofuel from sugars**  
Anaerobic respiration

4. **Describe process of using bacteria in genetic engineering to produce human proteins**

- The human gene / DNA that codes for (human) protein.
- ...is identified / isolated
- The DNA/gene is cut out / removed using restriction enzymes
- This will form sticky ends
- A plasmid (from bacteria) is cut using the same restriction enzyme
- The (human) gene/DNA is inserted into the plasmid / recombinant plasmid is formed
- (DNA) ligase is used to join the (human) gene with the plasmid
- (The recombinant) plasmids are inserted into bacteria

- These bacteria (with recombinant plasmids) replicate/reproduce/multiply
- The transformed bacteria can be purified (and grown in large fermenters)

#### **5. Why steam is used to clean fermenters**

- It kills microorganisms/bacteria/pathogens
- Steam will prevent contamination (by other bacteria/microorganisms)
- Steam does not contaminate the product/medicines (with other chemicals)
- It can reach all the crevices/spaces/corners/parts of the fermenter

#### **6. Conditions inside a fermenter that are measured & controlled**

- pH
- Temperature
- Oxygen (levels/concentration)
- Carbon dioxide (levels/concentration)
- Nutrients, e.g. glucose
- Waste (products)
- Turbidity (of liquid in fermenter)

#### **7. Examples of commercial products made in fermenters**

- Insulin
- Penicillin
- Mycoprotein
- Lactase enzymes
- Ethanol

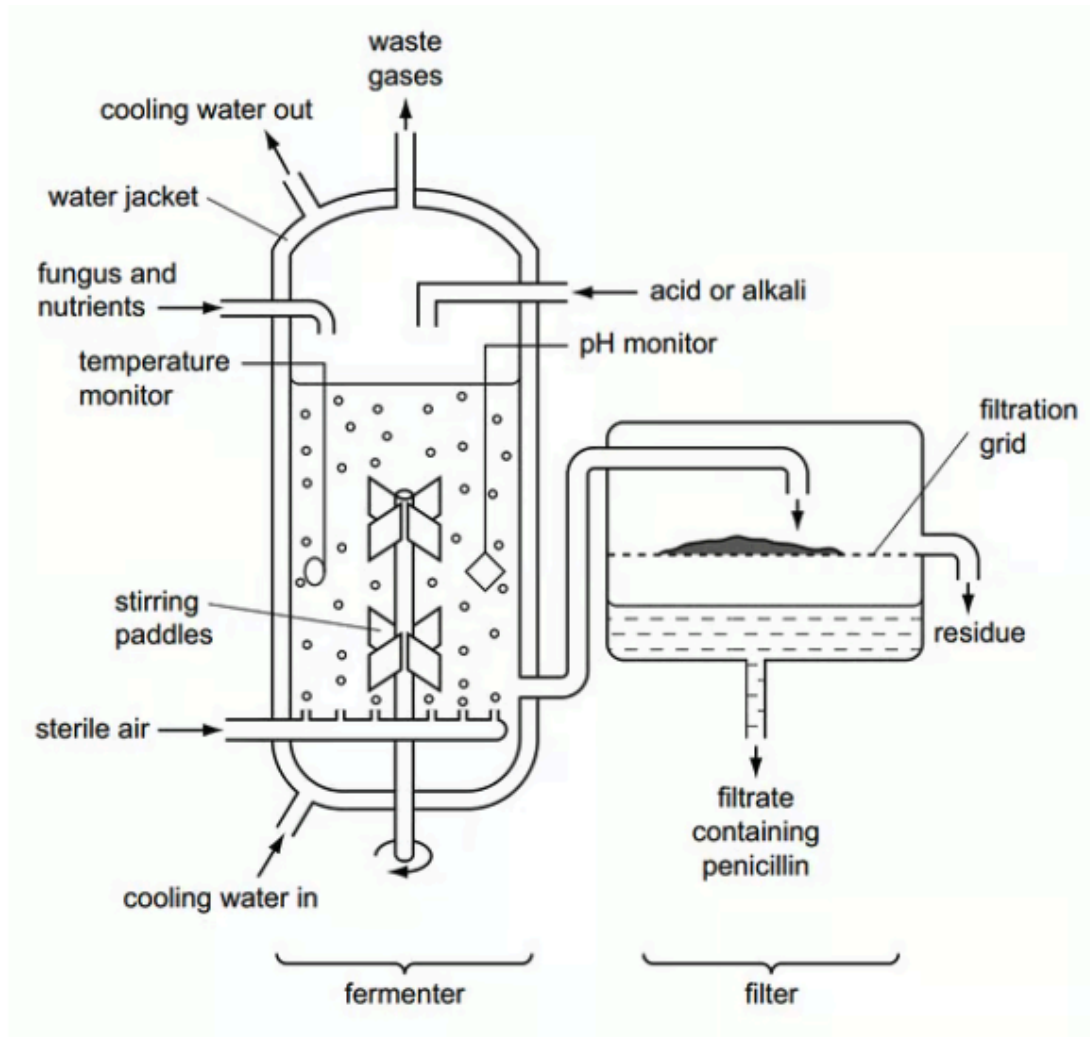
#### **8. Advantages of genetically modifying crops**

- Crops are more resistant to herbicides (used to kill weeds)
- Crops are more resistant to pests/insects
- Crops are more disease resistant
- Crops are more drought resistant
- Crops are more resistant to frost
- Crops are more resistant to high salt levels (in soil)
- Plants produce larger / faster yield
- Increased income is generated (for farmers)
- The nutritional content (of the plants) can be improved/enhanced/enriched
- Benefit to humans, e.g. relief from food shortages / preventing vitamin A deficiency
- It benefits the environment (in requiring less pesticides / water / fertilisers)
- (The modified plants) can be used to create/produce vaccines

#### **9. Why pectinase is used when making apple juice**

- It increases the quantity/volume of juice produced
- It speeds up the production process / allows more juice to be produced in less time
- It breaks down pectin (in plant cell walls)
- This allows the cell walls of plant cells to be broken down
- It makes clearer juice

**10. Why there's a water jacket around the fermenter, and why acids & alkalis are added**



Water jacket:

- Maintain optimum / constant temperature / prevent overheating
- To prevent enzymes denaturing
- (Because as) fungus respire...
- ... releases heat, so the temperature in the fermenter increases...
- ... which would kill fungus
- (Therefore) no product / no penicillin

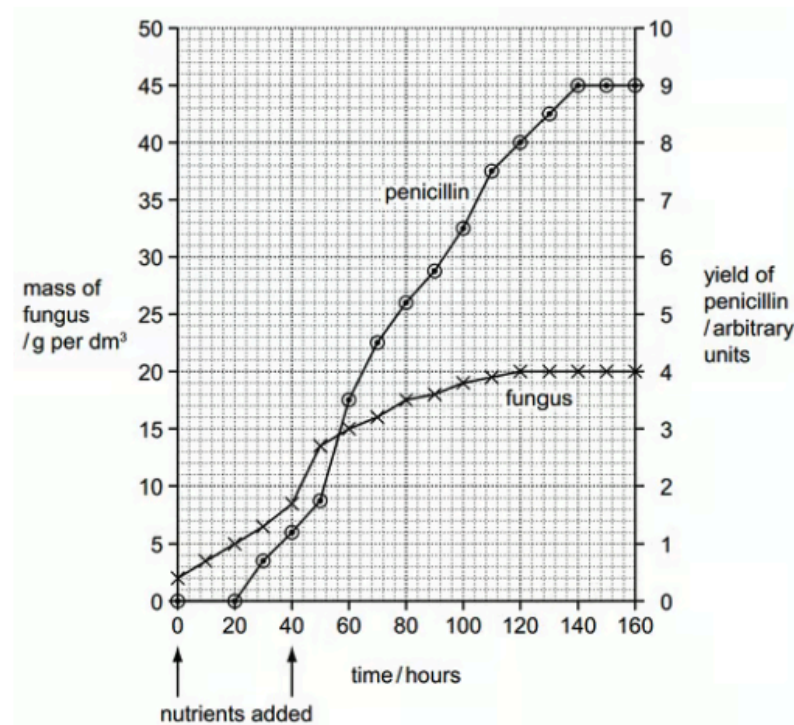
Acids & alkalis:

- Maintains pH / keeps pH constant

- Enzymes need optimum pH
- To give maximum enzyme activity / rate of reaction at its fastest
- To give maximum yield
- Stop enzymes denaturing

11.

Fig. 2 shows the mass of fungus and the yield of penicillin during the fermentation process.



**Explain why growth of fungus slows down & stops**

- Nutrients are used up
- Limiting (factors) e.g. not enough sterile air or pH becomes too high/low
- Explanation of limiting factor e.g. fungus cannot carry out enough aerobic respiration
- Waste products accumulate
- Wastes are toxic
- Penicillin could inhibit growth
- Population reaches carrying capacity

12.

*Downstream processing* refers to all the processes that occur to the contents of the fermenter after it is emptied. This involves making penicillin into a form that can be used as a medicine.

Suggest why downstream processing is necessary.

- Purifying or separating penicillin

- ... from waste or toxins
- Ensuring it is the correct concentration
- Making into pills / pressing into shape / putting into capsules
- Colour / taste

### **13. Ecological risks of growing herbicide-resistant crops**

- Herbicide resistant gene transferred to wild plants/ weeds during cross pollination
- Presence of genetically modified crops will decrease biodiversity in an area
- Unknown/possible negative effects on insect/animal life if they consume genetically modified crop plants
- Decomposition of genetically modified crop plants may produce toxic substances (and release it into the environment)

### **14. Advantages of biological washing powders**

- They can remove stains faster than non-biological washing powders
- They are effective at lower temperatures compared to non-biological washing powders // use less energy/money to clean clothes at lower temperatures
- They can be used to clean delicate fabrics that cannot be washed at high temperature

### **15. Genetic modification:**

- Changing the genetic material of an organism
- ... by removing/changing/inserting individual genes
- ... from another organism

### **16. Function of plasmid in genetic modification**

It provides a way for genes to be inserted into cells // it acts as a vector

### **17. Explain the purpose of 'sticky ends'**

- They form short sections of unpaired bases
- It provides a way for the gene to be inserted/joined/linked into the plasmid

### **18. Function of DNA ligase**

- It links/joins matching/complementary sticky ends (between the gene and plasmid)
- to form a single/unbroken DNA molecule

**19. Type of microorganism that produces penicillin:** fungus

**20. Type of pathogen penicillin is used to treat:** bacteria

**21. Name of the group of medicinal drugs that includes penicillin:** antibiotics

**22. Why it is important to stir the contents of the fermenter continuously**

- for even / uniform, distribution / concentration, of contents / AW ;
- ensure more access of bacteria with, medium / AW ;
- prevent settling / clumping of, contents / AW ;
- so oxygen / glucose / nutrients, dissolves ;
- so that growth is not limited ;
- so bacteria can absorb substances (more easily) ;
- bacteria need oxygen for respiration

### 23. Explain the population growth curve

#### Lag phase/ stage:

- bacteria growing/dividing slowly
- bacteria adjusting to conditions / absorbing resources

#### Exponential/ log phase/ stage:

- resources are not limiting /
- bacteria growing / dividing rapidly
- birth rate greater than death rate

#### Stationary phase/ stage:

- birth rate equal to death rate

#### Death phase/ stage:

- death rate greater than birth rate

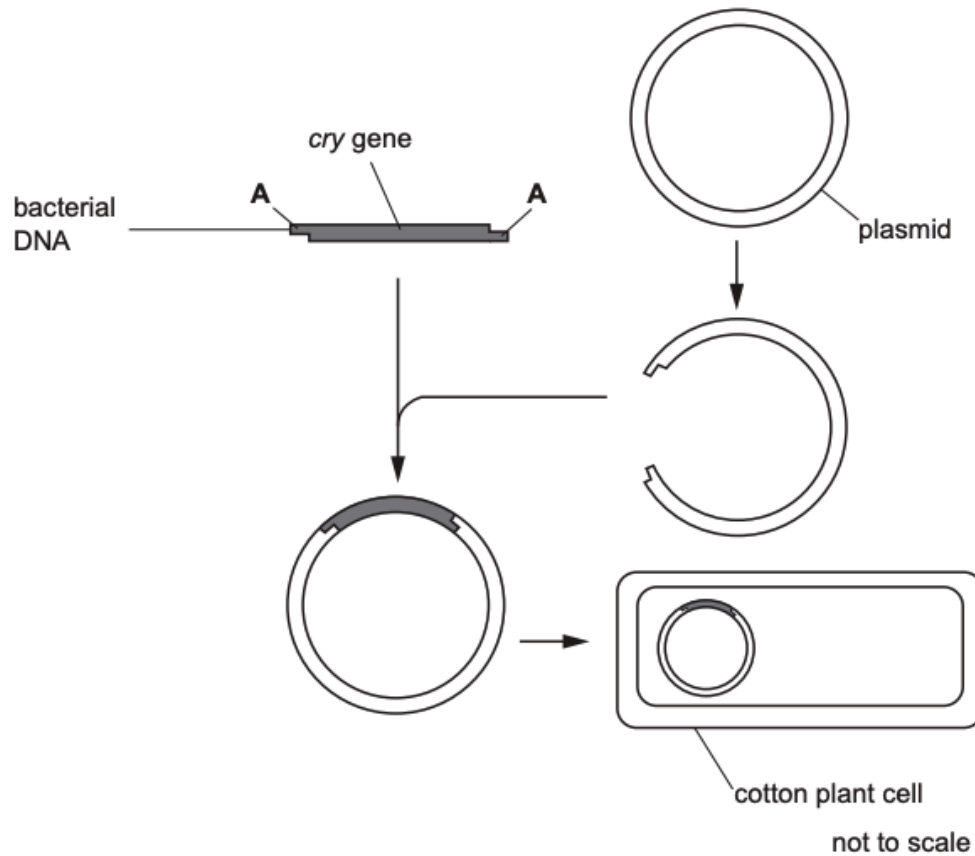
#### Stationary & death phase:

- many bacteria are dying
- concentration of resources decreasing / resources become limiting
- space becomes limiting
- toxins building up

### 24.

Cotton plants have been genetically engineered to produce a protein that is toxic to the caterpillars of several insect pests. This gives the cotton plants resistance to the pests.

The *cry* gene for pest resistance was isolated from the bacterium *Bacillus thuringiensis* and inserted into the cells of cotton plants as shown in Fig. 3.2.



**The plasmids containing the cry gene are inserted into the cells of cotton plants. Outline how the cells of cotton plants use the cry gene to make the toxic protein. Explain protein synthesis**

**Outline the advantages to farmers of growing genetically engineered cotton plants that contain the toxic protein.**

- to kill / harm / deter, caterpillars / insects / pests ;
- higher yield / reduce losses due to, (certain) caterpillars / insects / pests ;
- higher quality of cotton ;
- use less insecticide ;
- (so) less pollution ;
- (so) less money spent on, insecticides / spraying ;
- (so) less risk to workers' health (from using insecticides) ;
- (so) less chance of insecticide resistance ;

**25. Scientists who develop genetically engineered varieties of crop plants often breed them for several generations before releasing them for farmers to use. Suggest why the scientists do this.**

- need to check that offspring inherit 'new' gene / trait ;
- ensure new (GM) variety can grow in field conditions
- make sure the 'new' gene does not cause any adverse effects ;
- make sure (GM) plants have, the same / a high enough, yield ;
- idea of building up a large quantity of, seed / plants, to sell to farmers ;

**26. Examples of how enzymes are used in biotechnology**

- Genetic engineering - restriction enzymes
- Fruit juice production - pectinase
- To make lactose-free milk - lactase
- Washing powders

**27. Products of biotechnology that make use of microorganisms.**

- Bread
- wine/beer
- penicillin/antibiotic production
- Biofuels

**28. Why it is important to continuously stir the contents of a fermenter**

- for even/uniform distribution/concentration of contents
- prevent settling / clumping of contents
- ensure bacteria has more access with medium
- so bacteria can absorb substances more easily
- so oxygen / glucose / nutrients dissolves
- bacteria need oxygen for respiration
- so that growth is not limited

**29. Discuss the disadvantages of genetically modifying rice plants to produce beta-carotene**

- (additional) nutrient / energy, content may be (too) small
- seeds may be expensive to purchase ;
- farmers unable to save seeds ;
- ref. to side effects / (unknown) health risks, to consumers ;
- risk of cross-contamination with wild rice ;
- reduction, in biodiversity / genetic diversity ;
- consumers won't buy GM products / ethical concerns ;



### **30. disadvantages of genetic modification**

- reduced natural biodiversity
- insect-resistant plants negatively affect pollinators
- cross-pollinate into wild populations
- (GM seeds are) expensive
- seeds need to be bought each season
- ethical concerns of consumers