# 5.2 Selective breeding engineering and cloning

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

## Objective

Build the skills to answer exam questions on **selective breeding, genetic modification and cloning** 、 : breeding plants and animals with useful features, making transgenic organisms, human insulin from bacteria, micropropagation and cloning mammals.

**You must be able to:**

- describe how selective breeding produces useful plants and animals
- describe how a gene is put into bacteria using enzymes and a vector
- explain the advantages and risks of GM organisms
- calculate the growth of bacteria in a fermenter

## 1 Key knowledge and worked examples

### Changing organisms

| idea | rule |
|---|---|
| restriction enzyme | cuts DNA at a particular base sequence, leaving sticky ends |
| ligase | joins pieces of DNA together |
| vector | carries the gene into the cell: a plasmid or a virus |
| transgenic | an organism containing a gene from another species |
| micropropagation | many identical plants grown from small pieces of one plant, on agar with nutrients and hormones |
| doubling | number after $n$ divisions = start $\times 2^n$ |

**Worked example 1: doubling.** Bacteria divide every 20 minutes. How many are there after 4 hours, from one bacterium?

1. Known: $4 \times 60 \div 20 = 12$ divisions.
2. Rule: start $\times 2^n$.
3. Numbers: $1 \times 2^{12}$.
4. Result: 4096 **bacteria**.

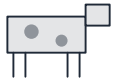
**Worked example 2: percentage gain.** After 10 generations of breeding, mean milk yield rises from 6000 to 7500 litres a year. Find the gain.

1. Known: old 6000; new 7500.
2. Rule: change ÷ old $\times 100$.
3. Numbers: $1500 \div 6000 \times 100$.
4. Result: 25%.

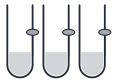
**Answer shapes:** in an evaluation, give benefits **and** risks, then a judgement.

## 2 Practice

**2.1** Give **two** features that farmers might selectively breed for in dairy cattle. [2]



**2.2** Give **one** advantage and **one** disadvantage of micropropagation. [2]



**2.3** Name **one** genetically modified crop and the benefit of its new gene. [2]



## 3 Exam-style questions

**3.1** Describe how a farmer could use selective breeding to produce a high-yielding variety of wheat. [3]



**3.2** Human insulin is made by genetically modified bacteria grown in large fermenters. In the past, insulin came from the pancreases of pigs. Some information is shown in the table.

(a) The bacteria divide every 30 minutes. Calculate the number of bacteria after 5 hours, starting from one. [2]



| | pigs | GM bacteria |
|---|---|---|
| same as human insulin | no | yes |
| amount made | limited | large |
| cost | higher | lower |

(b) Describe how the human insulin gene is put into a bacterium. [3]

(c) Use the table to give **three** advantages of insulin from GM bacteria. [3]

(d) The same company sells pest-resistant GM maize seed. Evaluate the growing of GM crops. [6]

## Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

**2.1**

Any two (1 mark each): high milk yield, good health or disease resistance, calm temper, milk with more fat or protein

**2.2**

- advantage: many identical plants quickly, all with the useful features
- disadvantage: no genetic variation, so a new disease could kill them all

**2.3**

- e.g. Bt maize: makes its own insecticide, so less crop is eaten by insects
- or golden rice: makes beta-carotene (vitamin A); or herbicide-resistant crops

**3.1**

- choose parent plants with high yield
- cross them, and grow the seeds
- choose the best offspring and breed them again, over many generations

**3.2**

(a) $5 \times 60 \div 30 = 10$ divisions; $2^{10} =$ **1024**

(b) the insulin gene is cut from human DNA with a restriction enzyme; a plasmid is cut with the same enzyme, giving matching sticky ends; ligase joins the gene into the plasmid, which is taken up by a bacterium

(c) any three (1 mark each): it is identical to human insulin, so fewer allergic reactions; large amounts can be made; it is cheaper; it does not depend on pigs, so it suits people who do not use animal products

(d) points to include:

- benefits: higher yields, as less crop is lost to insects (K)
- fewer insecticide sprays, which saves money and protects other insects (An)
- risks: the new gene could spread to wild plants by pollen (K)
- insects could become resistant over time (An)
- seed may cost more, and some people worry about safety, although tests have found no harm (An)
- judgement: useful where pests destroy many crops, if spread is monitored (An)

Levels: **5–6** a full, logical answer with correct biology and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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