3.3 Monoclonal antibodies

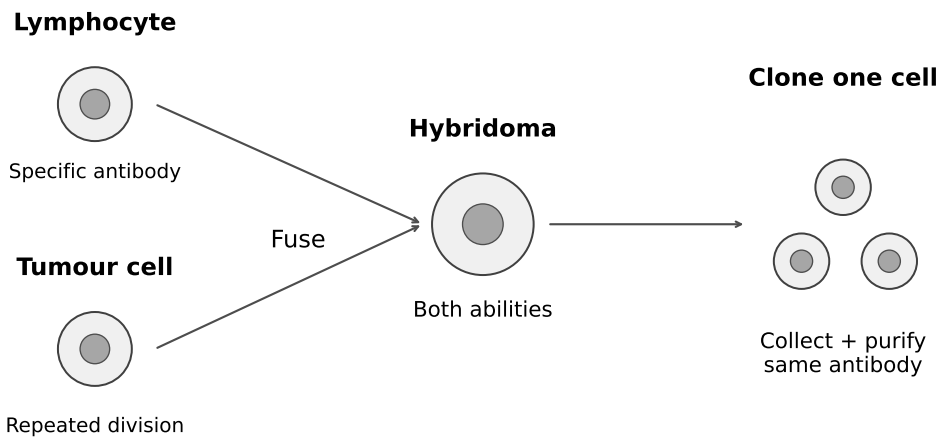
Name: _____ Class: _____ Date: _____ **Total: 18 marks**

KEY WORDS Monoclonal antibodies • hybridoma

Objective

Describe hybridoma production of monoclonal antibodies (HT) and their diagnostic and treatment uses. Biology only, HT. Original questions for spec statement 4.3.2.

1 Key knowledge and worked examples



Teacher schematic, not to scale; clone one antibody-producing cell.

Monoclonal antibodies come from one clone and bind one site on one protein antigen. Complementary shape means a binding fit, not identical shape.

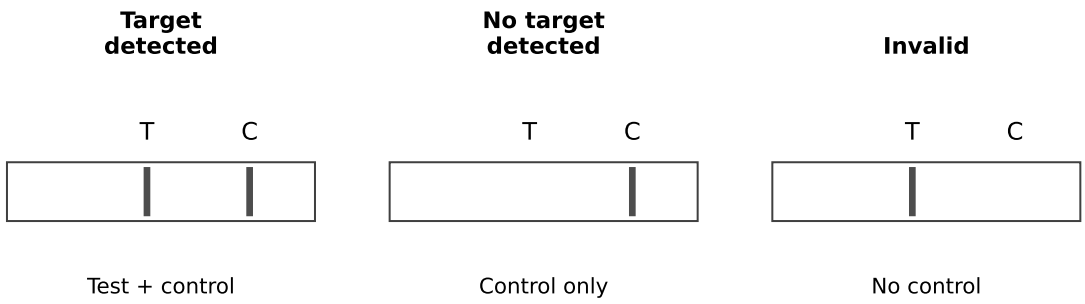
Production (sheet Q1.1/Q3.1): stimulate mouse lymphocytes with the relevant antigen → fuse an antibody-producing lymphocyte with a repeatedly dividing tumour cell → **hybridoma** combines both abilities → clone a single suitable hybridoma → collect and purify its identical antibody. Activated lymphocytes can divide; the culture-production issue is sustained division, not "lymphocytes cannot divide". Original 2025 Q07.4 requires the relevant liver antigen/cells, not an unspecified pathogen.

After fusion (original 2023 Q04.5 [3]): clone → many identical cells → same antibody → collect/purify. The original question starts from the hybridoma, so naming it alone is not enough.

Use	How binding is useful
Diagnosis / laboratory	detect hCG, a pathogen antigen or another chemical; measure hormone levels
Research	a fluorescent label locates a specific molecule
Targeted treatment	an attached toxic/radioactive agent or growth-inhibitor is delivered towards target cells

Cancer model (sheet Q3.2 [3]): assume the target antigen is confined to cancer cells. Antibody binds that antigen; attached agent is delivered to the target cells, reducing exposure elsewhere. "Without harming other cells" describes this ideal model, not guaranteed real treatment safety. Side effects can occur and must be evaluated.

Transplant model (original 2025 Q07.5 [3]): the supplied drug antibody binds liver antigens because it is complementary in shape → recipient antibodies cannot bind the occupied sites → recognition/attack is reduced. Specificity alone is insufficient for the three-mark explanation; do not substitute the cancer-payload mechanism.



Teacher sandwich-test model: T = test; C = control. Other assays must be read using their supplied mechanism.

Positive hCG model (sheet Q3.3 [3]): urine hCG binds mobile labelled antibody → complex moves and is captured by fixed antibody at the test zone → accumulated label forms a line. The control shows the process worked. Control only = no target detected under these conditions; no control = invalid, even if the test line appears. A negative-looking invalid result does not prove target absence.

Original 2023 Q04.7–.9: Figure 5 states test area captures antibody–steroid complex; control captures free antibody; binding changes the dye colour. Figure 6: A has control only; B neither line; C test without control; D both. B is invalid because its control has no dye; possible failure is no sample/antibody movement or missing antibody. D is the valid positive. Do not call C positive without checking control.

2 Practice

2.1 Which two cell types are fused to make a hybridoma, and what does each contribute? [4]

2.2 Why is the hybridoma's dual ability important? [2]

2.3 Give two uses of monoclonal antibodies. [2]

3 Exam-style questions

3.1 Describe how monoclonal antibodies are produced. [4]

3.2 Explain how a monoclonal antibody can treat cancer without harming other cells. [3]

3.3 A pregnancy test strip contains monoclonal antibodies to HCG in one zone. Explain how the test gives a positive result. [3]

Solutions

2.1 Mouse lymphocyte – makes the specific antibody; tumour cell – can divide repeatedly in culture.

2.2 A hybridoma both divides and produces the antibody, so large quantities of one antibody can be made.

2.3 Any two: pregnancy tests; measuring hormone levels; detecting pathogens; locating molecules in research; cancer treatment.

3.1 Stimulate mouse lymphocytes to make the antibody; fuse them with tumour cells to make hybridoma cells; clone a single hybridoma; collect and purify the large quantity of antibody produced.

3.2 In the ideal model, assume the target antigen occurs only on the cancer cells. The antibody binds that complementary target antigen; it carries a radioactive substance, toxic drug or growth-stopper; binding directs the agent to target cells, reducing exposure of non-target cells. This is selective-delivery reasoning, not a guarantee of zero side effects in real treatment.

3.3 In the stated sandwich-test model, hCG in urine binds mobile labelled antibodies; the complex moves along the strip and is captured by fixed antibody in the result zone; accumulated label forms a visible line. A control signal is also needed for a valid interpretation.