Solutions

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

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

2.1

1: peptide–MHC binds the T cell receptor

2: co-stimulation, B7 binds CD28

3: cytokines

2.2

the T cell becomes **anergic**: it will not respond

this stops responses to self-peptides shown without danger

2.3

A: **Th2**

B: **Th1**

C: **Th17**

2.4

polysaccharides give a T-independent response, which is weak under 2 years

joining the sugar to a protein brings in T cell help, giving IgG and memory

3.1

(a) the **germinal centre**

(b) the B cells' variable region genes mutate (somatic hypermutation); the B cells compete for a small amount of antigen; those that bind best get T cell help and survive, the rest die

(c) $10 \div 1 =$ **10 times**

(d) **T follicular helper (Tfh)** cells

3.2

(a) **CD4** helper T cells

(b) CD4 cells help B cells to switch class and make high-affinity antibody, and help CD8 cells to expand and keep working

(c) yes: 150 is below 200

(d) *Pneumocystis* pneumonia (or oral candida, toxoplasmosis)

3.3

(a) perforin makes pores in the target cell; granzymes enter and trigger apoptosis

(b) the contents, including virus, are packed up and removed without inflammation

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(c) **FOXP3**; **IL-10** and **TGF-β**

(d) there are no working regulatory T cells, so self-reactive T cells attack the pancreas and the gut

(e) 12 divisions: $2^{12} =$ **4096**