## 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 three of: shorter lag; much higher peak; mainly IgG; higher affinity; lasts longer

**2.2**

$1 - \frac{1}{15}$

$= 0.93$, about **93%**

**2.3**

the weakened microbe can still multiply

without a working immune system it can spread and cause disease

**2.4**

tetanus: **toxoid**

MMR: **live attenuated**

Hib: **conjugate**

**3.1**

(a) $540 \times 0.03 = 16.2$, about **16**

(b) $60 + 16 =$ **76**

(c) $524 \div 600 \approx$ **87%**; this is below about 93%, so yes, it can spread

(d) MMR within 72 hours (it can be given from 6 months); or human normal immunoglobulin within 6 days

**3.2**

(a) memory B cells from the old vaccine quickly make large amounts of high-affinity IgG: a secondary response

(b) it gives ready-made antibody at once (passive immunity), covering the days before his own antibody rises while toxin may already be made

(c) it is broken down and there are no memory cells to make more

**3.3**

(a) vaccine: $20 \div 20\,000 = 0.1\%$; placebo: $200 \div 20\,000 = 1\%$

(b) $1 - \frac{0.1}{1} =$ **90%**

(c) to compare with people treated the same in every other way, so the difference is due to the vaccine

(d) the protein is made inside our cells and shown on MHC I to CD8 T cells; it is also released and taken up, so it reaches B cells and CD4 cells on MHC II



(e) to give a secondary response: more memory cells and higher-affinity antibody



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