InkBiology

ANSWER BOOK

Antibodies, vaccination and the four kinds of immunity

Pathogens, disease and immunity · Unit B11

AQA 3.2.4 · OCR A 4.1.1 · Edexcel A Topic 6.7 · CAIE 11.2

7 questions · 24 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **B1** the breast milk gives natural passive immunity. **B1** the MMR vaccine gives artificial active immunity. [2]

SECTION B · Standard, 3 to 5 marks

B1 **B1** an antibody has two binding sites and cannot lyse a cell, digest a wall or poison anything; all it does is bind an antigen to form an antigen-antibody complex. **B1** agglutination: because each antibody has two identical binding sites it can bind two bacteria at once, clumping them so they cannot spread and so one phagocyte can engulf many at a time. **B1** neutralisation: antibody bound over a toxin, or over the attachment proteins of a pathogen, covers the part that would otherwise fit a host receptor, so it cannot act or enter a cell. **B1** marking for phagocytosis: the constant regions project outwards and phagocytes carry receptors complementary to them, so the pathogen is engulfed and hydrolysed inside the phagocyte. [4]

B2 **B1** in active immunity the person's own lymphocytes meet the antigen and respond, whereas in passive immunity ready-made antibody is introduced from outside. **B1** active immunity takes days or weeks to become established, whereas passive immunity works immediately because the antibody is already present. **B1** active immunity leaves memory cells behind, whereas passive immunity produces none. **B1** active immunity therefore lasts for years, whereas passive immunity fails within weeks as the introduced antibodies are broken down and nothing replaces them. [4]

B3 **B1** after infection the specific response takes time: antigen must be presented, a B cell selected, and clonal expansion must run before plasma cells exist. **B1** a primary response takes about eight days to produce detectable antibody and the concentration rises slowly, so it may still be below what the test can detect. **B1** the person is infected, and infectious, despite the negative result, which is a false negative. **B1** donated blood could therefore transmit HIV despite passing the screen, so an antibody test alone is not sufficient and a further test or a repeat test after an interval is needed. [4]

B4 **B1** in favour: a placebo group provides a valid comparison, so any difference in infection rate between the groups can be attributed to the vaccine rather than to other factors. **B1** against: the control group is deliberately left without protection during an epidemic, so people who could have been protected may catch the disease. **B1** the alternative of comparing against an existing vaccine avoids that, but makes the trial larger, slower and more expensive, which delays the new vaccine for everyone. **B1** a judgement supported by the points made, for example that a placebo group is defensible only where no effective vaccine already exists and consent is genuinely informed, with the recognition that this is a value judgement the biology does not settle. [4]

B5 **M1** uses the threshold proportion $1 - 1/R_0$. **M1** substitutes correctly: $1 - 1/12 = 1 - 0.0833$. **A1** 0.917, that is 91.7 per cent (accept 92 per cent), of the population must be immune. [3]

B6 **B1** immunity is immunity to a shape: memory cells and antibodies are complementary to one antigen and to no other. **B1** the surface proteins of influenza, haemagglutinin and neuraminidase, accumulate mutations and whole genome segments can be exchanged, so its antigens change from year to year, which is antigenic variation. **B1** memory cells raised against last year's antigens bind this year's poorly or not at all, whereas measles has stable surface antigens, so the same memory cells still fit and childhood doses last for life. [3]