7.4 Immunological memory and vaccination

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

KEY WORDS herd immunity

Objective

Read primary/secondary curves and compute herd-immunity thresholds.

1 Key knowledge and worked examples

■ **The curves**

Primary: 4–7 d lag, IgM→IgG, peak 7–14 d. Secondary: hours–2 d, IgG, 10–100× ✓. Herd: $1 - 1/R_0$.

■ **Worked example: policy from one equation**

Measles R_0 12–18 → 92–95 % immune; influenza 1.3 → ~25 % ✓.

2 Practice

2.1 Which Ig class dominates a secondary response? [3]

2.2 Compute the herd threshold for $R_0 = 4$. [3]

2.3 Why does a 3-dose schedule exist for hepatitis B? [3]

3 Exam-style questions

3.1 A serology shows day 5 IgM positive/IgG negative and day 16 IgM positive/IgG fourfold rise (fictional).

Interpret both timepoints (acute primary infection, seroconverting). Explain the class and titre pattern from the primary curve. State what a stable single IgG titre would mean. [7]

3.2 A region's measles vaccine coverage drops from 95 % to 84 % (fictional).

Compute the susceptible fraction above threshold (needed $\leq$ ~5–8 %; now 16 %). Explain why outbreaks follow (R_0 12–18). State what coverage the region must restore and why influenza policy differs (~25 % threshold). [7]

Solutions

2.1

- IgG ✓.

2.2

- $1 - 1/4 = 75\ \%$ ✓.

2.3

- Dose 1 primes, 2 boosts, 3 matures affinity and catches slow responders ✓.

3.1

- Day 5: early primary – IgM first ✓. Day 16: seroconversion with class switch ✓.
- Primary curve: IgM within days, IgG rising to peak 7–14, titre modest; the fourfold IgG rise dates the response.
- Stable IgG alone: past infection or vaccination (no rise, no IgM).

3.2

- Threshold herd $\approx 1 - 1/12$ to $1 - 1/18 = 92$–$95\ \%$ immune; at 84 % coverage susceptible $\approx 16\ \% > 5$–$8\ \%$ ✓.
- With R_0 12–18 each case infects >12 susceptibles: sustained transmission resumes.
- Restore ≥ 92–$95\ \%$; influenza ($R_0 \approx 1.3$) needs only ~25 %, so its policy targets the vulnerable rather than transmission alone.