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Question 4

Part 1

$$[\dot{B}] = \beta[B] - \frac{\beta[B]^2}{N} - \gamma[B] \longrightarrow \text{mean field equation}$$

$$[\dot{B}] = [B]^2 \left(\frac{\beta}{[B]} - \frac{\beta}{N} - \frac{\gamma}{[B]} \right)$$

$$\longrightarrow \boxed{\frac{1}{[B]^2} \cdot [\dot{B}] = \frac{\beta - \gamma}{[B]} - \frac{\beta}{N}}$$

Part 2

$$y = \frac{1}{[B]} \longrightarrow \text{using the chain rule to differentiate}$$

$$\dot{y} = -\frac{1}{[B]^2} \cdot [\dot{B}]$$

$\longrightarrow$ substituting $\dot{y}$ into the equation from part 1

$$-\dot{y} = \frac{\beta - \gamma}{[B]} - \frac{\beta}{N}$$

$$\dot{y} = \frac{\gamma - \beta}{[B]} + \frac{\beta}{N}$$

so $\boxed{\dot{y} = (\gamma - \beta)y + \frac{\beta}{N}}$

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