

Medical Microbiology and Infection

Curated preclinical study track (not a medical degree, no licensure claim; mechanism tasks and laboratory interpretation only, no treatment regimens). Original explanations and practice only, following the reviewed course handout.

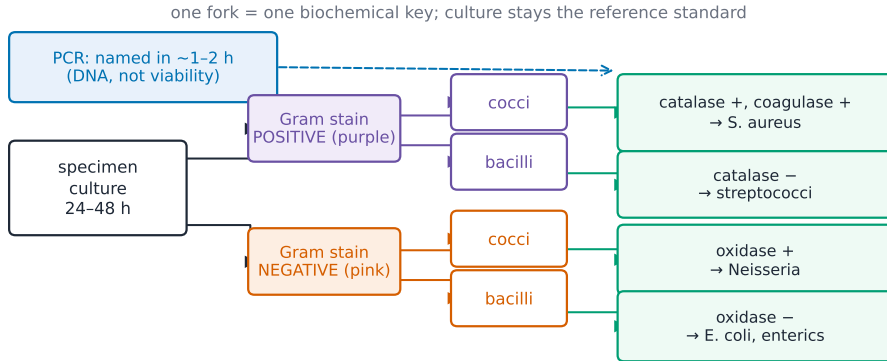
Organisms first, then the negotiation

- Units 8.1-8.4 name the attackers (classification, bacteria, viruses, fungi and parasites); 8.5-8.7 the interaction (transmission, drugs, prevention).
- Every number - doubling times, incubation periods, R_0 - is something you recompute.

Classification and the diagnostic laboratory: fork by fork

- 1 Gram chemistry** Crystal violet-iodine trapped by thick **peptidoglycan** → purple; thin wall + outer membrane loses it → pink counterstain.
- 2 Report walk** Gram-positive cocci in clusters; catalase + (not streptococci); coagulase + → *Staphylococcus aureus*.
- 3 Fast lane PCR** names DNA in ~1-2 h (meningitis); culture 24-48 h proves viability and susceptibility.

The classification tree from specimen to named organism

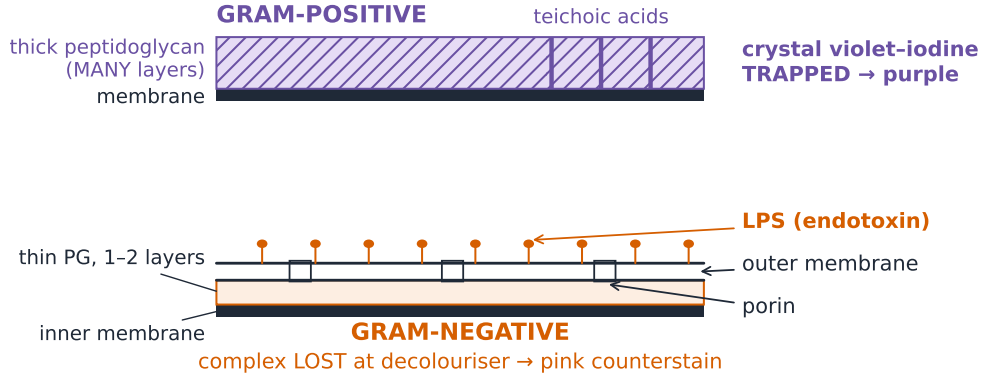


Gram stain first, then shape, then biochemistry; **PCR** is the fast lane.

Bacteria: structure, growth and pathogenesis - the wall decides

- 1 Walls** Gram-positive: many **peptidoglycan** layers + teichoic acids.
Gram-negative: 1-2 layers + outer membrane with LPS (endotoxin) and porins.
- 2 Growth** $N = N_0$ doubled ($t \div g$) times; a 20-minute doubler makes $2^{30} \approx 10^9$ cells in 10 h; a 20-hour doubler manages half a generation.
- 3 Virulence Capsule** defeats phagocytosis (the clear halo on a pneumococcal stain); exotoxins are secreted proteins with named targets.

Gram-positive versus Gram-negative cell walls

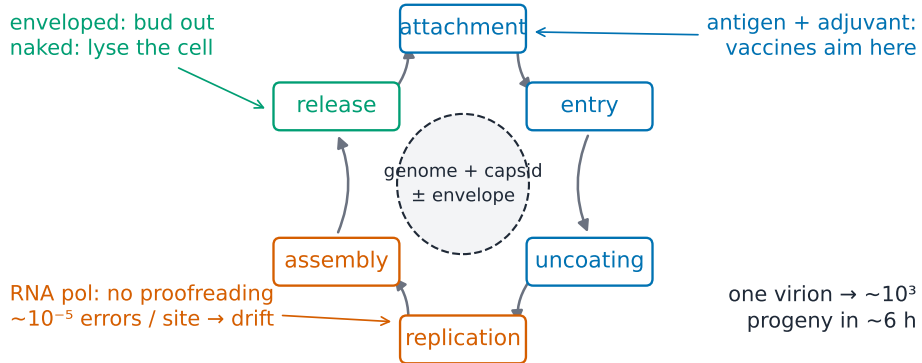


Thick **peptidoglycan** with teichoic acids versus thin peptidoglycan inside an LPS outer membrane.

Viruses: six steps around one cell

- 1 Cycle** Attachment → entry → uncoating → replication → assembly → release; enveloped viruses bud, naked viruses lyse.
- 2 Burst** One virion → $\sim 10^3$ progeny in ~ 6 h; two rounds → 10^6 ; a 1-2 day incubation is 4-8 rounds.
- 3 Drift and shift** No proofreading → $\sim 10^{-5}$ errors per site → **antigenic drift** (yearly vaccines); 8 segments reassort → **antigenic shift** (pandemics).

The virus replication cycle

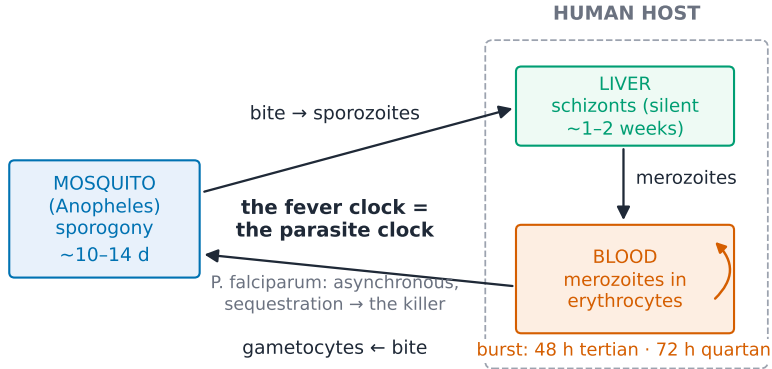


Attachment, entry, uncoating, replication, assembly, release - every antiviral target sits on it.

Fungi and parasites: two hosts, one clock

- 1 Dimorphism** Mould at 25 °C in the environment, yeast at 37 °C in tissue - the thermostat is the identity card.
- 2 Malaria cycle Sporozoites** → liver schizonts → erythrocytic **merozoites** → **gametocytes** → next mosquito; synchronous bursting every 48 h (tertian) or 72 h (quartan).
- 3 The exception** *P. falciparum*: asynchronous, sequestering - irregular fevers but the killer.

The malaria life cycle between mosquito and human



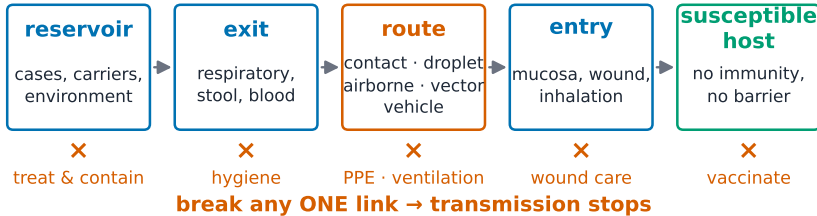
Liver stage, blood stage, gametocyte stage - each stage names a target.

Transmission: the chain and R_0

- 1 **Chain** Reservoir → exit → route (contact, droplet, airborne, vector, vehicle) → entry → susceptible host.
- 2 **R_0 clock** Measles ~12-18, SARS-CoV-2 ancestral ~2.5-3, influenza ~1.3; doubling time = $SI \times \log 2 / \log R_0$ (flu ~5-8 d, measles ~2.5-3 d).
- 3 **Outbreak page one** 54/120 ill = 45% **attack rate**; stratify once by dish (85% vs 10%) and the vehicle is named.

The chain of infection with its transmission routes

carriers make reservoirs silent — sick patients are not the only source



R_0 (secondary cases, fully susceptible population):

measles	12-18
SARS-CoV-2 (ancestral)	2.5-3
influenza	1.3

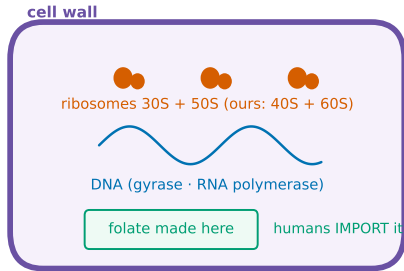
doubling $t_d \approx SI \cdot \log 2 / \log R_0$
 flu ~5-7 d · measles ~2.5-3 d

Five links; break any one and transmission ends.

Antimicrobials: four targets, resistance arithmetic

- 1 Targets** Wall (β -lactams $\rightarrow$ penicillin-binding proteins), ribosome (30S/50S vs our 40S/60S), gyrase/RNA polymerase, folate (bacteria make it, we import it).
- 2 Arithmetic** Resistance mutations 10^{-7} - 10^{-9} per cell per generation; $\sim 10^9$ cells per mL overnight $\rightarrow$ mutants against any single drug; two hits multiply to 10^{-14} - 10^{-18} .
- 3 Report read** β -lactamase opens the ring (hydrolysis); PBP2a is the altered target - different mechanisms, different reports.

Drug targets on a bacterium



**selective toxicity = a target
human cells lack**

wall

β -lactams $\rightarrow$ PBPs (cross-linking)

ribosome

30S/50S blocked; ours untouched

DNA enzymes

gyrase · RNA polymerase

folate

blocked; humans import it

resistance: mutation 10^{-7} - 10^{-9} /cell/generation
+ plasmids moving genes between species

Wall, ribosome, DNA enzymes, folate - four bacteria-specific targets on one cell.

Prevention: match the level to the physics

- 1 Levels** Standard (every patient) + contact / droplet / airborne; droplets $> 5 \mu\text{m}$ fall within $\sim 1\text{-}2 \text{ m}$; $\leq 5 \mu\text{m}$ drift for hours.
- 2 Ladder** Cleaning $\rightarrow$ disinfection (vegetative cells only) $\rightarrow$ **sterilisation** (steam $121\text{-}134^\circ\text{C}$ or chemical).
- 3 Clocks** Staff flu vaccination $40\% \rightarrow 90\%$ cuts the susceptible-staff fraction $60\% \rightarrow 10\%$ (six-fold); a surgical-site cluster on days 5-7 dates the breach.

The precaution levels and their transmission routes

level	route physics	what you add	examples
airborne	$\leq 5 \mu\text{m}$, suspended for hours, rides air	fitted respirator + negative-pressure room	<i>measles, TB</i>
droplet	$> 5 \mu\text{m}$, falls within ~1-2 m of the source	surgical mask within 1-2 m	<i>influenza (mainly)</i>
contact	hands, surfaces, fomites, wounds	gloves, gown, single room	<i>C. difficile, MRSA</i>
STANDARD PRECAUTIONS — every patient hand hygiene · gloves for anticipated exposure			



Standard for everyone; add the level that matches the route - contact, droplet or airborne.

Check yourself

- Gram-positive stains purple because...? (Thick **peptidoglycan** traps the crystal violet-iodine complex.)
- A 20-minute doubler in 10 h gives...? (30 generations, $\sim 10^9$ cells.)
- Tertian fever periodicity is...? (48-hour synchronous erythrocytic bursting.)
- Two independent resistance mutations multiply to...? ($\sim 10^{-14}$ - 10^{-18} .)