Study Guide 7

This guide covers chapters 13 and 14, the last of the review. Chapter 13 is systemic pathology, where each disease carries a signature: a lab pattern, a joint distribution, a radiographic sign, a red flag. Chapter 14 is microbiology, immunology and public health, where questions are among the most predictable on the exam: a classic organism, a classic toxin, a classic vector, a classic calculation. Work one chapter at a time, study the diagram, cover the steps of each worked case, then finish with the ten board-style items. The cram sheet at the end puts both chapters on one page, and the final guide pulls all fourteen together.

WHAT THIS GUIDE COVERS

- Chapter 13 · osteoporosis, osteomalacia, Paget disease and hyperparathyroidism by lab pattern, osteomyelitis, avascular necrosis, primary and metastatic bone tumors, osteoarthritis, rheumatoid arthritis, the seronegative spondyloarthropathies, crystals and DISH, lupus and the connective tissue antibodies, myopathies, stroke and hemorrhage, meningitis, multiple sclerosis and Guillain Barre, cord syndromes, atherosclerosis, infarction, aneurysm and dissection, obstructive and restrictive lung disease, lung cancer, GI and liver disease, nephritic and nephrotic syndromes, endocrine disease and the anemias and leukemias.
- Chapter 14 · innate and adaptive immunity, antibody classes, complement, MHC and T cell subsets, vaccines, bacterial structure and the Gram stain, genetics and toxins, major pathogens, antibiotics and resistance, viral structure and replication, herpesviruses, hepatitis serology, HIV, prions, fungi, protozoa, helminths and vectors, incidence and prevalence, study designs, sensitivity, specificity and predictive values, the chain of infection, sterilization levels and standard precautions.

CHAPTER 13

Systemic Pathology: Musculoskeletal, Nervous and Organ System Disease

Read it in full: **Chapter 13 in the review book**. Practice it: **the practice exams** (Exam 7 covers this chapter) and **the flashcards**.

What to know

Metabolic bone disease sorts by four labs. **Osteoporosis**: calcium, phosphate, ALP and PTH all normal; too little bone of normal quality; trabecular sites fail first (vertebrae, distal radius, femoral neck). T-score at or below -2.5, or any fragility fracture, makes the diagnosis; films need 30 to 50% loss. **Osteomalacia** (vitamin D deficiency): low or low-normal calcium, low phosphate, high ALP, high PTH, with Looser zones. **Paget disease**: very high ALP with normal calcium and phosphate. **Primary hyperparathyroidism**: high calcium, low phosphate, high PTH, with subperiosteal resorption of the radial side of the middle phalanges.

Paget disease runs lytic, mixed and sclerotic phases. Spine: picture frame and ivory vertebra (enlarged, unlike metastasis). Skull: osteoporosis circumscripta, then cotton wool, with rising hat size and hearing loss. Long bones: blade-of-grass front, bowing, banana fractures. Complications include high-output heart failure and about 1% osteosarcoma. **Osteomyelitis**: Staphylococcus aureus overall; Salmonella in sickle cell; Pseudomonas in nail puncture through a sneaker; films lag 10 to 14 days, MRI is best. Pyogenic spine infection **destroys the disc early**; tuberculous Pott disease spares the disc, crosses levels and gives a gibbus and psoas abscess. **Avascular necrosis** favors the femoral head (steroids, alcohol, trauma, sickle cell, caisson disease): crescent sign, then collapse.

Primary bone tumors sort by age and site. **Osteosarcoma**: 10 to 25, metaphysis around the knee, Codman triangle and sunburst. **Ewing sarcoma**: 5 to 20, diaphysis, onion skin, t(11;22), mimics osteomyelitis. **Giant cell tumor**: 20 to 40, epiphysis, soap bubble. **Osteochondroma**: commonest benign, metaphysis, points away from the joint. **Osteoid osteoma**: nidus under 2 cm, **night pain relieved by aspirin**, painful scoliosis. Vertebral hemangioma: corduroy cloth. In adults the commonest malignant bone tumor is metastasis, and the commonest primary is **multiple myeloma** (CRAB: calcium, renal, anemia, bone; M spike, punched-out lesions, cold bone scan).

Read arthritis from distribution, films, blood and joint fluid (under 2,000 WBC noninflammatory, 2,000 to 50,000 inflammatory, over 50,000 septic). **Osteoarthritis**: uneven joint space loss with bone production (sclerosis, osteophytes, cysts), DIP (Heberden), PIP (Bouchard), first CMC, hip, knee, spine; stiffness under 30 minutes. **Rheumatoid arthritis**: symmetric MCP, PIP, wrist and

MTP with **DIP spared**, periarticular osteopenia, uniform narrowing, marginal erosions from pannus; RF and the more specific anti-CCP; morning stiffness over an hour.

RA attacks the upper cervical synovial joints: pannus erodes the dens and weakens the transverse ligament, so an **ADI over 3 mm** in an adult (5 mm in a child) or cranial settling contraindicates upper cervical manipulation. Get flexion and extension films in RA, Down syndrome, and ankylosing spondylitis with trauma.

The **seronegative spondyloarthropathies** (PAIR: psoriatic, ankylosing spondylitis, inflammatory bowel, reactive) share HLA-B27, enthesitis, uveitis and inflammatory back pain (onset under 40, over 30 minutes of stiffness, better with exercise, worse at rest, wakes the patient late at night). Ankylosing spondylitis: bilateral symmetric sacroiliitis, shiny corners, squared vertebrae, thin marginal syndesmophytes and a bamboo spine, reduced Schober test and chest expansion. Psoriatic and reactive arthritis give bilateral asymmetric sacroiliitis; **unilateral sacroiliitis is infection until proven otherwise**. A fused AS spine fractures like a long bone.

Gout: needle-shaped, negatively birefringent urate; podagra; rat-bite erosions with overhanging edges and preserved joint space. **CPPD**: rhomboid, weakly positively birefringent; chondrocalcinosis of knee menisci, wrist TFC and pubic symphysis; think hyperparathyroidism and hemochromatosis. **DISH**: flowing ossification over four or more vertebrae on the right thoracic spine with **preserved discs** and normal facets and SI joints, in older men with diabetes. Lupus: ANA screens; anti-dsDNA and anti-Smith are specific; anti-histone marks drug-induced disease. Anti-Scl-70 diffuse scleroderma, anticentromere CREST, anti-Ro and anti-La Sjogren, anti-Jo-1 myositis. **Myasthenia** worsens with use; **Lambert-Eaton** improves with repetition.

Stroke follows arterial territory: MCA face and arm more than leg with aphasia or neglect; ACA leg more than arm with incontinence; PCA homonymous hemianopia with macular sparing; **PICA gives Wallenberg syndrome**. Hemorrhages: epidural (middle meningeal artery, biconvex, lucid interval), subdural (bridging veins, crescent, elderly and anticoagulated), subarachnoid (berry aneurysm, thunderclap headache, xanthochromia), intraparenchymal (hypertensive, lenticulostriate). **Cervical artery dissection** often starts as new unusual neck pain or occipital headache; screen for the 5 D's and 3 N's and refer immediately.

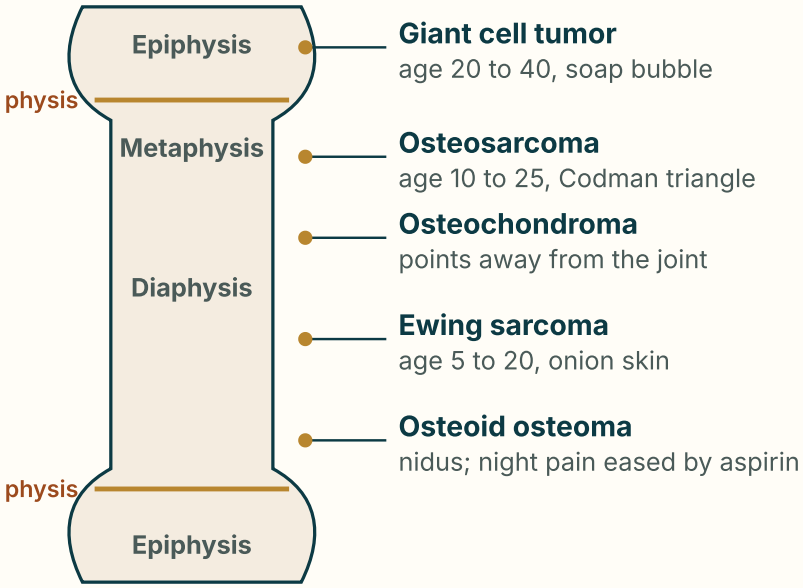
CSF: bacterial meningitis has neutrophils, high protein and **low glucose**; viral has lymphocytes and normal glucose; fungal and tuberculous have lymphocytes and low glucose. **Multiple sclerosis** demyelinates the CNS (periventricular Dawson fingers, optic neuritis, internuclear ophthalmoplegia, Lhermitte and Uhthoff signs, oligoclonal bands). **Guillain Barre** demyelinates peripheral nerves after Campylobacter: ascending flaccid weakness, areflexia and albuminocytologic dissociation. Alzheimer plaques and tangles, Parkinson nigral loss, Huntington CAG and caudate atrophy, ALS mixed UMN and LMN with sensation spared.

Cord syndromes repeat: **subacute combined degeneration** (B12: dorsal columns plus corticospinal), **tabes dorsalis** (dorsal roots and columns, Argyll Robertson pupils), **syringomyelia** (cape-like pain and temperature loss, then hand wasting), **anterior spinal artery** (everything but vibration and position), **Brown-Sequard** and **central cord**. **Cauda equina syndrome** is a lower motor neuron emergency: saddle anesthesia, retention with overflow, bilateral sciatica and reduced reflexes. Same-day surgical referral, never another adjustment.

Atherosclerosis: endothelial injury, oxidized LDL, foam cells, fatty streak, fibrous cap; the danger is plaque rupture, not stenosis alone. The abdominal aorta is worst affected. MI timeline: arrhythmia in the first day, fibrinous pericarditis at 1 to 3 days, rupture risk at 3 to 14 days when the wall is weakest, aneurysm and Dressler syndrome later; **troponin** rises at 3 to 4 hours and stays up 7 to 10 days. **AAA** (over 3 cm, infrarenal) in older male smokers may present as deep boring back pain with a pulsatile mass. Dissection gives tearing pain to the back with unequal arm pulses.

Spirometry: **obstructive** is FEV1/FVC under 0.70 with high TLC and RV (chronic bronchitis, emphysema, asthma, bronchiectasis); **restrictive** keeps the ratio normal or high with low TLC (fibrosis, pneumoconioses, sarcoidosis, kyphoscoliosis, ankylosing spondylitis). Lung cancer: adenocarcinoma peripheral and commonest; squamous central with PTHrP hypercalcemia; small cell central with SIADH, ectopic ACTH and Lambert-Eaton. GI and other systems: Crohn disease is transmural with skip lesions and granulomas, ulcerative colitis continuous and mucosal; nephritic means blood and RBC casts, nephrotic over 3.5 g of protein a day; anemia sorts by **MCV** (microcytic iron and thalassemia, macrocytic B12 and folate, normocytic loss or hemolysis).

Where primary bone tumors live, and what metastasis looks like



In an adult, a destructive spinal lesion is metastasis or myeloma first

Metastasis: destroys a pedicle (winking owl sign), spares the disc; prostate blastic, kidney and thyroid lytic and expansile. Infection destroys the disc early.

Red flags: age over 50, cancer history, weight loss, night pain, no improvement in a month.

Site plus age narrows the list. Epiphysis in an adult suggests giant cell tumor, metaphysis in a teenager osteosarcoma, diaphysis in a child Ewing sarcoma; in an older adult, think metastasis.

LOCK THESE IN

- Osteoporosis labs are all normal; Paget raises ALP alone; hyperparathyroidism raises calcium and lowers phosphate.
- Pyogenic spine infection destroys the disc; tumor and tuberculosis spare it.
- Osteosarcoma metaphysis with Codman triangle; Ewing diaphysis with onion skin; giant cell tumor epiphysis.
- OA builds bone unevenly and spares MCPs; RA erodes symmetric small joints and threatens C1 to C2.
- Bilateral symmetric sacroiliitis: AS. Unilateral: infection until proven otherwise.
- Gout needles negatively birefringent; CPPD rhomboid weakly positive; DISH preserves discs.
- Bacterial CSF: neutrophils, high protein, low glucose. Guillain Barre: high protein, normal cells.
- Cauda equina (retention with overflow, saddle anesthesia) is a same-day surgical referral.

Metabolic bone disease by labs

Condition	Calcium / phosphate	ALP and PTH
Osteoporosis	Normal / normal	Normal / normal
Osteomalacia or rickets	Low or low-normal / low	High / high
Paget disease	Normal / normal	Very high / normal
Primary hyperparathyroidism	High / low	Normal or high / high
Secondary hyperparathyroidism (kidney)	Low or normal / high	High / high
Hypoparathyroidism	Low / high	Normal / low
Multiple myeloma	Often high / normal	Normal (purely lytic) / low

Arthritis patterns

Disease	Joints	Signature
Osteoarthritis	DIP, PIP, 1st CMC, hip, knee, spine	Osteophytes, uneven narrowing, normal density
Rheumatoid arthritis	MCP, PIP, wrist, MTP, C1 to C2; spares DIP	Marginal erosions, uniform narrowing, osteopenia; anti-CCP
Ankylosing spondylitis	SI joints, spine, hips	Bilateral symmetric sacroiliitis, bamboo spine; HLA-B27
Psoriatic arthritis	DIP, asymmetric, dactylitis	Pencil-in-cup, fluffy periostitis
Gout	1st MTP, ankle, knee	Overhanging-edge erosions; needle crystals
CPPD	Knee, wrist, symphysis	Chondrocalcinosis; rhomboid crystals
DISH	Right thoracic spine	Flowing ossification, discs preserved
Septic arthritis	One joint, hot and refusing motion	Over 50,000 WBC; emergency

Worked cases

WORKED CASE 1 · FOUR LABS, ONE DIAGNOSIS

Margaret, 74, has deep pelvic and tibial aching and a hat that no longer fits. Calcium and phosphate are normal, PTH is normal, and alkaline phosphatase is five times the upper limit. GGT is normal.

STEP 1 · RULE OUT THE LIVER

A normal GGT with a high ALP points to bone, not bile ducts.

STEP 2 · USE THE CALCIUM AND PHOSPHATE

Both normal rules out hyperparathyroidism (high calcium, low phosphate) and osteomalacia (low phosphate, high PTH).

STEP 3 · USE THE PTH

Normal PTH rules out primary and secondary hyperparathyroidism.

STEP 4 · NAME IT

Paget disease: the one common bone disease with a very high ALP and otherwise normal chemistry.

STEP 5 · EXPECT THE FILMS

Picture frame or ivory, enlarged vertebrae, cotton wool skull, blade-of-grass lytic front in long bones.

WORKED CASE 2 · BACK PAIN WITH FEVER

Luis, 58, has one week of worsening thoracolumbar pain with fevers and night sweats. He had a urinary infection a month ago. MRI shows loss of the T9 to T10 disc with erosion of both endplates.

STEP 1 · USE THE DISC

Infection destroys the disc early; metastasis and tuberculosis tend to spare it.

STEP 2 · NAME THE PROCESS

Pyogenic discitis and vertebral osteomyelitis, most often Staphylococcus aureus, often from a urinary or skin source.

STEP 3 · RECALL THE TIMING

Plain films lag 10 to 14 days, so MRI is the early test.

STEP 4 · ACT

Fever with back pain is a red flag: same-day medical referral, no manipulation of the infected segment.

WORKED CASE 3 · SORTING AN INFLAMED JOINT

A 54-year-old man wakes with a red, hot, swollen first MTP joint. Aspirate shows 18,000 WBC per microliter and needle-shaped crystals that look yellow when parallel to the compensator axis.

STEP 1 · READ THE CELL COUNT

18,000 is in the inflammatory range (2,000 to 50,000), not the septic range (over 50,000).

STEP 2 · READ THE CRYSTALS

Needle shaped and yellow when parallel means negatively birefringent: monosodium urate.

STEP 3 · NAME IT

Acute gout, podagra.

CONTRAST

Pseudogout crystals are rhomboid and weakly positively birefringent, favor the knee and come with chondrocalcinosis.

STEP 4 · ACT

Do not manipulate the inflamed joint; refer for management of the flare and of urate.

TRAPS PEOPLE FALL INTO

- **Myeloma and bone scan.** Purely lytic lesions can leave the bone scan cold; use a skeletal survey or MRI.
- **Ivory vertebra.** In Paget disease the vertebra is enlarged; in metastasis or lymphoma it is not.
- **RA and the DIP.** RA spares the DIP joints; osteoarthritis and psoriatic arthritis favor them.
- **Serum urate in an attack.** It can be normal during an acute gout flare; crystals make the diagnosis.
- **DISH versus AS.** DISH keeps disc height and normal SI joints; AS fuses the SI joints first.
- **Anemia with neurologic signs.** That is B12 deficiency, never folate.

Chapter 13 self-test · ten board-style items

1. A 70-year-old has bone pain, ALP five times normal, and normal calcium, phosphate and PTH. Which disease fits?

A. Osteoporosis
B. Primary hyperparathyroidism
C. Osteomalacia
D. Paget disease of bone

D. Paget disease of bone Paget disease is the common bone disease that raises ALP dramatically while the rest of the chemistry stays normal.

2. Which film finding most suggests vertebral metastasis rather than infection?

A. Loss of disc height with endplate erosion
B. Paravertebral abscess crossing two levels
C. Destroyed pedicle with a preserved disc
D. Uniform osteopenia of all vertebrae

C. Destroyed pedicle with a preserved disc Metastasis enters the posterior body and pedicle and spares the disc; infection destroys the disc early.

3. A 15-year-old has a destructive metaphyseal lesion at the distal femur with a Codman triangle. Which tumor?

A. Ewing sarcoma
B. Osteosarcoma
C. Osteoid osteoma
D. Giant cell tumor

B. Osteosarcoma Osteosarcoma is metaphyseal around the knee in adolescents, with Codman triangle and sunburst periosteal reaction.

4. A teenager has night pain relieved by aspirin and a small cortical nidus with dense surrounding sclerosis. Which lesion?

A. Osteoid osteoma
B. Brodie abscess
C. Stress fracture
D. Osteoblastoma

A. Osteoid osteoma Prostaglandin-driven pain that responds to NSAIDs and a nidus under about 2 cm are classic for osteoid osteoma.

5. Which pattern fits rheumatoid arthritis rather than osteoarthritis?

A. Nonuniform joint space loss
B. DIP disease with normal density
C. Marginal erosions with osteopenia
D. Osteophytes with subchondral sclerosis

C. Marginal erosions with osteopenia RA is a synovial disease: pannus erodes bare areas, narrowing is uniform and bone density falls around the joint.

6. Which sacroiliac pattern should be treated as infection until proven otherwise?

A. Sacroiliitis on one side only
B. Normal joints with anterior ossification
C. Bilateral symmetric sacroiliitis
D. Bilateral asymmetric sacroiliitis

A. Sacroiliitis on one side only Symmetric disease suggests ankylosing spondylitis, asymmetric suggests psoriatic or reactive arthritis, and one-sided disease suggests septic sacroiliitis.

7. Which CSF profile fits bacterial meningitis?

A. Lymphocytes, normal protein, normal glucose
B. Neutrophils, high protein, low glucose
C. Normal cells, high protein, normal glucose
D. Lymphocytes, high protein, normal glucose

B. Neutrophils, high protein, low glucose Bacteria consume glucose and draw neutrophils. The last option describes Guillain Barre.

8. A patient has lost pain and temperature across both shoulders while light touch is intact. Which lesion?

A. Anterior cord infarct
B. Combined degeneration
C. Brown-Sequard lesion
D. A central cord syrinx

D. A central cord syrinx A central cavity first cuts the crossing spinothalamic fibers in the anterior white commissure, sparing the dorsal columns.

9. Which finding most strongly suggests cauda equina syndrome?

A. Night pain relieved by aspirin
B. Urinary retention with overflow and saddle anesthesia
C. Unilateral calf pain with a positive straight leg raise
D. Hyperreflexia with an upgoing toe

B. Urinary retention with overflow and saddle anesthesia Cauda equina compression gives lower motor neuron signs with saddle anesthesia and retention: a surgical emergency.

10. Spirometry shows FEV1/FVC of 0.85 with TLC at 65 percent of predicted. Which pattern?

A. Restrictive
B. Normal
C. Obstructive
D. Mixed obstructive and restrictive

A. Restrictive Both volumes fall together and the ratio is preserved, as in fibrosis, kyphoscoliosis or advanced ankylosing spondylitis.

CHAPTER 14

Microbiology, Immunology and Public Health

Read it in full: **Chapter 14 in the review book**. Practice it: **the practice exams** (Exam 7 covers this chapter) and **the flashcards**.

What to know

Innate immunity is immediate, pattern based (Toll-like receptors; TLR4 binds LPS) and has no memory: barriers, neutrophils first at a bacterial site, macrophages, NK cells (kill cells lacking MHC I), complement and acute phase proteins. Adaptive immunity is specific, takes days and remembers. **IgM** comes first and marks current infection; **IgG** is most abundant, dominates the secondary response and crosses the placenta; **IgA** guards mucosa and milk; **IgE** drives allergy and helminth defense; IgD sits on naive B cells.

Complement converges on C3. Classical starts with C1q on IgG or IgM complexes, lectin with mannose-binding lectin, alternative spontaneously on microbial surfaces. **C3b** opsonizes, **C3a and C5a** are anaphylatoxins, C5a is chemotactic, and **C5b to C9** make the membrane attack complex. Deficiency of C5 to C9 gives recurrent Neisseria infection; C1 esterase inhibitor deficiency gives hereditary angioedema.

MHC I is on all nucleated cells, holds endogenous peptides and presents to **CD8** cells; **MHC II** is on antigen-presenting cells, holds exogenous peptides and presents to **CD4** cells (rule of 8). Th1 (IFN-γ) activate macrophages and drive type IV reactions; Th2 (IL-4, IL-5) drive IgE and eosinophils; Th17 recruit neutrophils; regulatory T cells keep tolerance. Capsular polysaccharides are T-independent, which is why conjugate vaccines are needed for infants.

Vaccines: **live attenuated** (MMR, varicella, oral polio, BCG) give the strongest immunity but are avoided in pregnancy and immunodeficiency; inactivated are safe but need boosters; subunit (hepatitis B, HPV); **toxoid** (tetanus, diphtheria; boost every 10 years, or 5 for a dirty wound); **conjugate** (Hib, pneumococcal, meningococcal) turns a polysaccharide into a T-dependent antigen; mRNA. Active immunity is slow and lasting; passive (placental IgG, immune globulin) is immediate and brief. Anti-HBs alone means vaccinated.

The **Gram stain**: crystal violet, iodine, alcohol (the critical step), safranin. Gram-positive cells keep the dye in thick peptidoglycan and stain purple; gram-negative cells have thin peptidoglycan under an outer membrane carrying **LPS endotoxin** and stain pink. Poor stainers: Mycobacterium (acid fast), Treponema (dark field), Mycoplasma (no wall, so beta-lactams fail), Chlamydia and Rickettsia (intracellular), Legionella (silver). Capsules are the main antiphagocytic factor, so asplenic and sickle cell patients are vulnerable to encapsulated organisms. Spores (Bacillus, Clostridium) resist most disinfectants.

Genes move by transformation (naked DNA), **conjugation** (pilus and R plasmids, the main route of multidrug resistance), transduction (phage; diphtheria, botulinum, cholera, Shiga-like and erythrogenic toxins are phage encoded) and transposons. **Exotoxins** are potent proteins with specific targets and can be made into toxoids; **endotoxin** is lipid A, heat stable, and triggers IL-1, IL-6 and TNF for fever, hypotension and DIC. Tetanospasmin blocks glycine and GABA (spastic); botulinum blocks acetylcholine release (flaccid); diphtheria toxin blocks EF-2; cholera toxin locks Gs on; Shiga toxin blocks the 60S ribosome and causes hemolytic uremic syndrome.

Pathogens worth knowing by signature: **S. aureus** (clusters, coagulase positive) is the commonest cause of osteomyelitis and septic arthritis; **S. pyogenes** causes pharyngitis with rheumatic fever and poststreptococcal glomerulonephritis; S. pneumoniae causes pneumonia and meningitis; **Neisseria gonorrhoeae** is the commonest septic arthritis in sexually active young adults;

Pseudomonas follows nail puncture wounds; Salmonella osteomyelitis occurs in sickle cell disease; Brucella gives sacroiliitis; **Mycobacterium tuberculosis** gives Pott disease; Borrelia burgdorferi gives Lyme disease (erythema migrans, Bell palsy, heart block, knee arthritis).

Antibiotic targets: beta-lactams and vancomycin on the wall; aminoglycosides and tetracyclines on the 30S; macrolides, clindamycin and linezolid on the 50S; **fluoroquinolones** on DNA gyrase (tendinopathy and Achilles rupture, especially over 60 or with steroids); sulfonamides with trimethoprim on folate. Resistance comes from enzymes (beta-lactamases), altered targets (**PBP2a in MRSA**), reduced entry and efflux pumps. New heel cord pain after ciprofloxacin is not an ordinary tendinopathy: stop loading and notify the prescriber.

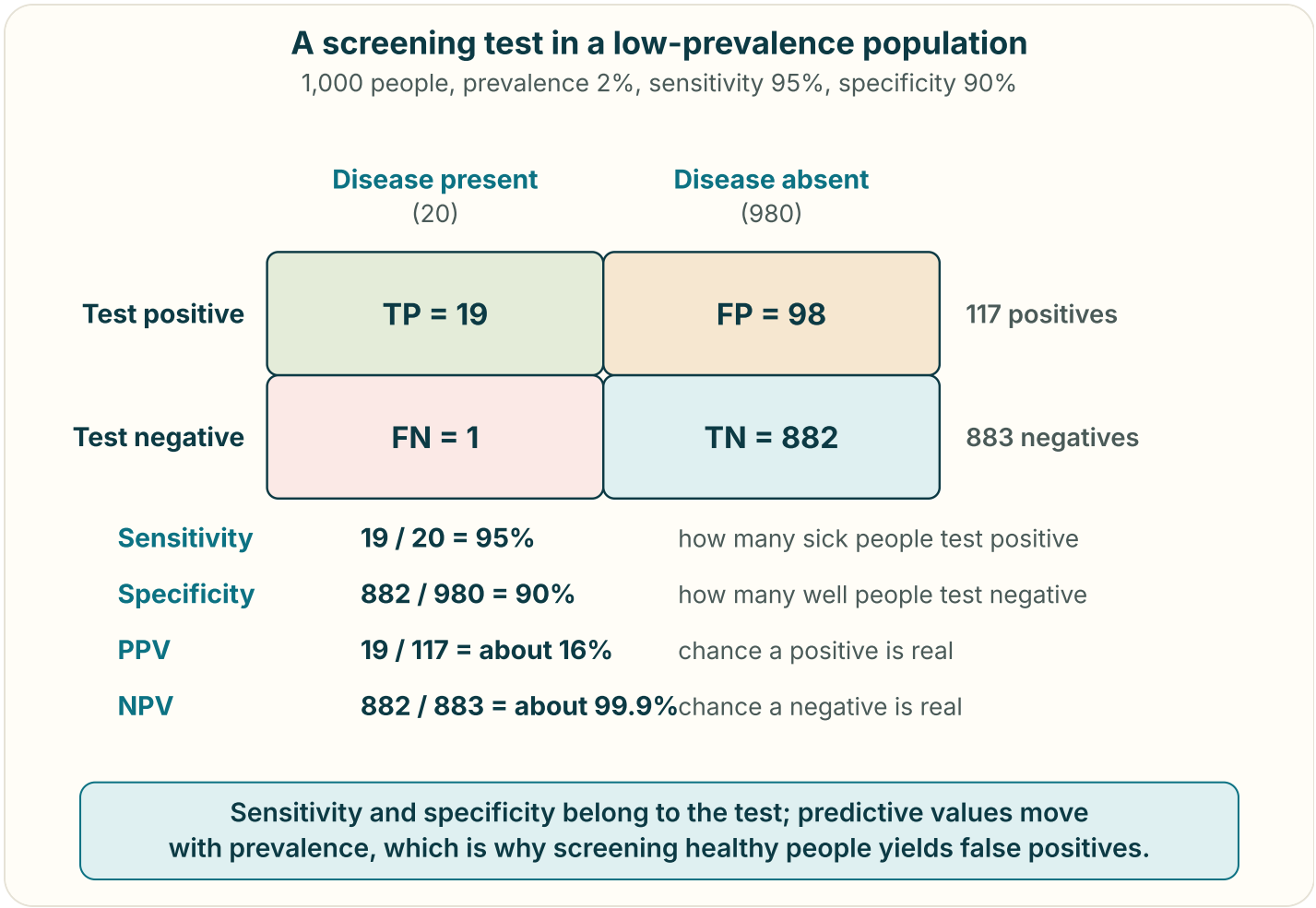
A virus is DNA or RNA in a capsid, sometimes enveloped. Enveloped viruses are fragile and spread by droplets, blood and contact; naked viruses survive on surfaces and spread fecal-orally. Receptors set tropism (HIV gp120 to CD4 and CCR5, EBV to CD21, SARS-CoV-2 to ACE2). Herpesviruses stay latent: HSV-1 in trigeminal ganglia, VZV in dorsal root ganglia (shingles with dermatomal pain that can precede the rash by days and mimic radiculopathy), EBV in B cells, CMV in monocytes. Influenza drifts and shifts.

Hepatitis serology: **HBsAg** means current infection; **anti-HBs alone** means vaccination; anti-HBs with IgG anti-HBc means recovery; **IgM anti-HBc** is the only marker in the window period; HBsAg beyond six months is chronic. Needlestick risk, rule of 3s: HBV 30%, HCV 3%, HIV 0.3%. **HIV** destroys CD4 cells; AIDS is a CD4 count under 200 or an AIDS-defining illness; opportunistic infections track the count (Pneumocystis under 200, toxoplasmosis and cryptococcus under 100, MAC and CMV under 50). Post-exposure prophylaxis starts within hours and no later than 72 hours. **Prions** are protein only and survive routine autoclaving, alcohol and UV.

Fungi have ergosterol membranes (the antifungal target). Dimorphic fungi are mold in the cold, yeast in the heat: **Histoplasma** (river valleys, bat caves), **Blastomyces** (Great Lakes, broad-based buds, lytic bone lesions), **Coccidioides** (desert Southwest, spherules, erythema nodosum). Aspergillus has septate hyphae branching at 45 degrees; Mucor is nonseptate at 90 degrees in ketoacidosis. Dermatophytes spread by contact and fomites, so face cradles and vinyl need a fungicidal wipe. Parasites by exposure: Giardia from streams, Toxoplasma from cats, Taenia and

Trichinella from pork, Diphyllobothrium from raw fish (B12 deficiency), Ixodes ticks for Lyme disease and Dermacentor for Rocky Mountain spotted fever.

Incidence counts new cases (risk); **prevalence** counts existing cases (burden); prevalence is about incidence times duration. Case-control studies give an **odds ratio** and suit rare diseases; cohort studies give **relative risk**; randomized trials give ARR and number needed to treat (1/ARR). An interval that includes 1 is not significant. **Sensitivity** rules out when negative (SnNout, screening); **specificity** rules in when positive (SpPin, confirming); predictive values swing with **prevalence**, while sensitivity and specificity do not. Infection control: sterilize critical items, high-level disinfect semicritical items, low- or intermediate-level disinfect noncritical items such as tables and face cradles; alcohol rub does not kill C. difficile spores.



Most positives can still be false. With a good test and low prevalence, only about one positive in six is real, while a negative is almost certainly true.

LOCK THESE IN

- IgM first and current; IgG most abundant and crosses the placenta; IgA mucosal; IgE allergy.
- MHC I to CD8, MHC II to CD4 (rule of 8); C5 to C9 deficiency means Neisseria infection.
- Live vaccines are avoided in pregnancy and immunodeficiency; conjugates let infants respond.
- Only gram-negative bacteria carry LPS endotoxin; Mycoplasma has no wall.
- Tetanus toxin is spastic, botulinum flaccid; cholera toxin locks Gs on.
- Anti-HBs alone = vaccinated; IgM anti-HBc is the window period marker.
- Prevalence is about incidence times duration; predictive values change with prevalence.
- Sterilize what enters tissue, high-level disinfect mucosal items, wipe tables and cradles between patients.

Toxins to know

Toxin (organism)	Mechanism	Result
Tetanospasmin (C. tetani)	Blocks glycine and GABA release	Spastic paralysis, lockjaw
Botulinum (C. botulinum)	Cleaves SNAREs, no ACh release	Descending flaccid paralysis
Diphtheria toxin	ADP-ribosylates EF-2	Pseudomembrane, myocarditis
Cholera toxin	Locks Gs on, cAMP up	Rice-water diarrhea
Pertussis toxin	Blocks Gi, cAMP up	Whooping cough, lymphocytosis
Shiga and Shiga-like	Blocks the 60S ribosome	Bloody diarrhea, HUS
TSST-1 (S. aureus)	Superantigen	Fever, rash, shock
Endotoxin (lipid A)	TLR4, IL-1, IL-6, TNF	Fever, hypotension, DIC

Epidemiology toolbox

Term	Formula or rule	Use
Incidence	New cases / population at risk per time	Risk
Prevalence	Existing cases / population	Burden; about incidence × duration
Relative risk	[a/(a+b)] / [c/(c+d)]	Cohort studies
Odds ratio	ad / bc	Case-control studies
ARR and NNT	Control rate - treated rate; NNT = 1/ARR	Trials
Sensitivity	TP / (TP + FN)	Negative rules out (SnNout)
Specificity	TN / (TN + FP)	Positive rules in (SpPin)
PPV and NPV	TP/(TP+FP); TN/(TN+FN)	Change with prevalence

Worked cases

WORKED CASE 1 · WORKING A SCREENING TEST

A test with 95% sensitivity and 90% specificity is used in 1,000 people where the disease prevalence is 2%.

STEP 1 · FILL THE MARGINS

2% of 1,000 is 20 with the disease and 980 without.

STEP 2 · FIND TP AND FN

Sensitivity 95% of 20 = 19 true positives and 1 false negative.

STEP 3 · FIND TN AND FP

Specificity 90% of 980 = 882 true negatives and 98 false positives.

STEP 4 · COMPUTE PPV

19 / (19 + 98) = 19/117 = about 16%. Most positives are false.

STEP 5 · COMPUTE NPV

882 / (882 + 1) = about 99.9%. A negative is very reassuring.

THE LESSON

Sensitivity and specificity did not change; low prevalence alone made the PPV poor.

WORKED CASE 2 · READING HEPATITIS B SEROLOGY

A new staff member has HBsAg negative, anti-HBs positive and total anti-HBc negative.

STEP 1 · CHECK HBSAG

Negative, so there is no current infection.

STEP 2 · CHECK ANTI-HBC

Negative, so there has never been natural infection (core antibody only comes from infection).

STEP 3 · CHECK ANTI-HBS

Positive, which means protective antibody.

STEP 4 · CONCLUDE

Immune by vaccination. Anti-HBs with IgG anti-HBc would mean recovery from past infection.

WORKED CASE 3 · CHOOSING HOW TO PROCESS EQUIPMENT

After a visit you must process three things: an acupuncture needle, a reflex hammer used on intact skin and a face cradle.

STEP 1 · APPLY THE SPAULDING CLASSES

Critical items enter sterile tissue, semicritical touch mucous membranes or nonintact skin, noncritical touch intact skin only.

STEP 2 · THE NEEDLE

Critical: sterile single-use, discarded in a sharps container at the point of use, never recapped by hand.

STEP 3 · THE HAMMER AND CRADLE

Noncritical: low- or intermediate-level disinfection with an EPA-registered product, observing the label contact time, plus fresh face paper.

REMEMBER THE EXCEPTION

Alcohol rub does not kill C. difficile spores or work well against norovirus: use soap and water, and bleach on surfaces.

TRAPS PEOPLE FALL INTO

- **Endotoxin.** Only gram-negative bacteria have it; gram-positive shock comes from superantigens and lipoteichoic acid.
- **Anti-HBc.** Core antibody never comes from vaccination, so it separates immunity from past infection.
- **Prevalence and test properties.** Prevalence changes PPV and NPV, never sensitivity or specificity.

- **Odds ratio versus relative risk.** Case-control studies cannot give a relative risk because incidence is unknown.
- **Live vaccines.** Avoid in pregnancy and immunodeficiency; inactivated and subunit vaccines are safe there.
- **Prions.** They survive routine autoclaving, alcohol and UV; special protocols or disposal are needed.

Chapter 14 self-test · ten board-style items

1. A rising titer of which class points to an infection happening now?

A. IgE
B. IgA
C. IgM
D. IgG

C. IgM IgM appears first in a primary response. IgG dominates later and crosses the placenta.

2. A patient with recurrent Neisseria infections most likely lacks which complement components?

A. C1 esterase inhibitor
B. C3 alone
C. Mannose-binding lectin
D. C5 through C9

D. C5 through C9 The membrane attack complex is needed against thin-walled Neisseria. C1 esterase inhibitor deficiency gives angioedema.

3. MHC class II molecules present peptides to which cells?

A. CD8 cytotoxic T cells
B. CD4 helper T cells
C. Plasma cells
D. Natural killer cells

B. CD4 helper T cells Rule of 8: MHC II with CD4, MHC I with CD8.

4. Which vaccine type turns a polysaccharide into a T-dependent antigen so infants respond?

A. Conjugate
B. Inactivated whole cell
C. Toxoid
D. Live attenuated

A. Conjugate Linking the polysaccharide to a protein carrier recruits T cell help and creates memory.

5. Which feature belongs only to gram-negative bacteria?

A. Heat-resistant endospores
B. A thick peptidoglycan layer
C. Teichoic acid in the wall
D. Lipopolysaccharide endotoxin

D. Lipopolysaccharide endotoxin LPS sits in the outer membrane, which gram-positive cells lack.

6. Which toxin causes spastic paralysis by blocking inhibitory transmitter release?

A. Diphtheria toxin
B. Tetanospasmin
C. Cholera toxin
D. Botulinum toxin

B. Tetanospasmin Tetanus toxin cleaves SNAREs in spinal inhibitory interneurons, removing inhibition of motor neurons.

7. A heel cord becomes painful days after a course of levofloxacin. What is the concern?

A. Calcific tendinitis of the heel
B. Gout in the tendon
C. Drug-related tendinopathy
D. Overuse tendinopathy

C. Drug-related tendinopathy Fluoroquinolones are linked to tendinopathy and Achilles rupture, especially over 60 or with steroids. Stop loading and notify the prescriber.

8. Laboratory results show HBsAg negative, anti-HBs positive and anti-HBc negative. What does this mean?

A. Immunity from vaccination
B. Chronic infection
C. Immunity after natural infection
D. Acute infection in the window period

A. Immunity from vaccination Core antibody appears only after natural infection, so its absence with anti-HBs means vaccination.

9. A treatment keeps people alive without curing them. What happens to incidence and prevalence?

A. Incidence rises, prevalence falls
B. Both of them fall together
C. Both of them rise together
D. Prevalence rises, incidence steady

D. Prevalence rises, incidence steady Prevalence is about incidence times duration, so prolonging disease raises the burden without changing new cases.

10. Which item needs sterilization or sterile single use under the Spaulding classes?

A. A dry needling needle
B. A blood pressure cuff
C. An adjusting table
D. A reflex hammer

A. A dry needling needle Items entering sterile tissue or the bloodstream are critical. The others touch intact skin and need only low- or intermediate-level disinfection.

ONE PAGE

Cram sheet

Both chapters on one page. Cover the right columns and rebuild each row from memory. If a row will not come back, go back to that chapter.

Systemic pathology

Topic	Rule	Board hook
Bone labs	Osteoporosis normal; Paget ALP only	Hyperparathyroid: Ca up, PO4 down
Spine infection	Disc destroyed early	TB spares the disc, gibbus
Bone tumors	Metaphysis teen, diaphysis child, epiphysis adult	Codman, onion skin, soap bubble
Myeloma	CRAB, punched out, cold scan	M spike, Bence Jones
OA versus RA	Bone production versus erosion	RA: C1 to C2 instability
Spondyloarthropathy	HLA-B27, enthesitis, uveitis	Bamboo spine; unilateral SI = infection
Crystals	Urate needles negative; CPPD rhomboid positive	DISH preserves discs
Stroke	MCA arm, ACA leg, PCA vision, PICA Wallenberg	Dissection: 5 D's and 3 N's
CSF	Bacterial low glucose; GBS high protein, normal cells	MS: oligoclonal bands
Cord	B12, tabes, syrinx, anterior, hemisection, central	Cauda equina: retention, refer
Heart and lung	Troponin 3 to 4 h; FEV1/FVC sorts patterns	AAA and dissection mimic back pain
Anemia	Sort by MCV	Neuro signs mean B12

Microbiology and public health

Topic	Rule	Board hook
Antibodies	IgM first, IgG placenta, IgA mucosa, IgE allergy	Secondary response is IgG
Complement	C3b opsonin, C5a chemotaxis, MAC lysis	C5 to C9: Neisseria
MHC	I to CD8, II to CD4	Rule of 8
Vaccines	Live strongest, conjugate for infants	Toxoid boosters every 10 years
Gram stain	Purple thick wall; pink outer membrane with LPS	Mycoplasma: no wall
Toxins	Tetanus spastic, botulinum flaccid	Endotoxin: fever, shock, DIC
Pathogens	S. aureus osteomyelitis; gonococcus septic arthritis	Salmonella in sickle cell
Antibiotics	Wall, 30S, 50S, gyrase, folate	Fluoroquinolone tendon rupture
Viruses	Latency in ganglia; HBsAg, anti-HBs, anti-HBc	Shingles mimics radiculopathy
Fungi and parasites	Mold in the cold, yeast in the heat	Match place and food to organism
Epidemiology	Prevalence = incidence × duration	SnNout, SpPin; PPV follows prevalence
Infection control	Critical, semicritical, noncritical	Alcohol misses C. difficile spores

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