

The Physician Pharmacist: Musculoskeletal

Rotator Cuff Muscles:

1. **Supraspinatus** (Suprascapular n.):

- Abducts arms initially (before action of deltoid)
- Most common rotator cuff injury = trauma, degeneration, impingement → Tendinopathy/Tear
- Ddx = “Empty/full can” test

2. **Infraspinatus** (Suprascapular n.):

- Externally rotates arm
- Pitching injury

3. **Teres Minor** (Axillary n.)

- Abducts + externally rotates arm

4. **Subscapularis** (Upper/Lower Subscapular nerves)

- Internally rotates + ADDucts the arm

-Innervated by C5-C6

-**SItS** (little t for “minor”)

Arm Abduction:

-0-15° = Supraspinatus (suprascapular n.)

-15-90° = Deltoid (axillary n.)

>90° = Trapezius (accessory n.)

>90° = Serratus Anterior (Long Thoracic n.) = SALT

Upper Extremity Nerves:

Axillary n (C5-C6):

-Damaged = fractured **surgical neck of humerus** + anterior dislocation of humerus

-sxs

- flattened deltoid
- loss of arm abduction at shoulder >15°
- loss of sensation over deltoid + lateral arm

Musculocutaneous n. (C5-C7):

-damaged = Upper Trunk Compression

-sxs:

- Biceps (C5-C6) reflex
- Loss of forearm flexion + supination
- Loss of sensation over radial + dorsal forearm

Radial n. (C5-T1):

-damaged =

- Compression of axilla (due to **crutches** or sleeping w/ arm over chair - “**Saturday night palsy**”)
- **Midshaft fracture of humerus**
- Repetitive pronation/supination of forearm (screwdriver use - “Finger Drop”)

-Sxs:

- Injures above elbow = loss of sensation over posterior arm/forearm and dorsal hand, wrist drop (loss of elbow, wrist, finger extension) w/ grip strength (wrist extension necessary for maximal action of flexors)
- Injuries below the elbow = distal paresthesias **w/o wrist drop**

-Tricep function + posterior arm sensation spared in midshaft fracture

Median n. (C5-T1):

-damaged:

- **Supracondylar fracture of humerus** → proximal lesion of the nerve
 - **Carpal Tunnel Syndrome** + wrist laceration → distal lesion of nerve
- sxs:
- “**Ape Hand**” and “**Hand of Benediction**”
 - Loss of Wrist Flexion + function of the lateral two Lumbricals, Opponens pollicis, Abductor Pollicis Brevis, Flexor Pollicis Brevis (**1/2 LOAF**)
 - Loss of sensation over thenar eminence + dorsal and palmar aspects of lateral 3 ½ fingers w/ proximal lesion

Ulnar n. (C8-T1):

-damaged:

- Fracture of **medial epicondyle** of humerus (“Funny Bone” - proximal lesions)
- Fractured Hook of Hamate (distal Lesion) from fall on Outstretched hand

-sxs:

- “Ulnar Claw” on digit extension
- Radial deviation of wrist w/ flexion (proximal lesion)
- flexion of ulnar fingers, abduction and ADDuction of fingers (Interossei), thumb adduction, actions of ulnar 2 lumbrical muscles
- Loss sens 1 ½ fingers + Hypothenar eminence

Recurrent Branch of Median n (C5-T1):

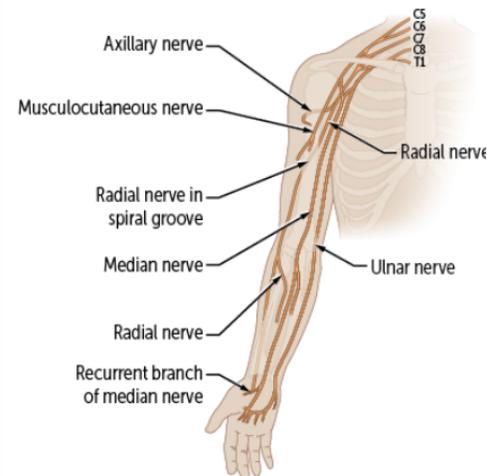
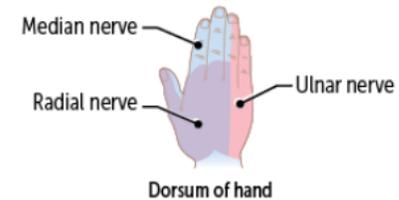
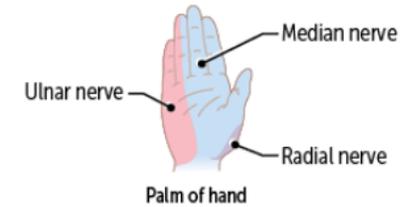
-damaged = Superficial Laceration of Palm

-sxs:

- “**Ape Hand**”
- Loss of Thenar Muscle Group (Opposition, abduction, flexion of thumb)
- No loss of sensation***

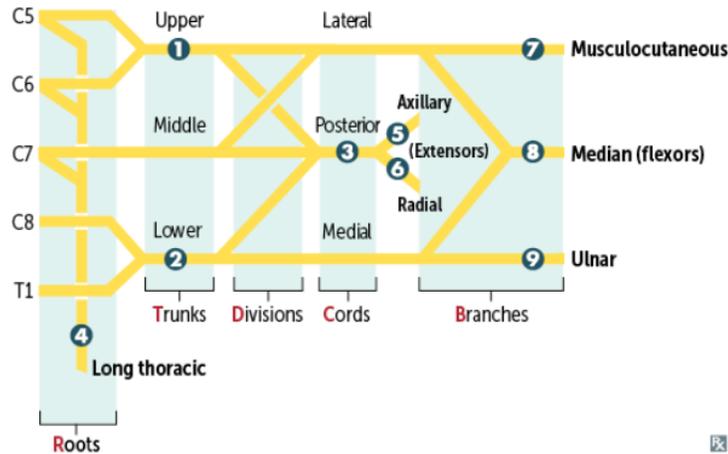
Humerus Fractures (proximally to distally) follow the ARM;

- **Axillary** → **Radial** → **Median**



Brachial plexus lesions

- 1 Erb palsy ("waiter's tip")
- 2 Klumpke palsy (claw hand)
- 3 Wrist drop
- 4 Winged scapula
- 5 Deltoid paralysis
- 6 "Saturday night palsy" (wrist drop)
- 7 Difficulty flexing elbow, variable sensory loss
- 8 Decreased thumb function, "Pope's blessing"
- 9 Intrinsic muscles of hand, claw hand



Randy
Travis
Drinks
Cold
Beer

1. Erb Palsy ("Waiter's Tip"):

-Traction/tear of Upper Trunk (C5-C6 roots)

-Causes:

- Infants = lateral traction on neck during delivery
- Adults = trauma

-Muscles Affected:

- Deltoid/Supraspinatus = Abduction loss (arm hangs by side)
- Infraspinatus, Supraspinatus = lateral rotation lost (arm is medially rotated)
- Biceps Brachii = flexion, supination lost (arm extended and pronated)

"hERB gets DIBs on TIPS"

2. Klumpke Palsy:

-Traction/tear of Lower Trunk (C8-T1)

-Causes:

- Infants = upward force on arm during delivery
- Adults = trauma (grabbing a tree branch to break a fall)

-Muscles Affected:

- Intrinsic hand muscles (Lumbricals, Interossei, Thenar + Hypothenar Eminence) = "Claw Hand" (lumbricals normally flex MCP joints, and extend DIP and PIP joints)

Thoracic Outlet Syndrome:

-Compression of Lower Trunk and subclavian vessels = commonly within the Scalene Triangle

-Causes = Cervical Rib Compressing or Pancoast Tumor

-Muscles = Same as Klumpke (Intrinsic Hand m. = LITH)

-sxs = atrophy of intrinsic hand muscles; Ischemia, pain, edema due to vascular compression

4. Winged Scapula: "SALT"

-Lesion of Long Thoracic n. (C5-C7)

-Causes = Axillary node dissection after mastectomy, Stab wounds

-Muscle = Serratus Anterior

-Sxs = Inability to anchor scapula to thoracic cage → cannot abduct arm above horizontal position (>90°)

Wrist Region:

-Bones: "from lower thumb side"

- Scaphoid, Lunate, Triquetrum, Pisiform
- Hamate, Capitate, Trapezoid, Trapezium

-Scaphoid (Palpable Anatomical Snuff box) = most commonly fractured carpal bone

- Typically due to a fall on an outstretched hand
- Complications of proximal scaphoid fractures = Avascular necrosis + nonunion due to retrograde blood supply from a branch of the radial a.
- Occult fracture not always seen on x-ray

-Lunate = dislocation can impinge Median nerve (causing Carpal Tunnel Syndrome)

-Guyon Canal = Ulnar nerve and artery (within the Flexor Retinaculum (Transverse Carpal Ligament))

-Carpal Tunnel = Median n. + Flexor pollicis longus tendon, Flexor digitorum profundus tendons, flexor digitorum superficialis tendons

Hand Muscles:

-Thenar (Median):

- Opponens Pollicis
- Abductor Pollicis Brevis
- Flexor Pollicis Brevis
- Superficial Head (Deep Head by Ulnar n.)

-Hypothenar (Ulnar):

- Opponens Digiti Minimi
- Abductor Digiti Minimi
- Flexor Digiti Minimi Brevis

-Dorsal Interossei (Ulnar) = Abduct Fingers

-Palmar Interossei (Ulnar) = ADDuct fingers

"DAB = Dorsals ABduct, PAD = Palmers ADDuct)

-Lumbricals (1st, 2nd = Median)(3rd, 4th = Ulnar) = flex at the MCP joint, extend PIP and DIP joints

Distortions of Hand:

-at rest, balance exists btw extrinsic flexors and extensors of hand, as well as intrinsic muscles of the hand - particularly the lumbrical muscles (Flexion of MCP, Extension of DIP/PIP)

-"Clawing" = seen best w/ distal lesions of median or ulnar nerves

-Remaining extrinsic flexors of the digits exaggerate the loss of the lumbricals → fingers extend at MCP, flex at DIP and PIP

-Deficits less pronounced in Proximal Lesions; deficits only seen w/ voluntary flexion of the digits

1. "Ulnar Claw"

-extending fingers/at rest (trying to open hand but ulnar fingers can't)

-lesion at Distal ulnar nerve



2. "Hand of Benediction":

-trying to make a fist (but Median n. Fingers can't (thumb, index, middle)

-lesion at Proximal Median n.



3. "Median Claw"

- extending fingers/at rest
- Lesion at DISTAL median n.



4. "OK Gesture"

- making a fist
- lesion at Proximal Ulnar n.



NOTE: Atrophy of the thenar eminence can be seen in Median n. Lesions, while atrophy of the Hypothenar eminence is seen w/ Ulnar n. Lesions

Actions of Hip Muscles:

1. Abductors:

- Gluteus Medius
- Gluteus Minimus

2. ADDuctors:

- Adductor Magnus
- Adductor Longus
- Adductor Brevis

3. Extensors:

- Gluteus Maximus
- Semitendinosus
- Semimembranosus

4. Flexors:

- Iliopsoas
- Rectus Femoris
- Tensor Fascia Lata
- Pectineus
- Sartorius

5. Internal Rotation:

- Gluteus Medius
- Gluteus Minimus
- Tensor Fascia Lata

6. External Rotation:

- Iliopsoas
- Gluteus Maximus
- Piriformis
- Obturator

Lower Extremity Nerves:

1. Iliohypogastric (T12-L1):

- Sensory = suprapubic region
- Motor = transversus abdominis + internal oblique
- injury = Abdominal surgery
- sxs = burning/tingling pain at surgical incision site radiating to inguinal + suprapubic region

2. Genitofemoral n. (L1-L2):

- Sensory = scrotum, labia majora, medial thigh
- motor = cremaster
- injury = laparoscopic surgery
- sxs = upper medial thigh + anterior thigh sensation beneath the inguinal ligament (lateral part of the femoral triangle)
- Responsible for **Cremasteric Reflex** (absent if injured)

3. Lateral Femoral Cutaneous (L2-L3):

- Sensory = anterior + lateral thigh
- injury = Tight clothing, obesity, pregnancy, pelvic procedures
- sxs = thigh sensation (anterior + lateral)

4. Obturator n. (L2-L4):

- Sensory = medial thigh
- Motor = Obturator externus, adductor longus, adductor brevis, gracilis, pectineus, adductor magnus
- Injury = pelvic surgery
- sxs = **Thigh sensation (medially) + inability to ADDuct the hip**

5. Femoral n. (L2-L4):

- Sensory = anterior thigh, medial leg
- Motor = Quadriceps, Iliacus, Pectineus, Sartorius
- Injury = Pelvic Fracture**
- sxs = **Leg Extension (Patellar Reflex)**

6. Sciatic (L4-S3):

- Motor = semitendinosus, semimembranosus, biceps femoris, Adductor magnus
- Injury = Herniated Disc, Posterior hip Dislocation
- sxs = Splits into Common Peroneal and Tibial Nerves

6a. Common (Fibular) Peroneal (L4-S2):

- Superficial Peroneal n.:
 - Sensory = dorsum of foot (except webspace btw hallux and 2nd digit)
 - Motor = peroneus longus + brevis

-Deep Peroneal n.

- Sensory = webspace btw hallux and 2nd digit
- Motor = tibialis anterior

-Injury = Trauma or compression of lateral aspect of leg, fibular neck fracture

-sxs:

- **PED** = Peroneal Everts and Dorsiflexes; if injured, foot dropPED
- Loss of sensation on Dorsum of foot
- **Foot Drop** = inverted and plantar flexed at rest, loss of eversion and dorsiflexion; "Steppage gait"

6b. Tibial n. (L4-S3):

-Sensory = sole of foot
-motor = biceps femoris (long head), Triceps surae, plantaris, popliteus, flexor muscles of foot
-Injury = Knee trauma, Baker Cyst (Proximal lesion); Tarsal Tunnel Syndrome (distal lesion)

-Sxs:

- **TIP** = Tibial Inverts and plantarflexes; injury **can't stand on toes**
- Inability to curl toes and loss of sensation on sole
- Proximal lesions = foot everted at rest w/ weakened inversion + plantar flexion

7. Superior Gluteal (L4-S1):

-Motor = gluteus medius, gluteus minimus, tensor fascia lata

-Injury = iatrogenic injury during IM injection to superomedial gluteal region (prevent by choosing superolateral quadrant, preferably anterolateral region)

-sxs:

- **Trendelenburg Sign/Gait** = Pelvis tilts b/c weight-bearing leg cannot maintain alignment of pelvis through hip abduction
 - Standing leg muscles abduct (pull) hips to balance and keep pelvis horizontal
- Lesion is contralateral to side of the hip that drops (**opposite side of the drop**), ipsilateral to extremity on which the pt stands

8. Inferior Gluteal (L5-S2):

-Motor = **gluteus maximus**

-injury = Posterior hip dislocation

-sxs = **difficulty climbing stairs, rising from seat (Loss of Hip extension)**

9. Pudendal n.(S2-S4):

-Sensory = perineum

-Motor = external urethral + anal sphincters

-injury = stretch injury during childbirth, **Prolonged cycling, horseback riding**

-sxs:

- sensation in perineum + genital area (**Fecal/Urinary incontinence**)
- Blocked w/ Local Anesthetic during childbirth using ischial spine as landmark for injection

Knee Exam:

-Lateral Femoral Condyle to Anterior Tibia (ACL)

-Medial Femoral Condyle to Posterior Tibia (PCL)

1. Anterior Drawer Sign:

-Bending knee at 90° angle, anterior gliding of tibia (relative to femur)

-used for ACL injury

-**Lachman Test** = also tests ACL but is more sensitive (anterior gliding of tibia, w/ knee bent at 30°)

2. Posterior Drawer Sign:

-Bending knee at 90 degree angle, posterior gliding of tibia due to PCL injury

3. Abnormal Passive Abduction:

-**"Valgus Stress Test"**

-Knee either extended or at 30 degrees

-Lateral (Valgus) force → medial space widening of tibia → indicates **MCL** injury

4. Abnormal Passive ADDuction:

-**"Varus Stress Test"**

-knee either extended or at 30 degrees

-Medial (Varus) force applied → lateral space widening of tibia → indicates **LCL Injury**

5. McMurray Test:

-Bend knee, rotate foot/tibia lateral/medially (**LIME**):

- Pain; "Popping" on internal rotation and Varus force = **Lateral Meniscal Tear** (Internal rotation stresses lateral meniscus)
- Pain; "Popping" on external rotation and valgus force → **Medial meniscal tear** (External rotation stresses Medial meniscus)

-**"External Force "meets" direction of the rotation"**

Ankle Sprains:

-**Anterior Talofibular Ligament** = Most common ("Always Tears First"), considered a low ankle sprain

- Over Inversion/Supination of Foot

-Anterior Inferior Tibiofibular Ligament (AITF) = most common high ankle sprain

- Connects Fibula and Tibia on the anterior surface

Signs of Lumbosacral Radiculopathy:

-paresthesia + weakness related to specific lumbosacral spinal nerves

-Intervertebral disc (Nucleus pulposus) herniates posterolaterally through Annulus Fibrosus (Outer ring) into central canal due to **thin posterior longitudinal ligament** + thicker anterior longitudinal ligament along midline of vertebral bodies

-Nerve affected is usually below the level of herniation

ex.) Disc Herniation level at L3-L4 = Nerve root affected is L4

- Weakness of knee extension
- patellar reflex

ex.) Disc herniation level L4-L5 = L5 affected

- Weakness of dorsiflexion
- Difficulty walking on Heels

ex.) L5-S1 herniation = S1 affected

- Weakness of plantar flexion
- Difficulty in toe walking
- achilles reflex

Neurovascular Pairing:

-nerves and arteries are frequently names together by the bones/regions they are associated w/

-Exceptions:

- Axilla/Lateral Thorax = Long thoracic n. + Lateral Thoracic a.
- Surgical Neck of Humerus = Axillary n. + Posterior Circumflex a.
- Midshaft of Humerus = Radial n. + Deep Brachial a.
- Distal Humerus/Cubital Fossa = Median n. + Brachial a
- Popliteal Fossa = Tibial n. + Popliteal a. (prone to injury)
- Posterior to Medial Malleolus = Tibial n. + Posterior Tibial a.

Motoneuron AP to Muscle Contraction:

-T-tubules are extensions of plasma membrane in contact w/ Sarcoplasmic Reticulum = allowing for coordinated contraction of striated muscles

1. AP opens Presynaptic VG-Ca²⁺ channels → inducing ACh Release
2. Postsynaptic ACh binding leads to muscle cell depolarization at the Motor end plate
3. Depolarization travels over entire muscle cell and deep into the muscle via T-tubules
4. Membrane depolarization induces conformational changes in **voltage-sensitive Dihydropyridine Receptors (DHPR)** + its mechanically **coupled Ryanodine Receptor (RR)** → **Ca²⁺ release form the SR** into the cytoplasm
5. Tropomyosin normally blocks myosin-binding sites on Actin Filament.
 - a. Released **Ca²⁺ binds to Troponin C (TnC) shifting the Tropomyosin to exposure Myosin-binding sites**
6. Myosin head binds Strongly to Actin, forming crossbridge
 - a. Pi is released triggering Power-Stroke
7. During Power stroke; force is produced as Myosin pulls on the thin filament
 - a. Muscle Shortening occurs = H + I bands, and btw Z lines ("**HIZ Shrinkage**")
 - b. A-band remains the same ("A-band Always the sAme")
 - c. ADP is released at end of Powerstroke
8. **Binding of New ATP molecule causes detachment of Myosin head from Actin filament**
 - a. Ca²⁺ is sequestered
9. **ATP Hydrolysis into ADP and Pi results in Myosin head returning to High-energy position (Cocked)**
 - a. Myosin head can bind to a new site on actin to form a crossbridge if Ca²⁺ remains available
10. Reuptake of Calcium by SR Ca²⁺ ATPase (**SERCA**) → Muscle Relaxation

Types of Skeletal Muscle Fibers:

Type I:

- Slow
- Red
- Oxidative phosphorylation → sustained contraction
- Mitochondria/Myoglobin
- Endurance Training
- "1 Slow Red Ox"

Type II:

- Fast, White, Anaerobic Glycolysis
- Mitochondria, Myoglobin
- Weight/Resistance training, sprinting
- "2 Fast, White Antelopes"

Skeletal Muscle Adaptations:

Atrophy:

- Myofibrils = removal via ubiquitin-proteasome system)
- Myonuclei = selective apoptosis

Hypertrophy:

- Myofibrils = addition of Sarcomeres in PARALLEL
- Myonuclei = fusion of stellate cells

Vascular Smooth Muscle Contraction/Relaxation:

1. Endothelial Cells Receptor is bound by Agonist (ACh, Bradykinin, etc.)
2. Ca²⁺ → Stimulation of Nitric Oxide Synthase (NOS)
 - a. Converts L-arginine to NO
3. NO diffuses from Endothelial Cell to Smooth Muscle Cell → stimulating conversion of GTP to cGMP
4. cGMP binds to **Myosin-Light-Chain Phosphatase (MLCP)** → Relaxation

Contraction:

1. AP travels and depolarizes Smooth muscle cell → L-type VG Ca²⁺ channels to allow Ca²⁺ to flow intracellularly
2. Ca²⁺ intracellular → Ca²⁺-Calmodulin Complex formation
3. Ca²⁺/Calmodulin bind Myosin-Light-Chain-Kinase (MLCK)
4. MLCK → Contraction

Muscle Proprioceptors:

-Specialized sensory receptors that relay info about muscle dynamics

Muscle Stretch Receptors:

1. Length + speed of stretch
2. Signals send to Dorsal Root Ganglion (DRG)
3. Activation of Inhibitory Interneuron and a-Motor Neuron
4. Simultaneous inhibition of antagonist muscle (prevents overstretching) + activation of Agonist Muscle (Contraction)

-Body of muscle/Type Ia and II sensory axons

-activated by Muscle Stretch (**Deep Tendon Reflexes**)

Golgi Tendon Organ:

1. Tension → signals via DRG → activation of Inhibitory Interneuron → Inhibition of Agonist muscle (reduced tension within muscle + tendon)

-Tendons/Type Ib Sensory Axons

-activated by muscle tension

Bone Formation:

Endochondral Ossification:

-bones of Axial skeleton, Appendicular Skeleton, Skull base
-cartilaginous model of bone is first made by chondrocytes
-Osteoclasts and Blasts later replace w/ woven bone + then remodel to lamellar bone
-Adults = woven bone occurs after fractures and in Paget Dx (defective in Achondroplasia)

Membranous Ossification:

-bones of Calvarium, Facial Bones, Clavicle
-Woven bone formed directly WITHOUT cartilage
-Later remodeled to Lamellar bone

Cell Biology of Bone:

1. Osteoblast:

-Builds bone = secretes collagen + catalyzes mineralization in Alkaline environment via ALP (Alk Phos)

-**Mesenchymal Stem Cell** Origin in Periosteum
-Osteoblastic activity measured by bone ALP, Osteocalcin, Propeptides of Type I Procollagen

2. Osteoclast:

-Dissolves bone by secreting H⁺ and Collagenases
-Originates from **Fusion of Monocyte/Macrophage** lineage precursors

-RANK receptors (Osteoclast) are stimulated by RANKL (from Osteoblasts)

-**OPG (Osteoprotegerin = RANKL decoy receptor)** binds RANKL to prevent RANK-RANKL interaction → **Osteoclast Activity**

3. PTH:

-low levels = anabolic effects (building bone) on Osteoblasts and Osteoclasts (indirect)
-chronically PTH (Primary HyperPTH) → catabolic effects (Osteitis Fibrosa Cystica)
-**Normal PTH levels cause bone building, PTH causes resorption**

4. Estrogen:

-**Inhibits apoptosis in bone-forming Osteoblasts + induces apoptosis in bone-resorbing Osteoclasts**
-Causes closure of Epiphyseal plate during puberty
-Estrogen def (surgical/postmenopausal) = cycles of remodeling and bone resorption → risk of Osteoporosis

Overuse Injuries of Elbow:

1. Medial Epicondylitis (Golfer's Elbow):

-Repetitive flexion or idiopathic → pain near medial epicondyle

2. Lateral Epicondylitis (Tennis Elbow):

-Repetitive Extension (Backhand Shots) or Idiopathic → pain near lateral epicondyle

Clavicle Fractures:

- common in children + birth trauma
- usually caused by a fall on outstretched hand or direct trauma to shoulder
- weakest point = Junction of middle + lateral thirds (fractures of middle third segment are most common)
- sxs = "Shoulder drop", shortened clavicle (lateral fragment is depressed due to arm weight and medially rotated by arm adductors (pectoralis Major))

Wrist and Hand Injuries:

Guyon Canal Syndrome:

- Compression of **Ulnar** n. At wrist
- classically seen in Cyclists due to pressure from Handlebars

Carpal Tunnel Syndrome:

- Entrapment of **Median** n. In carpal tunnel (btw transverse carpal ligament + carpal bones) → nerve compression → Paresthesias, pain, numbness
- sxs = median n. Numbness, Thenar eminence atrophy but sensation spared (b/c palmar cutaneous branch enters hand external to carpal tunnel)
- (+) **Tinel Sign** (Percussion of Wrist causes Tingling) + **Phalen Maneuver** (90 degree flexion of wrist causes tingling)
- Associated w/ Pregnancy (due to edema), RA, Hypothyroidism, DM, Acromegaly, Dialysis-related amyloidosis, repetitive use

Metacarpal Neck Fracture:

- "Boxer's Fracture"
- commonly caused by direct blow w/ closed fist (5th Metacarpal most commonly broken)

Common Knee Conditions:

Unhappy Triad:

- Laterally directed force (Valgus) to a planted foot
- Consists of Damage to ACL, MCL, and Medial Meniscus (attached to MCL), however Lateral meniscus is actually more common
- sxs = acute pain, signs of joint instability

Prepatellar Bursitis:

- inflam of the prepatellar bursa in front of the Knee cap
- can be caused by repeated trauma or pressure from excessive kneeling ("Housemaid's Knee")

Popliteal Cyst: "Baker Cyst"

- Popliteal Fluid collection in gastrocnemius-semimembranosus bursa commonly communicating w/ synovial space
- related to chronic joint dx (OA, RA)

Common Musculoskeletal Conditions:

De Quervain Tenosynovitis:

- Extensor Retinaculum (area tendons pass under) + Thumb involved
- Noninflammatory thickening of Abductor Pollicis Longus + Extensor Pollicis Brevis Tendons → Pain or Tenderness at radial styloid
- (+) **Finkelstein Test** (Pain at radial styloid w/ Active or Passive Stretch of Thumb Tendons)
 - risk of new parent (lifting baby), Golfers, Racquet Sport Players, "Thumb Texters"

Ganglion Cysts:

- Fluid-filled swelling overlying joint or tendon sheath
- most commonly dorsal side of wrist
- arises from herniation of dense connective tissue
- Spontaneously resolves

Iliotibial Band Syndrome (IT Band):

- overuse injury of lateral knee ("Runners")
- pain = secondary to friction of Iliotibial band against lateral femoral epicondyle

Limb Compartment Syndrome:

- pressure within fascial compartment of a limb → venous outflow obstruction + arteriolar collapse → anorexia/necrosis
- causes = significant long bone fractures, reperfusion injury, animal venoms
- sxs = severe pain, tense/swollen compartment w/ passive stretch of muscles in the area
 - CK, Motor Deficits are late signs of irreversible nerve damage
- 5 P's = Pain, Palor, Paresthesia, Pulselessness, Paralysis

Medial Tibial Stress Syndrome:

- "Shin Splints" = diffuse tenderness in runners and military
- caused by bone resorption that outpaces bone formation in tibial Cortex

Plantar Fasciitis: Inflam of Plantar aponeurosis = Hell pain (worse w/ 1st steps in morning or periods of inactivity), heel Tenderness

Temporomandibular Disorders:

- Disorders of the TMJ + muscles of Mastication
- Multifactorial etiology; associated w/ TMJ trauma, poor head/neck posture, abnormal trigeminal nerve pain processing
- sxs = Dull, Constant unilateral facial PAIN that worsens w/ Jaw movement, otalgia, HA, TMJ Dysfunction (Limited Range of Motion)

Childhood MSK Conditions:

Radial Head Subluxation:

- "Nursemaids Elbow"
- Children < 5 yo
- Sudden pull on arm → immature annular ligament slips over head of radius
- Arm is held in Slightly Flexed + Pronated Position

Osgood-Schlatter Dx:

- "Traction Apophysitis"
- Pain and swelling at Patellar tendon insertion point at the Tibial Tuberosity**
- overuse injury = repetitive strain + chronic avulsion of secondary ossification center of proximal tibial tubercle
- Adolescents after growth spurt
- common in runners/jumping athletes
- Progressive anterior knee pain

Patellofemoral Syndrome:

- Overuse injury, pain in front of knee around the kneecap
- young, female athletes = Anterior Knee Pain
- occurs from prolonged sitting or weight-bearing on a flexed knee

Developmental Dysplasia of Hip:

- Abnormal acetabular development in newborns
- RF= Breech Position delivery
- "Hip instability and Dislocation"
- Commonly tested w/ **Ortolani and Barlow Maneuvers** (manipulation of newborn hip reveals a "Cluck")
- Confirmed via US (No X-ray until 4-6 months b/c cartilage has not ossified yet)

Legg-Calve-Perthes Disease:

- Idiopathic avascular necrosis of femoral head
- 5-7 yo w/ insidious onset of hip pain (causing child to limp)
- Males > females (4:1)
- initial x-ray is often normal

Slipped Capital Femoral Epiphysis:

- Obese Young Adolescent w/ Hip/knee pain + altered gait
- axial force on femoral head → epiphysis displaces relative to femoral neck (like a scoop of ice cream slipping off a cone)
- ddx = X-ray

Common Pediatric Fractures:

1. Greenstick Fracture:

- incomplete fracture extending partway through the bone following bending stress
- Bone fails on tension side but compression side intact (side not being acted on)
- "essentially a partial break" that doesn't cross midline

2. Torus (Buckle) Fracture:

- Axial force applied to immature bone → cortex buckles on compression (concave) side and fractures
- Tension side (side closer to the force) remains solid (Intact)



Greenstick fracture

Torus fracture

Achondroplasia:

- failure of longitudinal bone growth (Endochondral Ossification) → short limbs
- Membranous Ossification is NOT affected = large head relative to limbs
- Constitutive Activation of Fibroblast Growth Factor Receptor (**FGFR3**) inhibits chondrocyte proliferation
- > 85% of mutations occur sporadically
- Pull Penetrance** (homozygosity is lethal)
- rates w/ Paternal Age
- Most common cause of short-limbed Dwarfism

Osteoporosis:

- Trabecular** (Spongy) + **cortical** bone lose mass** despite normal bone mineralization and Lab values (Serum Ca²⁺ and Phos normal)
- cause = **Bone Resorption related Estrogen w/ old age**
- Secondary to:
 - Drugs (Steroids, Alcohol, Anticonvulsants, Anticoagulants, Thyroid Replacement Tx)
 - Hyperparathyroidism
 - Hyperthyroidism
 - Multiple Myeloma (MM)
 - Malabsorption syndromes
 - Anorexia
- DDx w/ Bone Mineral Density Measurements by DEXA Scans at Lumbar Spine, Total Hip, Femoral Neck w/ T-score of ≤ -2.5 or fragility fracture at hip/vertebrae (fall from standing height, minimal trauma)
- One time screening in Females ≥ 65 yo
- Complications = **Vertebral compression fractures** (acute back pain, loss of height, kyphosis), Femoral Neck Fractures, Distal radius (Colles Fracture)
- PPx = Regular weight-bearing exercise + adequate Ca²⁺/Vit D intake throughout adulthood
- Tx = Bisphosphonates, Teriparatide, SERMs, Calcitonin, Denosumab (RANKL inhib)

Osteopetrosis:

- Failure of normal bone resorption due to **defective Osteoclasts** → thickened, dense bones, prone to fractures
- Mutations (Carbonic Anhydrase II) impair ability of osteoclast to generate acidic environment necessary for bone resorption**
- Overgrowth of **Cortical bone fills marrow space** → pancytopenia, Extramedullary Hematopoiesis
 - Bone growth crowds out marrow
- sxs = Cranial Nerve impingement + palsies due to narrowed foramina
- X-rays = diffuse symmetric sclerosis (bone-in-bone, "Stone Bone")
- Tx = Bone Marrow Transplant can be curative b/c Osteoclasts are derived from monocytes

Osteomalacia/Rickets:

- Defective mineralization of osteoid** (Osteomalacia) or **Cartilaginous Growth plates** (Rickets = children)
- Due to **Vitamin D Deficiency****
- X-rays = Osteopenia + Pseudofractures in Osteomalacia, Epiphyseal Widening and Metaphyseal Cupping/Fraying in Rickets
- Rickets = characteristic Bow Legs (Genu Varum), Bead-like Costochondral Junctions (Rachitic Rosary), Craniotabes (Soft Skull)
- Vit D → Serum Ca²⁺ → PTH secretion → Phos
 - Vit D
 - Hypocalcemia
 - Hyperparathyroidism
 - hypophosphatemia
- Hyperactivity of Osteoblasts → ALP (Alk Phos)

Osteitis Deformans/"Paget's Dx of Bone":

- "Paget Dx of Bone"
- Localized **Bone Remodeling Disorder** → **osteoclastic** activity followed by **osteoblastic** activity (forming poor quality bone)
- Serum Ca²⁺, Phos, PTH levels are NORMAL**
- **ALP**
- Mosaic Pattern of Woven + Lamellar bone (Osteocytes within lacunae in chaotic juxtapositions)
- Long bone Chalk-Stick Fractures
- Blood flow from Arteriovenous shunts cause **High-Output Heart Failure**
- **risk of Osteosarcoma**
- sxs:
 - **Hat size is due to skull thickening**
 - **Hearing loss (skull deformity)**
- Stages of Paget Bone Dx:
 1. Lytic = Osteoclasts
 2. Mixed = Osteoclasts + Osteoblasts
 3. Sclerotic = Osteoblasts
 4. Quiescent = minimal osteoclast/blast activity
- Tx = Bisphosphonates

Avascular Necrosis of Bone:

- Infarction of bone/marrow = VERY PAINFUL
- Femoral Head = Most common site (Watershed Zone) due to insufficiency of medial Circumflex femoral a.)
- Causes = Steroids, Chronic Alcohol, Sickle Cell, Trauma, SLE, the "Bends" (Caisson/Decompression Dx), Legg-Calve-Perthes Dx (Idiopathic), Gaucher Disease (Lysosomal Storage Dx - Oh My Gauch, that's a Big Bro), Slipped Capital Femoral Epiphysis

	Ca2+	Phos	ALP	PTH	Notes
Osteoporosis	-	-	-	-	- Bone Mass
OsteoPetrosis	-/	-	-	-	-Dense, Brittle Bones, Ca2+ only in severe dx
Paget Dx of Bone	-	-		-	-Abnormal "Mosaic" bone architecture
Osteitis Fibrosa Cystica (Primary HyperPTH)					-"Brown Tumors" due to Fibrous replacement of Bone, Subperiosteal Thinning -Idiopathic or Parathyroid Hyperplasia, Adenoma, Carcinoma
Secondary HyperPTH					-Often as Compensation for CKD (Phos excretion + production of Calcitriol - 1a-Hydroxylase)
Osteomalacia/Rickets					-Soft bones; Vitamin D deficiency (also causing secondary hyperPTH)
Hypervitaminosis D			-		-Oversupplementation or Granulomatous Dx (Sarcoidosis)

Primary Bone Tumors:

-metastatic dx is more common than primary bone tumors

Benign Tumors:

-Benign tumors that start w/ "O" are more common in boys

1. Osteochondroma:

-MOST common benign bone tumor
-males < 25 yo
-Location = **Metaphysis of Long Bone**
-Lateral bony **projection** of Growth plate (Continuous w/ marrow space), covered in cartilaginous cap
-Rarely transforms to Chondrosarcoma

2. Osteoma:

-Middle Age Males
-Location = **Surface of Facial Bones**
-Associated w/ Gardner Syndrome (subtype of FAP - Polyp disorder)

3. Osteoid Osteoma:

-Adults < 25 yo, Males > Females
-Location = **Cortex of Long Bones**
-Presents w/ **Bone Pain (Worse at Night)** = relieved w/ NSAIDs
-Bony Mass (< 2 cm) w/ Radiolucent Osteoid Core **-hole**

4. Osteoblastoma:

-Male > F
-Location = **Vertebrae**
-Similar histology to Osteoid Osteoma
-Larger Size (> 2 cm), Pain unresponsive to NSAIDs**

5. Chondroma:

-location = Medulla of Small bones of Hand/feet
-Benign tumor of cartilage

6. Giant Cell Tumor:

-20-40 yo
-location = **Epiphysis** of Long Bones (Knee Region)
-Locally aggressive benign tumor
-"**SOAP bubbles**" appearance on X-ray
-Neoplastic Mononuclear cells w/ RANKL + Multinucleated giant (osteoclast-like Cells = Osteoclastoma"

Malignant Tumors:

1. Osteosarcoma (Osteogenic Sarcoma):

-20% of primary bone cancers
-Males < 20 yo
-Less common in elderly (often secondary due to other factors = Paget Dx of Bone, Bone Infarcts, Radiation, Familial Retinoblastoma, Li-Fraumeni Syndrome (TP53))
-Location = **Metaphysis of Long bones (Knee Region)**
-Pleomorphic Osteoid-Producing Cells (Malignant Osteoblasts)
-sxs = Painful enlarging mass or Pathological fractures
-X-Ray = **Codman Triangle** (elevation of Periosteum) or **Sunburst Pattern** (looks like solar flare)
-Aggressive Cancer but Primary is usually responsive to Surg/Chemo
-Secondary Osteosarcoma has Poor prognosis

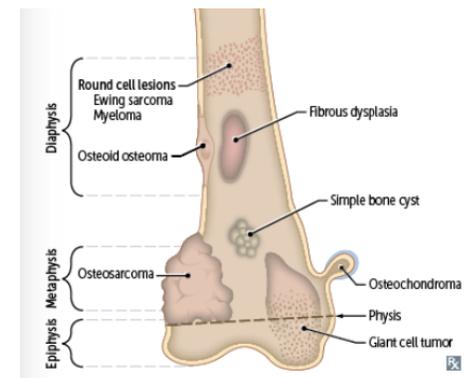
2. Chondrosarcoma:

-Loc = Medulla of Pelvis, Proximal Femur/Humerus
-Tumor of Malignant Chondrocytes
-Rarely occurs from progression of Osteochondroma

3. Ewing Sarcoma:

-MOST common in White pts
-Generally Males < 15 yo
-loc = **Diaphysis of Long Bones** (esp Femur), Pelvic Flat bones
-**Anaplastic small blue cells** of Neuroectodermal origin (Resemble Lymphocytes)
-Differentiate from conditions w/ similar morphology (Lymphoma, Chronic Osteomyelitis)
-**t(11:22) Fusion of EWS-FLI1**
-"Onion Skin" periosteal rxn in bone
-Aggressive w/ early metastases, but responsive to chemo

-"**11 + 22 = 33**" →
Patrick Ewings Jersey"



Osteoarthritis (OA):

-mechanical wear + tear **destroys articular cartilage** (degenerative joint disorder) → inflammation w/ inadequate repair

-Chondrocytes mediate degradation and inadequate repair

-RF = Age, Female, Obese, Joint Trauma

-sxs:

- Pain in weight-bearing joints after use (end of day)
- Pain improves w/ rest
- Asymptomatic joint involvement
- Knee cartilage loss begins medially (“Bowlegged”)
- No systemic sxs**

-Joint Findings:

- Osteophytes (Bone Spurs)
- Joint space narrowing
- Subchondral sclerosis + Cysts
- Synovial fluid is noninflammatory (WBC <2,000)
- Heberden Nodes (DIP) and Bouchard Nodes (PIP), and 1st MCP; not MCP

-Tx = Activity modification, APAP, NSAIDs, Intra-articular Steroids

	OA	RA
Bone	-osteophytes -sclerotic bone -subchondral bone cysts	-Bone Erosion
Joint Capsule of Synovial Lining	-thickened capsule -slight synovial hypertrophy	-Pannus formation -hypervascularity
Synovial Cavity	-	- Synovial Fluid
Cartilage	-Joint space narrowing -Ulcerated Cartilage	-

Rheumatoid Arthritis (RA):

-**Autoimmune = inflammation induces formation of pannus (proliferative granulation tissue) which erodes articular cartilage + bone**

-RF = Female, **HLA-DR4** (“4 walled Rheum”), Smoking, (+) Rheumatoid Factor (IgM Antibody that targets IgG Fc Region - 80%), Anti-cyclic Citrullinated Peptide Antibody

-sxs:

- Pain, swelling, Morning Stiffness lasting > 1 hr but improves w/ use
- Symmetric
- Systemic sxs (Fever, fatigue, weight loss)
- Extra Articular manifestations common
 - Rheumatoid nodules (fibrinoid necrosis w/ palisading histiocytes) in SQ tissue and Lung (+ Pneumoconiosis → Caplan Syndrome)
 - Interstitial Lung Dx
 - Pleuritis
 - Pericarditis
 - Anemia of Chronic Dx
 - Neutropenia + Splenomegaly (Felty Syndrome)
 - AA Amyloidosis
 - Sjogren Syndrome
 - Scleritis
 - Carpal Tunnel Syndrome

-Joint Findings:

- Erosions
- Juxta-articular osteopenia
- Soft tissue swelling
- Subchondral cysts
- Joint space narrowing
- Deformities = Cervical Subluxation, Ulnar finger deviation, swan neck, boutonniere
- Involves MCP, PIP, Wrist; **NOT DIP or 1st MCP**

-Tx = NSAIDs, Glucocorticoids, Disease Modifying (MTX, Sulfasalazine), Biologic Agents (TNF-a Inhibitors)

Gout:

-Acute inflammation monoarthritis = caused by precipitation of **monosodium urate** crystals in joints
-RF = Male, HTN, Obesity, DM, Dyslipidemia, Alcohol use, Hyperuricemia

-Hyperuricemia:

- Underexcretion of uric acid (90%) = Idiopathic, Renal failure, Thiazides
- Overproduction of Uric Acid (10%) = Lesch-Nyhan Syndrome, PRPP Excess, Cell Turnover, Tumor Lysis Syndrome, Von Gierke Dx (GSD - def of Glc-6-Phos)

-Crystals are needle shaped and (-) Birefringence under polarized light (**Yellow under parallel light, Blue under Perpendicular light**)

-Serum uric acid levels may be normal during acute attack

-sxs:

- Asymmetrical joint pain
- Swollen, red, painful
- Often MTP joint of Big Toe (Podagra)
- Tophus Formation (External Ear, olecranon bursa, Achilles Tendon)

-Acute attacks follow Large Meals rich in Purines (red meat, seafood), Trauma, Surgery, Dehydration, DLuresis, **Alcohol Consumption** (Alcohol Metabolites compete for same excretion sites in kidney as uric acid → uric acid secretion and buildup)

-Acute Tx = NSAIDs (Indomethacin), Glucocorticoids, Colchicine

-Chronic Tx = Xanthine Oxidase Inhib (Allopurinol, Febuxostat)

Calcium Pyrophosphate Deposition Dx:

-”Pseudogout”

-deposition of calcium pyrophosphate crystals within joint space

-pts > 50 yo, M = F, idiopathic

-associated w/ Hemochromatosis,

Hyperparathyroidism, Joint trauma

-Pain/swelling w/ acute inflammation (pseudogout) and/or chronic degeneration (pseudo-osteoarthritis)

-Knee = most common joint

-**Chondrocalcinosis** (Cartilage Calcification) w/ X-ray

-Crystals are Rhomboid and weakly (+) birefringent under polarized light (**blue when parallel to light**)

-Acute Tx = NSAIDs, Colchicine, GCs

-Ppx = Colchicine

-”**Blue P’s = Blue when Parallel, Positive**

birefringence, calcium Pyrophos, Psuedogout”

Septic Arthritis:

- staph aureus, strep, neisseria gonorrhoeae
- affected joint is swollen, red, painful
- Synovial fluid purulent (WBC > 50,000)
- Disseminated Gonococcal Infxn** = STI that presents as either purulent arthritis (knee) or Triad of Polyarthralgia, Tenosynovitis (hand), dermatitis (Pustules)

Seronegative Spondyloarthritis:

- arthritis w/o Rheumatoid factor (no anti-IgG antibody)
- HLA-B27 (MHC Serotype Class I)**
- 4 Subtypes = share variable occurrence of **inflammatory back pain** (associated w/ morning stiffness, improves w/ exercise), **Peripheral Arthritis, Entesitis** (Inflamed insertion sites of tendons - Achilles), **Dactylitis** ("Sausage Fingers"), **Uveitis**

1. Psoriatic Arthritis:

- associated w/ skin psoriasis + nail lesions
- Asymmetric + patchy involvement
- Dactylitis + "Pencil-in-cup" deformity of DIP on X-ray
- seen in < 1/3rd of pts w/ Psoriasis

2. Ankylosing Spondylitis:

- Symmetric** involvement of spine and sacroiliac joints → **ankylosis (joint fusion)**, Uveitis, Aortic Regurgitation
- "Bamboo Spine (Vertebral Fusion)" = costovertebral + costosternal ankylosis may cause restrictive lung dx
- monitor degree of reduced chest wall expansion to assess dx severity
- M > F

3. Inflammatory Bowel Dx:

- crohn dx + UC often associated w/ spondyloarthritis

4. Reactive Arthritis:

- Triad:
 - **Conjunctivitis**
 - **Urethritis**
 - **Arthritis**

- "Can't See, Can't Pee, Can't Bend the Knee"
- Shigella, Campylobacter, E. coli, Salmonella, Chlamydia, Yersinia

SLE:

- Systemic, remitting, relapsing autoimmune dx
- Organ damage due to **Type III HSR** and lesser degree **Type II HSR**
- deficiency of Early complement proteins (C1, C4, C2) → clearance of immune complexes
- Presentation:
 - Rash
 - Joint Pain
 - Young Female (AA, Caribbean, Asia, Hispanic > White)
 - Fever

- Libman-Sacks Endocarditis (LSE)** = Nonbacterial, verrucous thrombi on Mitral or Aortic Valve (present on either surface of valve - usually under surface)
- Mortality = Infxns, Cardiovascular (accelerated CAD), Kidney Dx (most common - Lupus Nephritis)
- Anti-SSA (+) Pregnant Pt = risk of newborn **Neonatal Lupus** → congenital heart block (bradycardia), Periorbital/diffuse rash, transaminitis, Cytopenias at birth
- Keys:

- Rash (Malar or Discoid)
- Arthritis (Nonerosive)
- Serositis (Pleuritis, Pericarditis)
- Hematologic Disorders (Cytopenias)
- Oral/Nasopharyngeal Ulcers (Usually painless)
- Renal Dx
- Photosensitivity
- Antinuclear Abs ((+) ANA)
- Immunologic disorder (anti-dsDNA, anti-Sm, Antiphospholipid)
- Neurologic Disorders (Seizures, Psychosis)

Mixed Connective Tissue Disease (MCTD):

- features of SLE, systemic sclerosis, and/or polymyositis
- associated w/ Anti-U1 RNP antibodies (Speckled ANA)

Antiphospholipid Syndrome (APS):

- primary or secondary disorder (most commonly in SLE)
- DDx based on clinical criteria including hx of thrombosis (arterial or venous) or spontaneous abortion along w/ Lab findings of Lupus Anticoagulant, Anticardiolipin, Ant9-B2 Glycoprotein I antibodies
- Tx = Systemic Anticoagulation
- Anticardiolipin abs can cause false (+) VDRL/RPR for Syphilis
- Lupus anticoagulant can cause prolonged PTT that is not corrected by the addition of normal platelet-free plasma

Polymyalgia Rheumatica:

- Pain and stiffness in proximal muscles (shoulders, hips)
- often w/ fever, malaise, weight loss
- Does NOT cause muscular weakness**
- females >50 yo ; associated w/ Giant Cell (Temporal Arteritis)
- **ESR, CRP, normal CK**
- Tx = rapid response to low-dose corticosteroids

Fibromyalgia:

- most common in Females (20-50 yo)
- Chronic, widespread MSK pain** associated w/ "Tender Points," Stiffness, paresthesias, poor sleep, fatigue, cognitive disturbance (**Fibro-Fog**)
- Tx = regular exercise, Antidepressants (TCAs, SNRIs), Neuropathic pain agent = gabapentin

Polymyositis:

- Nonspecific = (+) ANA, CK,
- Specific = (+) anti-Jo-1 (Histidyl-tRNA Synthetase), (+) Anti-SRP (Signal recognition particle), (+) Anti-Mi-2 (Helicase)
- progressive symmetric proximal muscle weakness w/ Endomysial inflammation from CD8+ T Cells (usually hitting shoulders)

Dermatomyositis:

- Nonspecific = (+) ANA, CK,
- Specific = (+) anti-Jo-1 (Histidyl-tRNA Synthetase), (+) Anti-SRP (Signal recognition particle), (+) Anti-Mi-2 (Helicase)
- Similar to Polymyositis BUT also involves:
 - **Gottron Papules**
 - **Photodistributed Facial Erythema (Heliotrope - violaceous - edema of the Eyelids)**
 - "Shawl and Face" Rash
 - Darkening + thickening of Fingertips and sides resulting in irregular "Dirty" appearing marks
- risk of Occult Malignancy
- Perimysial Inflammation + atrophy w/ CD4+ T-Cells

Myositis Ossificans:

- heterotopic ossification of Skeletal muscle (Quads) from blunt muscle trauma
- Painful soft tissue mass w/ Eggshell calcifications
- Metaplastic bone w/ fibroblastic proliferation (benign)

Small-Vessel Vasculitis:

Behcet Syndrome:

- incidence in Turkish + eastern Mediterranean Descent
- Recurrent Aphthous Ulcers, Genital Ulcerations, Uveitis, Erythema Nodosum
- Precipitated by HSV or Parvovirus B19
- Flares last 1-4 weeks
- "Immune Complex Vasculitis"
- Associated w/ **HLA-B51**

Cutaneous Small-Vessel Vasculitis:

- occurs 7-10 days after certain meds (PCN, Cephalosporins, Phenytoin, Allopurinol) or Infxns (HVC, HIV)
- Palpable Purpura, No Visceral Involvement
- IC-Mediated Leukocytoclastic Vasculitis = late involvement indicates systemic vasculitis

Mixed Cryoglobulinemia:

- often due to viral infxn (especially HCV)
- Triad of Palpable Purpura, weakness, arthralgias
- "Cryoglobulins" = immunoglobulins that precipitate in the Cold
- Vasculitis due to mixed IgG and IgM immune complex deposition

Myasthenia Gravis:

- most common NMJ disorder
- Autoantibodies to POSTsynaptic ACh Receptors
- sxs = **Fatigable** muscle weakness:
 - Ptosis
 - Diplopia
 - proximal weakness
 - Respiratory muscle involvement → SOB
 - Bulbar muscle involvement → Dysphagia, difficulty chewing
- Reflexes Spared (no reflex issues)
- Associated w/ **Thymoma, Thymic Hyperplasia**
- AChE Inhibitors = reverses sxs (Pyridostigmine for Tx)

Lambert-Eaton Myasthenic Syndrome:

- uncommon
- autoantibodies against Presynaptic Ca²⁺ channels → ACh release
- Proximal muscle weakness, autonomic sxs (Dry mouth, COnstipation, Impotence), **Hyporeflexia**
- Sxs improve w/ Muscle Use**
- Associated w/ **Small Cell Lung Cancer**
- AChE Inhibitor (Pyridostigmine) = Minimal Effect

Raynaud Phenomenon:

- blood flow to skin due to arteriolar (small vessel) vasospasm in response to cold, stress
- Color changes from white (Ischemia) to blue (hypoxia) to red (reperfusion)
- commonly in fingers + toes
- Primary dx = Idiopathic
- Secondary Dx = Connective Tissue Dx, SLE, CREST Syndrome (Limited Scleroderma)
- Tx = CCBs

References:

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