



**SCS Continuing Education
presents:**

Basic Structure and Function of the Wrist and Hand

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Introduction:

Hello and welcome to this program from **SCS Continuing Education**! Knowledge is the key to success for ourselves and our patients. This easy-to-use point and click program allows you to navigate through text and visual aides designed to provide a comprehensive view of the material covered. Please feel free to contact **Shane Smith** at ceuarmy@yahoo.com if you have any questions.

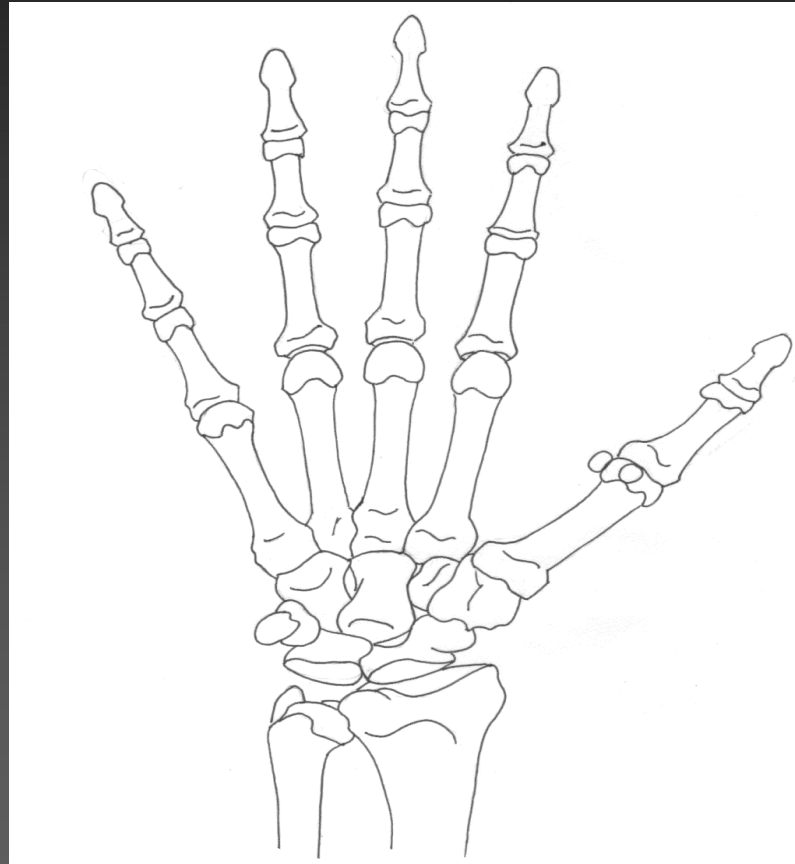
Course Abstract and Objectives:

The objective of this home study course is to provide the learner with a computer based tutorial that will give them the means to learn the basic anatomy and function of the wrist and hand. A mastery test will be administered at the end of this home study course in order to ensure that competency of the material has been achieved.

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Basic Structure and Function of the Wrist and Hand



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Bony Anatomy

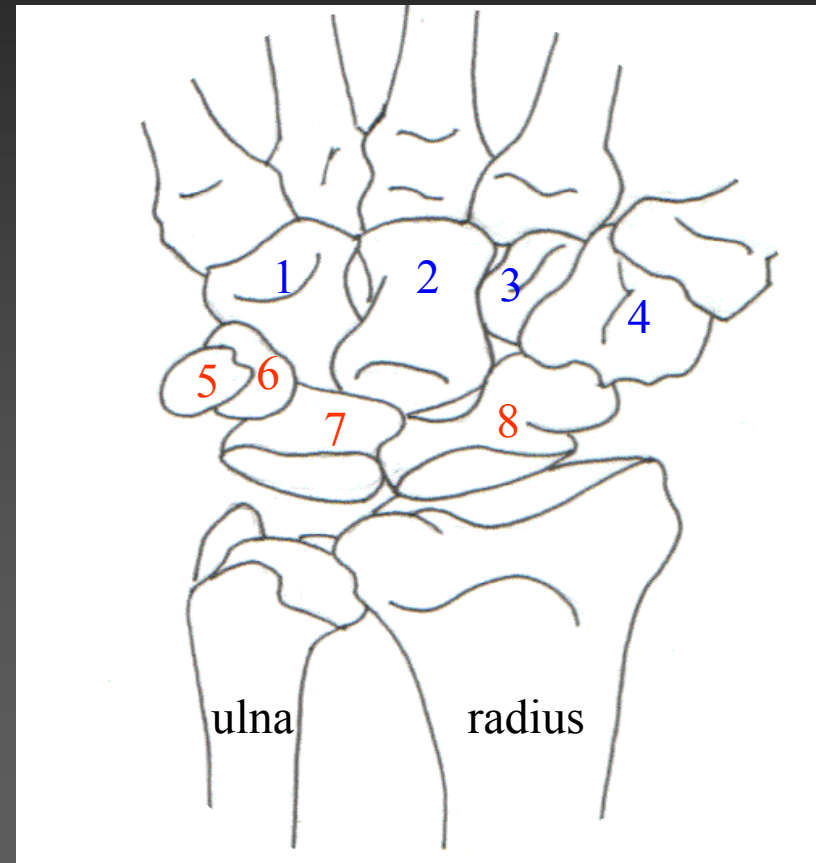
Let's begin by reviewing the bones of the right wrist in **anatomical** position:

Distal Row:

1. Hamate (unciform)
2. Capitate (os magnum)
3. Trapezoid (lesser multangular)
4. Trapezium (greater multangular)

Proximal Row:

5. Pisiform
6. Triquetral (triquetrum)
7. Lunate (semilunar)
8. Scaphoid (navicular)



Note: the ulna is not considered part of the wrist complex and is named for identification purposes only.

Now let's review the bones of the right hand in **anatomical** position:

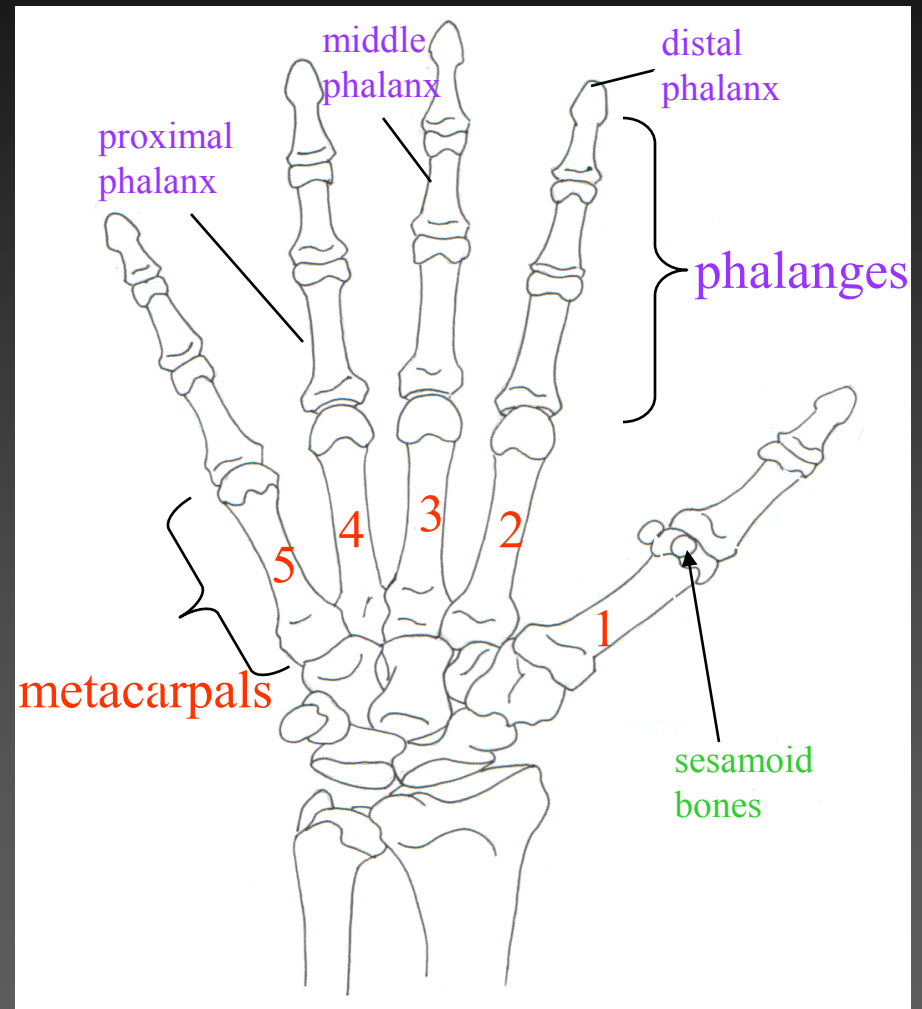
Metacarpals:

There are **5** metacarpals in the hand.

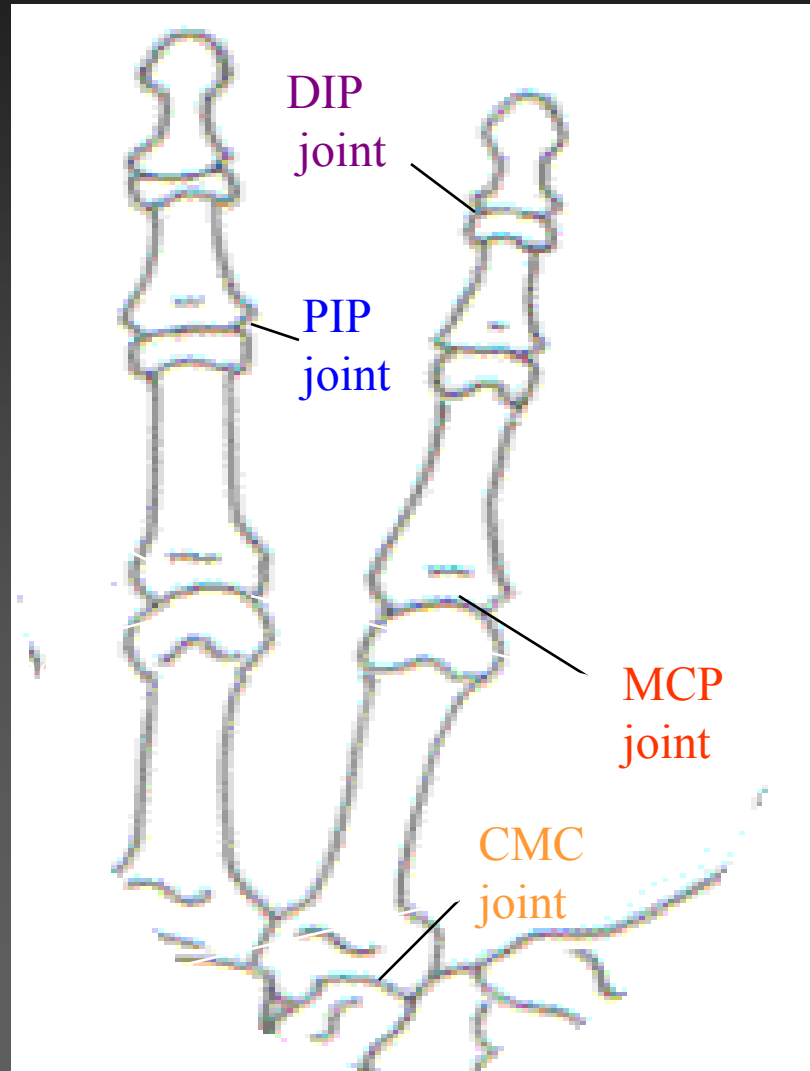
Phalanges:

Digits **2-5** have a proximal, middle and distal phalanx. The thumb (**pollicis**) does not consist of a middle phalanx, however, it does have two **sesamoid** bones.

- Both the Metacarpal and Phalanx have articulating surfaces; the **head** distally and the **base** proximally.



Let's take a closer look at the hand/fingers. The diagram below of the fingers of the right hand in **anatomical** position identifies the joints.



Origins and Insertion of Muscles

The muscles of the wrist and hand are divided into:

Anterior compartments:

- superficial and deep
- function as flexors

Posterior compartments:

- superficial and deep
- function as extensors

Extrinsic muscles:

- originate outside the hand and insert within it
- produce basic, powerful movements

Intrinsic muscles:

- originate and insert within the hand
- produce weak, intricate movements
- divided into three muscle groups:

- 1) **thenar:** act on thumb; form the thenar eminence (lateral rounded area of palm)
- 2) **hypothenar:** act on the little finger; form the hypothenar eminence (medial rounded area of palm)
- 3) **intermediate (midpalmar):** act on all digits (except thumb)

Wrist Flexion and Radial Deviation:

There are three **primary** and three **secondary** muscles that contribute to **wrist flexion**. These are:

➤ **Primary:**

1. Flexor carpi radialis (FCR)
2. Flexor carpi ulnaris (FCU)
3. Palmaris longus (PL)

➤ **Secondary:**

1. Flexor digitorum superficialis (FDS)
2. Flexor digitorum profundus (FDP)
3. Flexor pollicis longus (FPL)

The **FCR**, along with the **extensor carpi radialis longus** and the **extensor carpi radialis brevis**, is also responsible for **radial deviation** of the wrist.

To the right is an illustration of the right hand, wrist and forearm in **anatomical** position. Let's review the origins and insertions of the **primary** muscles.

Flexor carpi ulnaris:

O: medial epicondyle (humerus)

I: pisiform, hamate, 5th metacarpal base

Palmaris longus:

O: medial epicondyle (humerus)

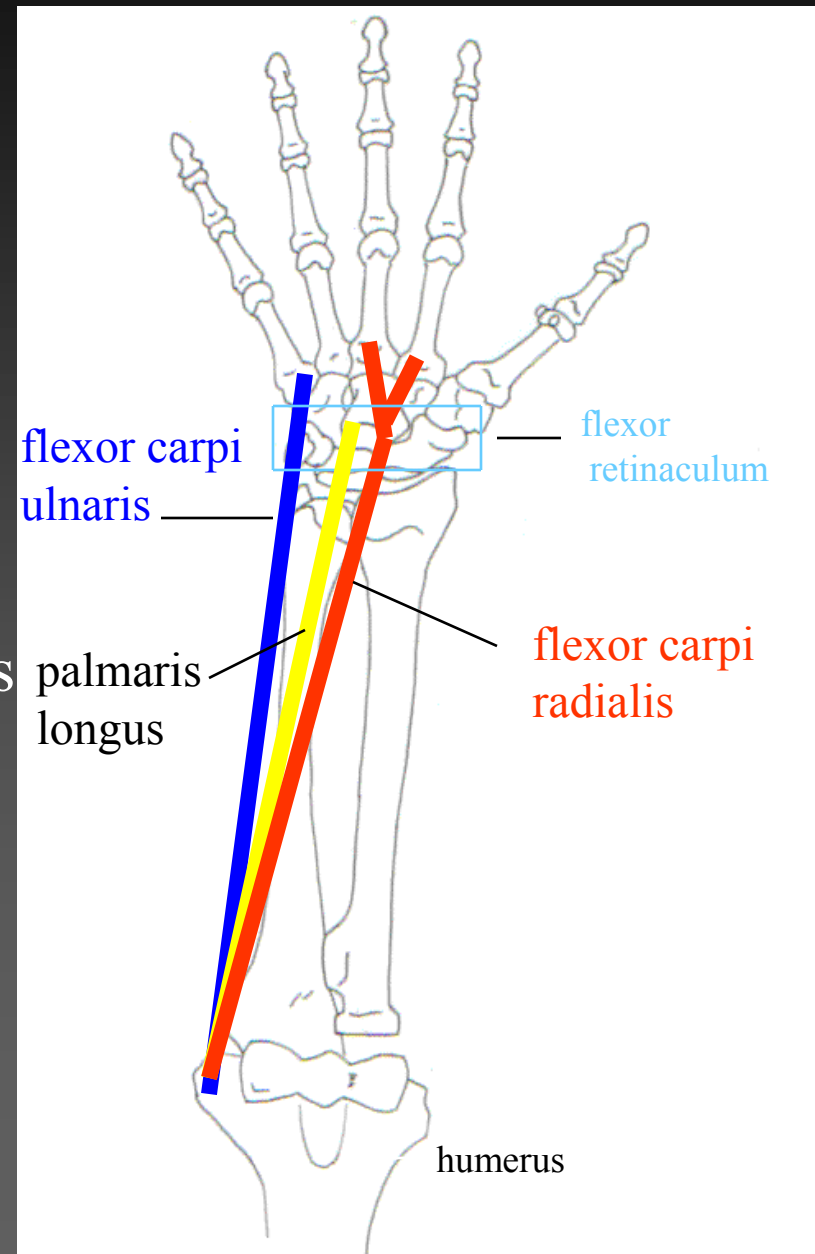
I: flexor retinaculum; carpal ligaments

Flexor carpi radialis:

O: medial epicondyle (humerus)

I: bases of 2nd and 3rd metacarpals

Note that the Palmaris Longus does not pass under the Flexor Retinaculum. It is the only flexor muscle that doesn't.



Finger and Thumb Flexors:

The **primary** muscles responsible for **finger** and **thumb flexion** are the same as the **secondary** flexor muscles of the wrist.

Flexor digitorum superficialis:

O: medial epicondyle (humerus)

I: digits 2-5 middle phalanx

Flexor digitorum profundus:

O: ulna (proximal 3/4 shaft)

I: digits 2-5 base of distal phalanx

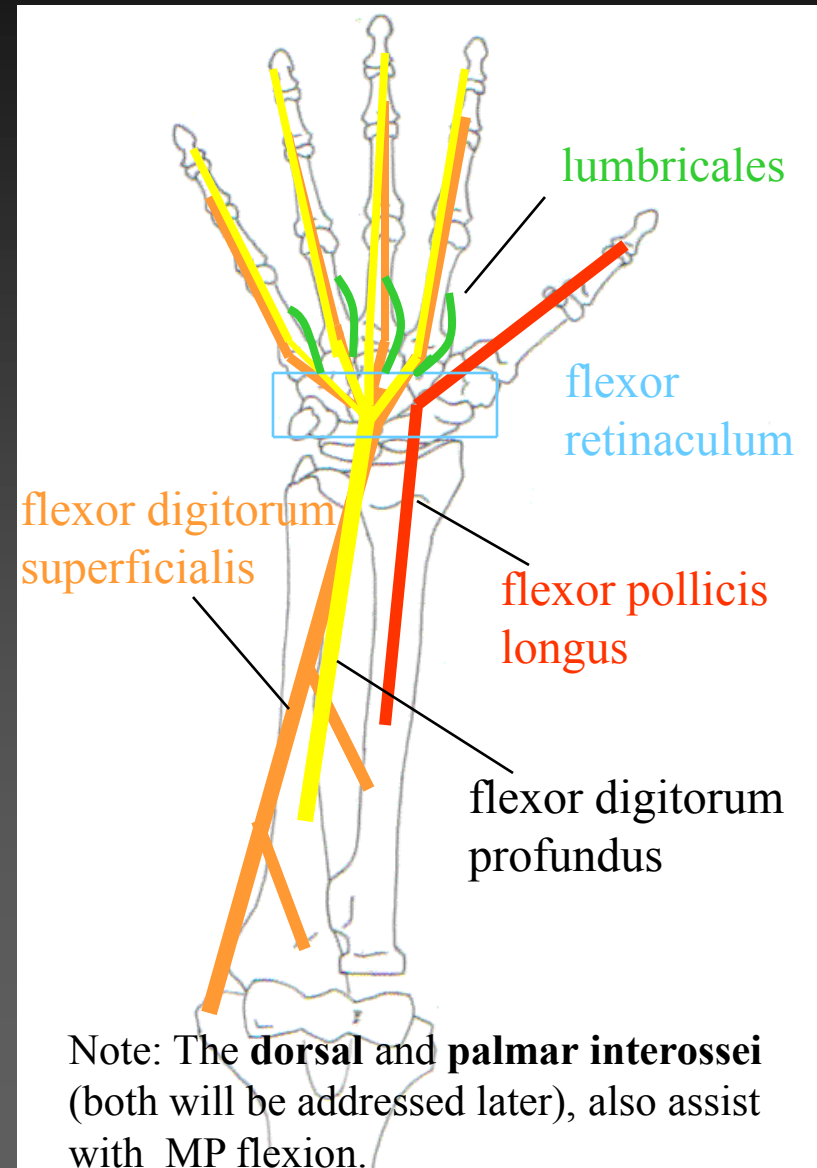
Flexor pollicis longus:

O: radius (volar side of middle 1/2)

I: thumb base of distal phalanx

Lumbricales:

O and I: tendons of flexors



Wrist Extension and Ulnar Deviation:

There are three **primary** and six **secondary** muscles that contribute to **wrist extension**. These are:

- **Primary:**
 1. Extensor carpi radialis longus (ECRL)
 2. Extensor carpi radialis brevis (ECRB)
 3. Extensor carpi ulnaris (ECU)

- **Secondary:**
 1. Extensor digitorum (ED)
 2. Extensor indicis (EI)
 3. Extensor digiti minimi (EDM)
 4. Extensor pollicis longus (EPL)
 5. Extensor pollicis brevis (EPB)
 6. Abductor pollicis longus (APL)

The **ECU**, along with the **FCU**, is responsible for **ulnar deviation** of the wrist.

➤Note: The last three secondary muscles contribution to wrist mobility is minimal.

To the right is an illustration of the right hand, wrist and forearm in a **pronated** (palm down) position. Let's review the origins and insertions of the **primary** muscles.

Extensor carpi radialis longus:

O: humerus (lateral supracondylar ridge)

I: base 2nd metacarpal

Extensor carpi radialis brevis:

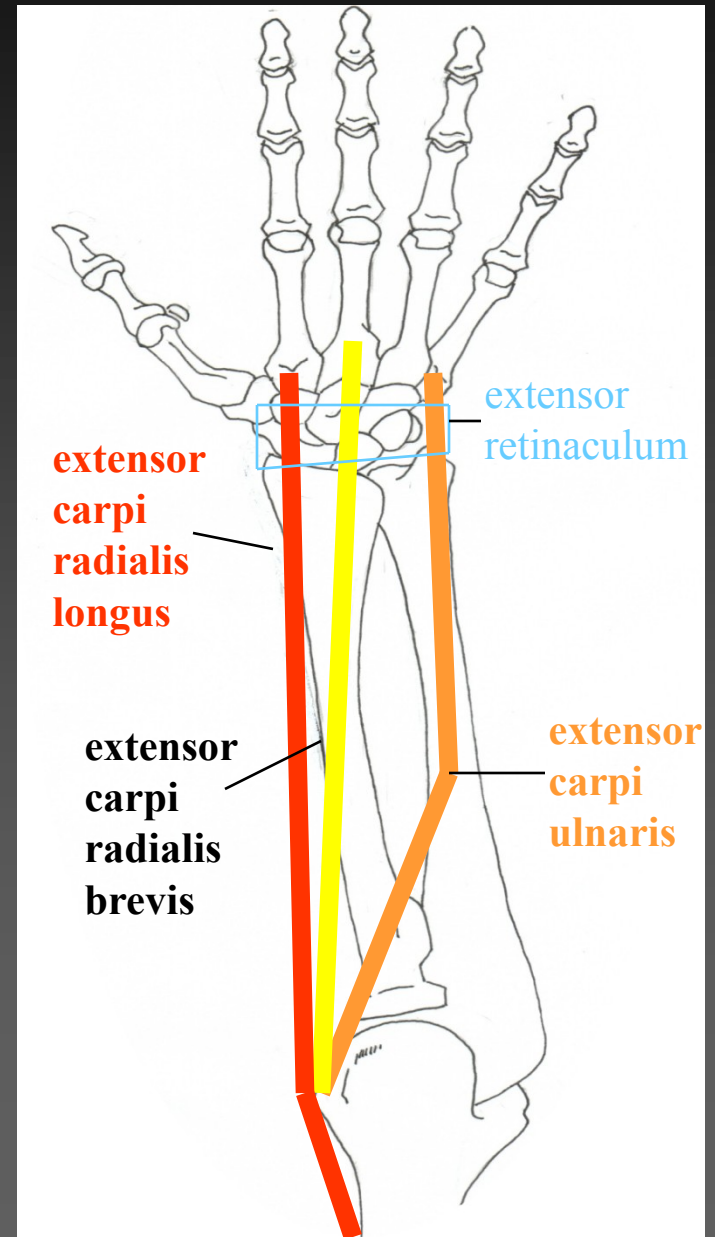
O: humerus (lateral epicondyle)

I: base 3rd metacarpal

Extensor carpi ulnaris:

O: humerus (lat.epicondyle); ulna (dorsal border)

I: 5th metacarpal



Finger and Thumb Extension:

The **primary** muscles responsible for **finger** and **thumb** extension are the same as the **secondary** muscles of the wrist.

Extensor digitorum:

O: humerus (lateral epicondyle)

I: 4 tendons to mid. and distal phalanges 2-5

Extensor digiti minimi:

O: humerus (lateral epicondyle)

I: 5th digit

Extensor pollicis longus:

O: ulna (middle posterior shaft)

I: thumb base of distal phalanx

Extensor pollicis brevis:

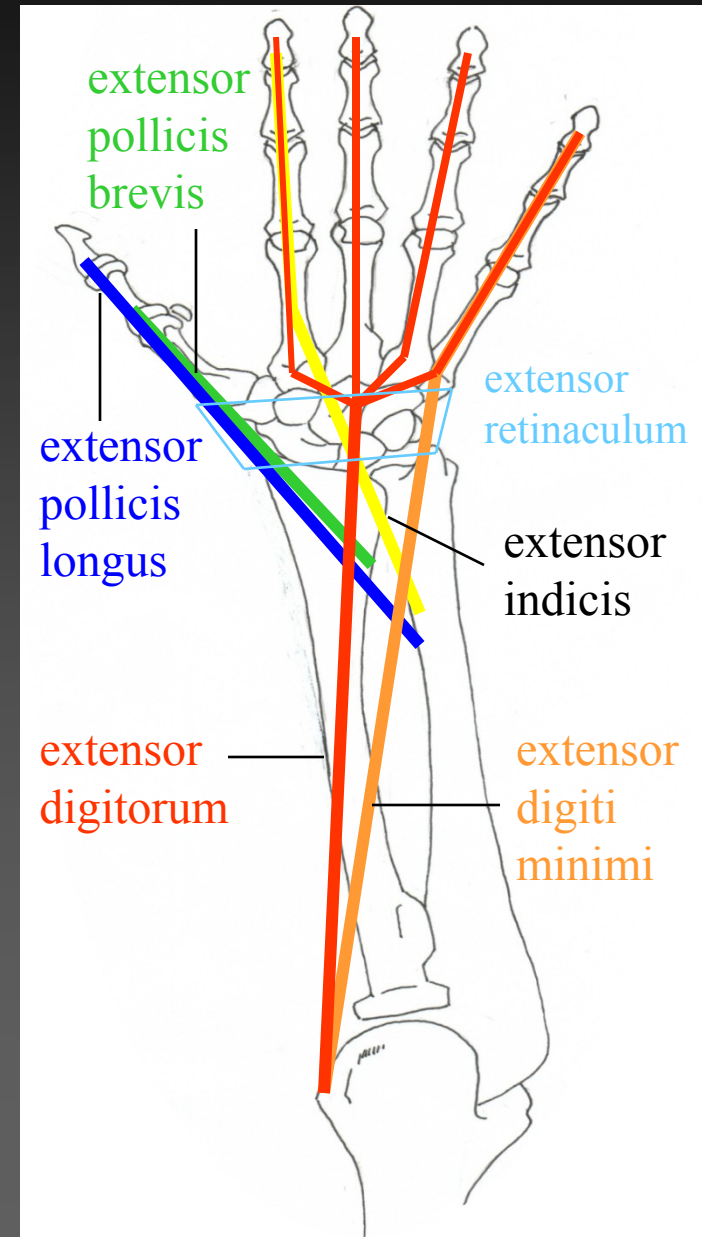
O: radius (distal posterior surface)

I: thumb base of proximal phalanx

Extensor indicis:

O: ulna (distal posterior shaft)

I: 2nd digit (extensor hood)



Finger and Thumb Abduction/Adduction:

There are four **primary** muscles that contribute to **abduction** and two that contribute to **adduction**. They are:

➤ **Abduction:**

1. Dorsal interossei (DI)
2. Abductor digiti minimi (ADM)
3. Abductor pollicis longus (APL)
4. Abductor pollicis brevis (APB)

➤ **Adduction:**

1. Palmar interossei (PI)
2. Adductor pollicis (AP)

To the right is an illustration of the right hand in a **pronated** (palm down) position. Let's review the **abductors** of the fingers and thumb.

Dorsal interossei:

O: metacarpals

I: index finger (radial side)

long finger (radial and ulnar side)

ring finger (ulnar side)

Abductor digiti minimi:

O: pisiform and FCU tendon

I: 5th digit base of proximal phalanx

Abductor pollicis longus:

O: ulna (posterior lateral surface)

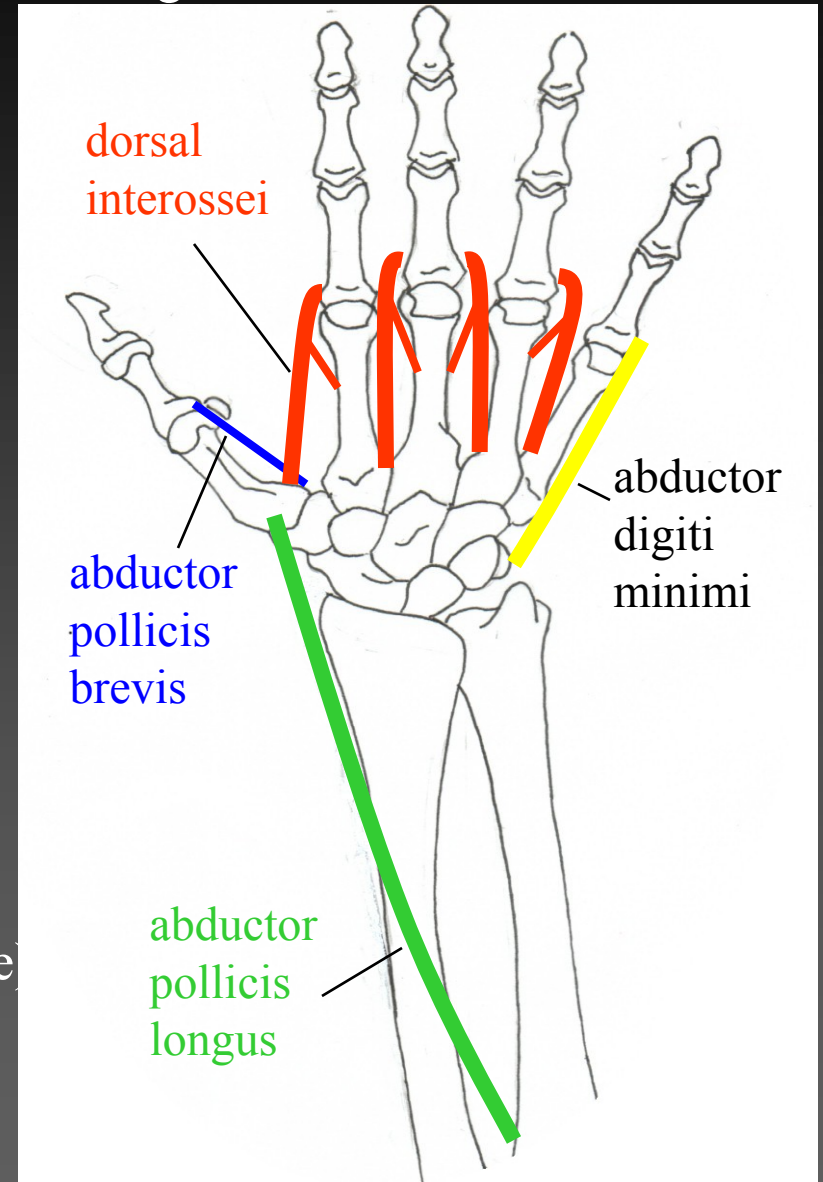
radius (mid. 1/3 posterior shaft)

I: trapezium & base 1st metacarpal (radial side)

Abductor pollicis brevis:

O: scaphoid, trapezium & flexor retinaculum

I: thumb base of proximal phalanx (radial side)



Note: the **APB** will be better demonstrated on the following slide.

To the right is an illustration of the right hand in **anatomical** position.
Let's review the **adductors** of the fingers and thumb.

Palmar interossei:

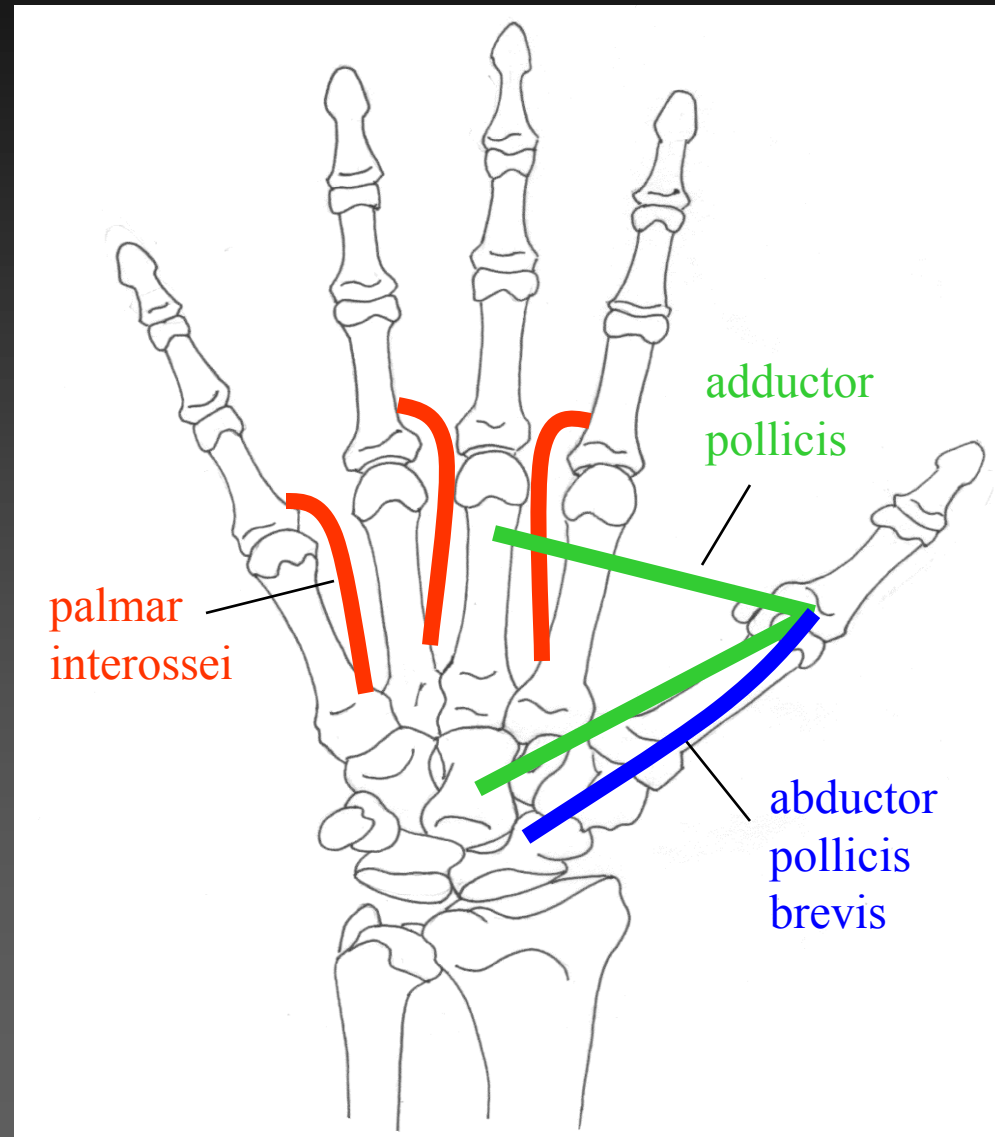
O: metacarpals

I: index finger (ulnar side)
ring finger (radial side)
little finger (radial side)

Adductor pollicis:

O: capitate, 2nd and 3rd metacarpals
and intercarpal ligaments

I: thumb base of proximal phalanx



Opposition:

There are two **primary** muscles that perform **opposition** (thumb to little finger).

Opponens pollicis:

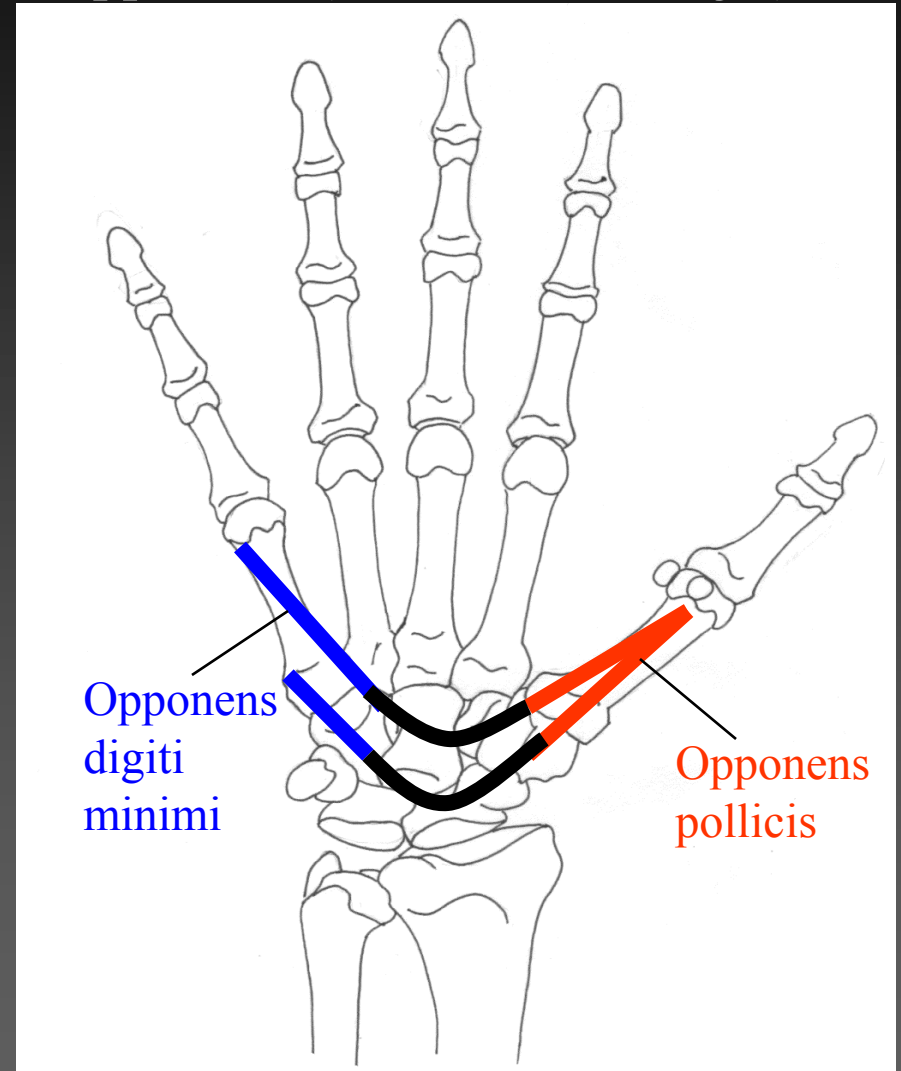
O: trapezium & flexor retinaculum

I: 1st metacarpal

Opponens digiti minimi:

O: hamate & flexor retinaculum

I: 5th metacarpal



Nerve Innervations: Motor and Sensory

Nerve Innervations:

There are three nerves associated with the motor and sensory functions of the hand and wrist. They are:

Ulnar nerve (C8-T1)

Radial nerve (C5-C8)

Median nerve (C6-T1)

Nerve Innervations: Motor

Ulnar nerve (C8-T1):

- Opponens digiti minimi
- Adductor pollicis
- Flexor pollicis brevis
- Palmar interossei
- Dorsal interossei
- Abductor digiti minimi
- Flexor digitorum profundus (4-5)
- Lumbricales (3-4)
- Flexor carpi ulnaris

Nerve Innervations: Motor

Radial nerve (C5-C8):

- Abductor pollicis longus
- Extensor pollicis longus
- Extensor pollicis brevis
- Extensor digitorum
- Extensor digiti minimi
- Extensor indicis
- Extensor carpi radialis longus
- Extensor carpi radialis brevis
- Extensor carpi ulnaris

Nerve Innervations: Motor

Median nerve (C6-T1):

- Opponens pollicis
- Abductor pollicis brevis
- Flexor pollicis longus
- Flexor pollicis brevis
- Flexor digitorum superficialis
- Flexor digitorum profundus (2-3)
- Lumbricales (1-2)
- Flexor carpi radialis
- Palmaris longus

Nerve Innervations: Sensory

Ulnar nerve:

- palm and dorsum of hand ulnar to midline of the ring finger
- palmar and dorsal surfaces of the small and ulnar ½ of the ring finger
- autonomous zone = ulnar aspect of tip of the small finger

➤ Note: autonomous is defined as independent of external influences.

Nerve Innervations: Sensory

Radial nerve:

- dorsum of the hand radial to midline of the ring finger
- dorsum of the 1st web space
- dorsum of the thumb
- autonomous zone = dorsal 1st web space

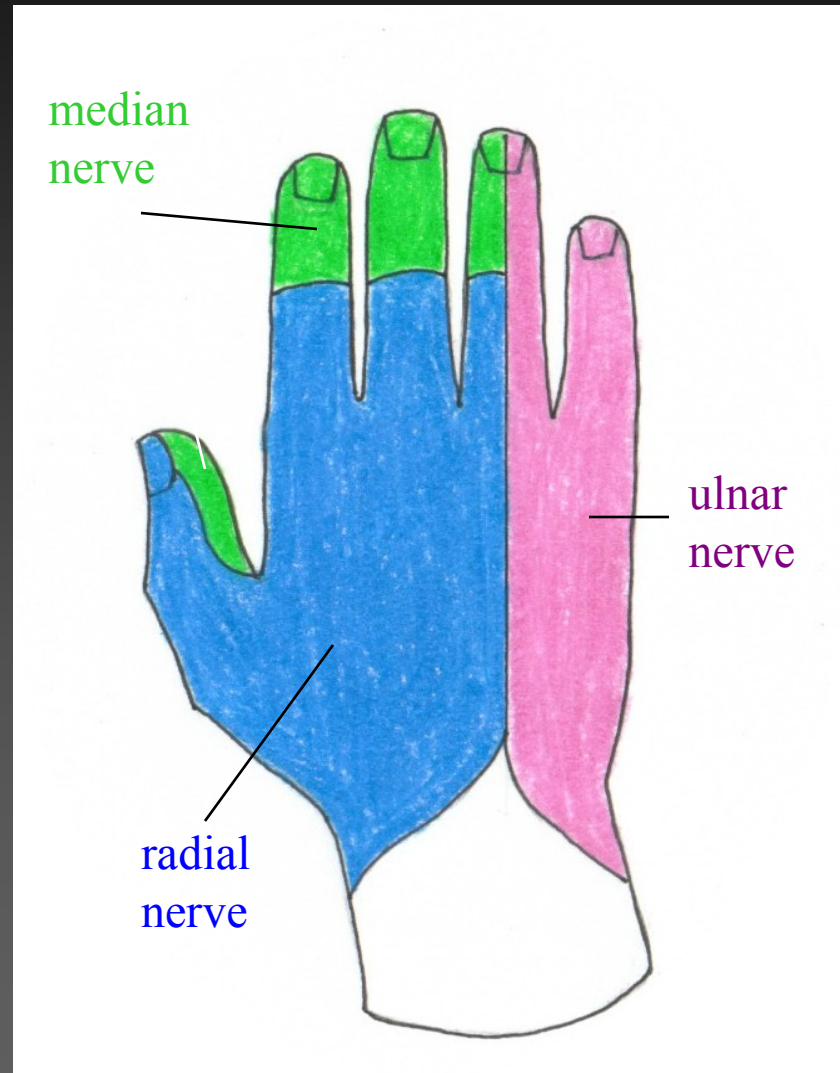
Nerve Innervations: Sensory

Median nerve:

- palm radial to midline of the ring finger
- palmar surfaces of the thumb, index finger, middle finger and radial ½ of the the ring finger
- dorsal ends of the index, middle and radial ½ of the ring finger
- autonomous zone = radial aspect of the tip of the index finger

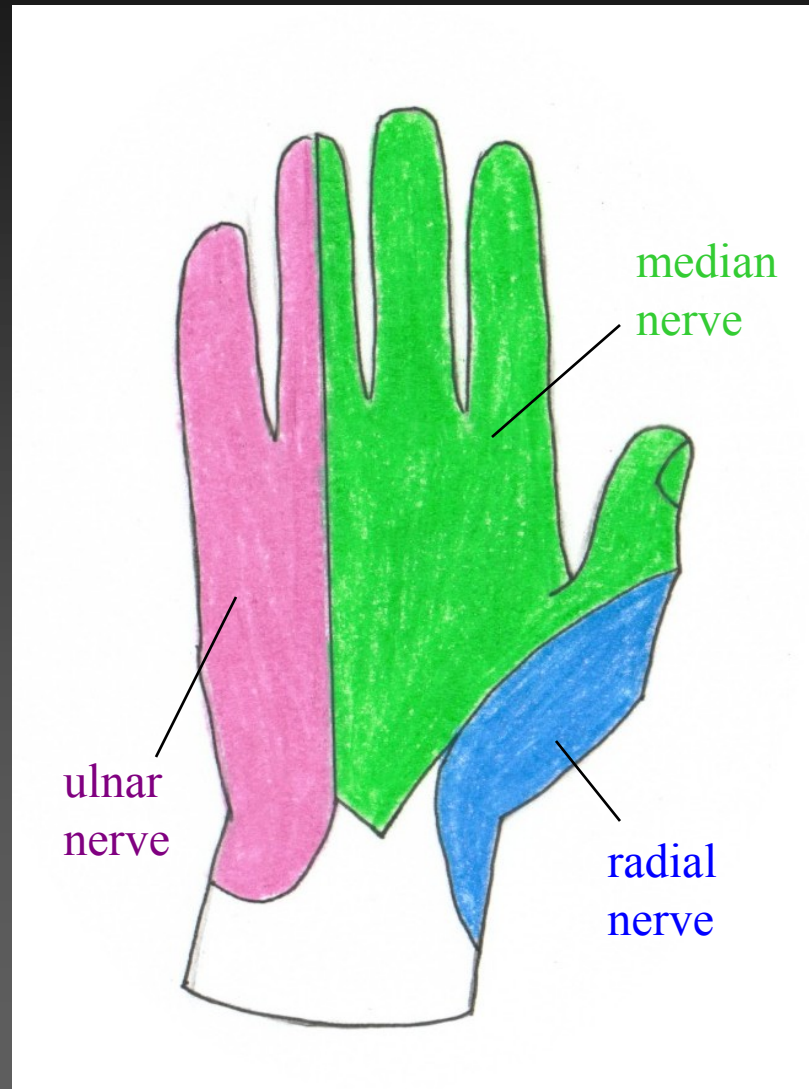
Nerve Innervations: Sensory

The responsibility of each nerve to its associated area has been explained. Now let's use the illustration, of the dorsal view of the right hand, to review.



Nerve Innervations: Sensory

This illustration is of the right hand in anatomical position. Let's review the areas that each nerve is responsible for from this view point.

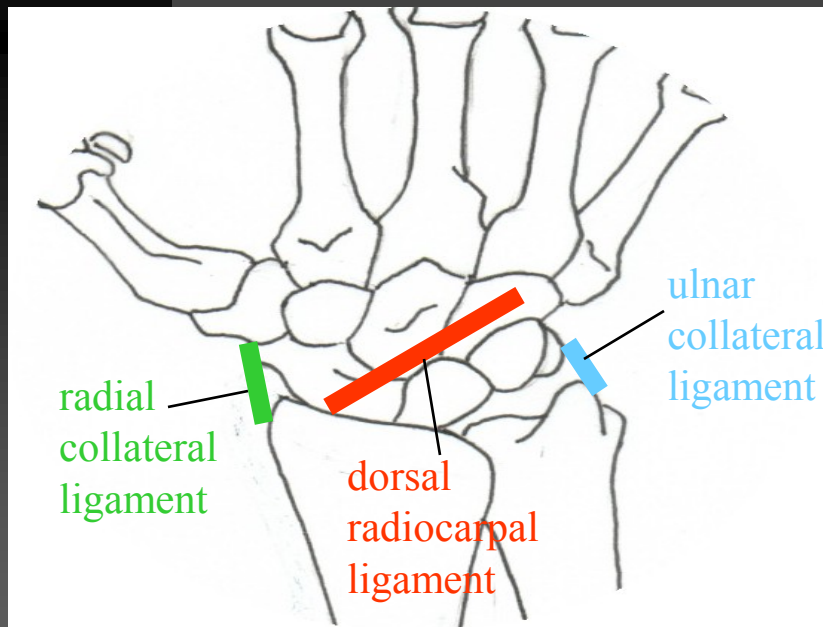


Ligaments

Ligaments:

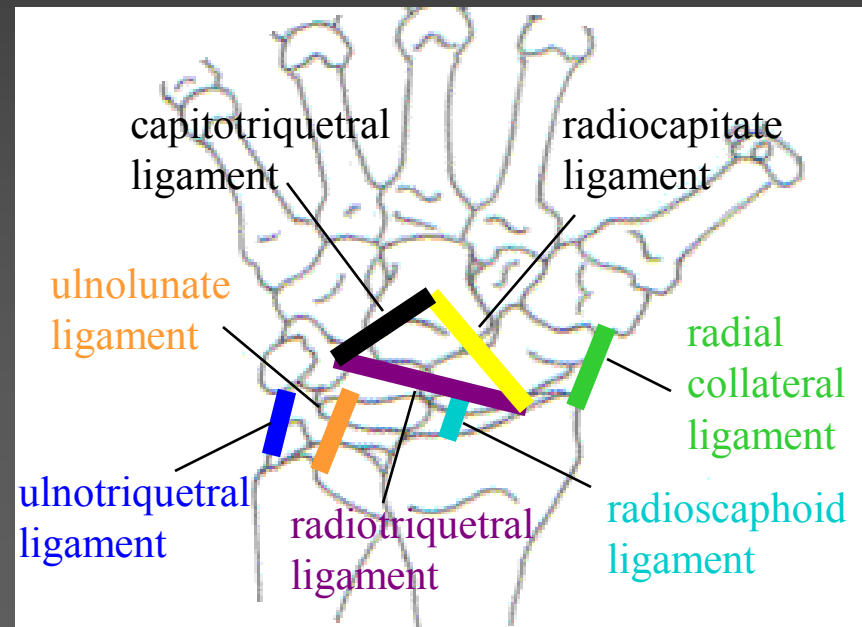
There are several ligaments involved with the wrist. The diagrams below show the ligaments of the right wrist in a **pronated** position (**dorsal** view) and **anatomical** position (**volar** view).

pronated



Dorsal view

anatomical



Volar view

Ligaments:

The function of a ligament is to provide support to a joint by allowing and limiting movement. Below is a list of wrist/hand movements and the ligament(s) that become taut or limit that movement:

dorsal radiocarpal ligament: taut in full wrist flexion

volar radiocarpal ligament: taut in extension

radial collateral ligament: taut in radial deviation/ulnar flexion

ulnar collateral ligament: taut in ulnar deviation/radial flexion

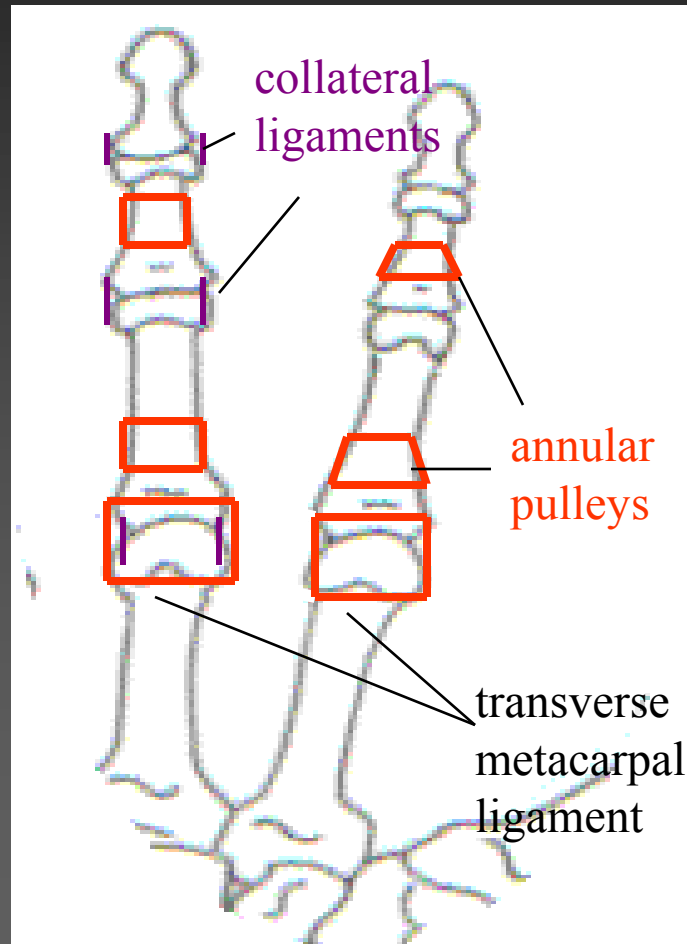
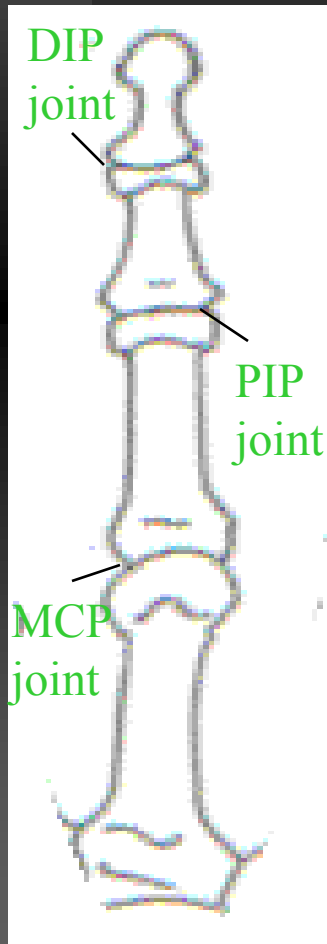
ulnocarpal ligaments: taut in extension

volar plate: resists hyperextension at MCP joint

collateral ligaments of digits: provide medial/lateral stability

Ligaments:

There are only a few ligaments to be mentioned in the hand/fingers. The diagrams below of the fingers of the right hand in **anatomical** position identify the joints and the ligaments.



Note: The **collateral ligaments** are found laterally at each **MCP** (metacarpophalangeal), **PIP** (proximal interphalangeal) and **DIP** (distal interphalangeal) joint outside of the joint capsule.

Arthrokinematics

Arthrokinematics:

Now that we have been reoriented to the structure of the wrist and hand, let's review the key concepts related to motion. This section is split into three sections: **joint classification**, **mechanisms** and **range of motion/ key concepts of motion**.

Let's begin by reviewing some terminology that will be used in the forthcoming slides.

- **synovial joint**: diarthrotic; allows one or more types of free movement; contain articular cartilage, synovial fluid, synovial membrane and a fibrous capsule.
- **bursae**: flat, fluid-filled sac that reduces friction.
- **tendon sheath**: a modified, elongated bursa that surrounds a tendon.
- **ellipsoid (ovoid) joint**: oval surface of one bone fits into an elliptical cavity of another; biaxial, typically flexion/extension and abduction/adduction.
- **gliding joint**: side to side or front to back slipping between nearly flat bones.
- **hinge joint**: monaxial; flexion/extension.
- **saddle joint**: biaxial; both bones contain concave and convex portions.

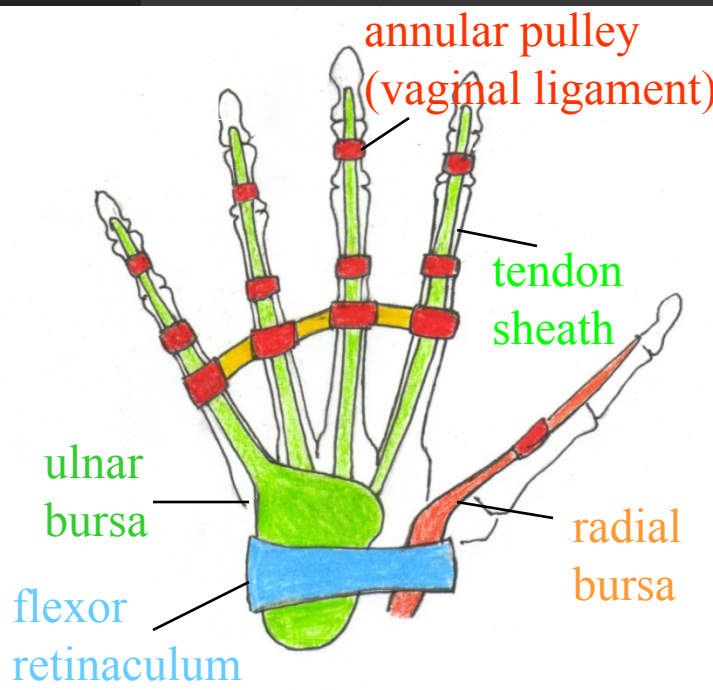
Joint Classification:

Joint	Bones involved	Type
➤ radiocarpal (wrist)	radius and carpals	synovial; ellipsoid
➤ intercarpal	adjacent carpals	synovial; gliding
➤ carpometacarpal (digits 2-5)	carpals and metacarpals	synovial; gliding
➤ carpometacarpal (thumb)	trapezium and 1 st metacarpal	synovial; saddle
➤ metacarpophalangeal	metacarpal and proximal phalanx	synovial; gliding
➤ interphalangeal	adjacent phalanges	synovial; hinge

Mechanisms:

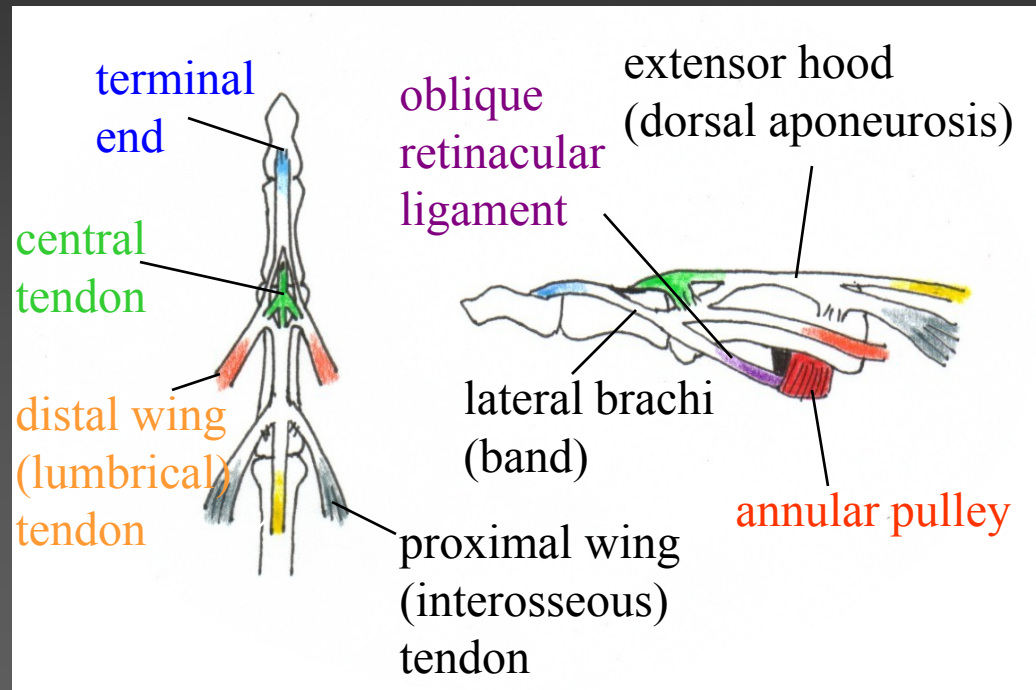
In the hand, there are two **mechanisms**: the **flexor mechanism** and the **extensor mechanism**. Let's review the anatomy of both using the diagrams below.

flexor mechanism



Volar view

extensor mechanism



Dorsal view

Mechanisms: Functions

Extensor Mechanism:

The **extensor digitorum** alone is not capable of overcoming passive flexor forces. The function of the extensor mechanism is to assist in extension by providing a chain reaction of events: contraction of ED pulls the extensor hood proximally which extends the proximal phalanx at MCP joint; this produces extensor force at PIP which, in turn, applies extensor force at the DIP joint (the PIP and DIP joint are interdependent). The extensor mechanism also prevents bowstringing of the extensor tendon.

Flexor Mechanism:

The function of the flexor mechanism is to keep the tendons of the flexor muscles (flexor digitorum superficialis and profundus) close to the bone (metacarpals and phalanges) like a fishing pole, for example.

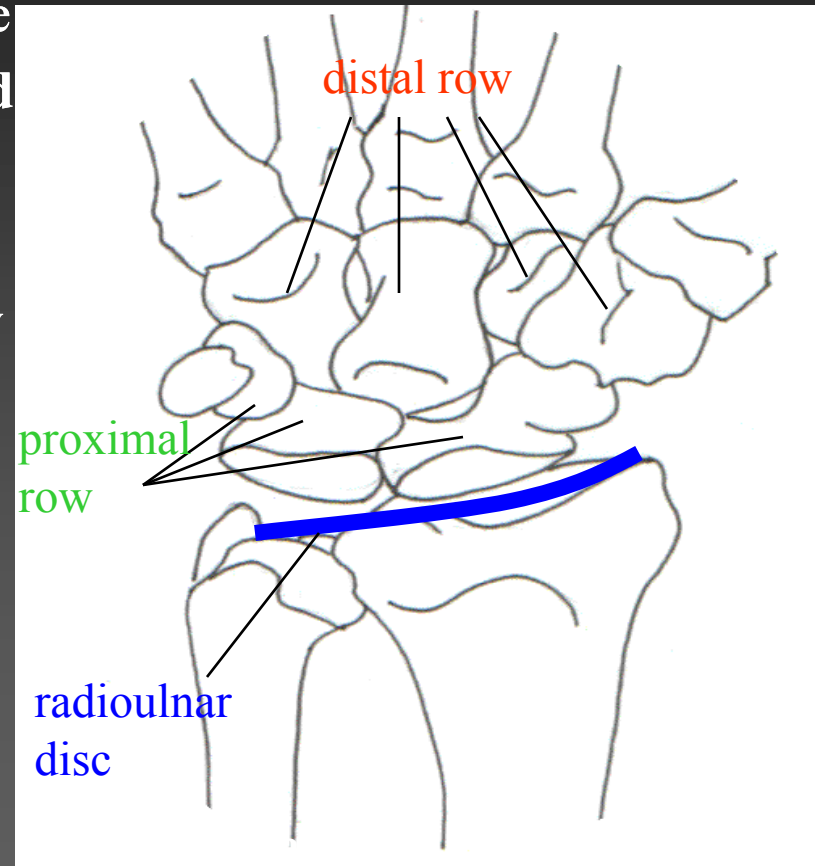
Range of Motion:

Let's begin this section by reviewing the range of motion (**ROM**) of the wrist joint; the **radiocarpal** and **midcarpal** articulations. The **radiocarpal joint** consists of the **proximal row** (scaphoid, lunate and triquetrum) articulating on the **radius** and the **radioulnar disc** (or **triangular cartilage**). The proximal row is also known as the **intercalated segment** because there are no direct muscle attachments to it.

The **midcarpal joint** consists of the **distal row** (trapezium, trapezoid, capitate and hamate) articulating on the **proximal row**.

Total wrist motion is approximately:

- **flexion:** 80°-90°
- **extension:** 70°-85°
- **radial deviation:** 15°-25°
- **ulnar deviation:** 30°-45°



Key Concepts of Motion:

The wrist joint is biaxial, capable of flexion/extension and radial/ulnar deviation (abduction/adduction). Range of motion is restricted by tightness of opposing ligaments, bony limitations or a combination of both. Let's review the key concepts associated with achieving these movements:

- **extension:** The **closed-packed** position of the wrist is obtained with full (terminal) extension. Extension begins (from a flexed position) with movement at the midcarpal joint. At the neutral position, the distal row begins to draw into the proximal row. At 45° of hyperextension, the distal row and proximal row are “locked” together and the rest of the movement is completed at the radiocarpal joint.
- **flexion:** The **loose-packed** position; above sequence is reversed.
- **radial deviation:** A **closed-packed** of the wrist is obtained again with full radial deviation. From a neutral position, the distal carpal row moves radially on the proximal carpal row.
- **ulnar deviation:** From a neutral position, distal carpal row moves ulnarly and the proximal row moves radially.
- Note: the greatest **radial** and **ulnar deviation** can be achieved when the wrist is in neutral.

Range of Motion:

Let's review the ROM of the **CMC**, **MCP** and **IP** joints of the thumb/fingers. The **CMC** joint consists of the base of a metacarpal articulating with a carpal bone in the distal row. The **MCP** joint consists of the head of a metacarpal articulating with the base of a phalanx and the **IP** joint consists of the head of a proximal phalanx articulating with the base of a distal phalanx.

Total **CMC** joint motion:

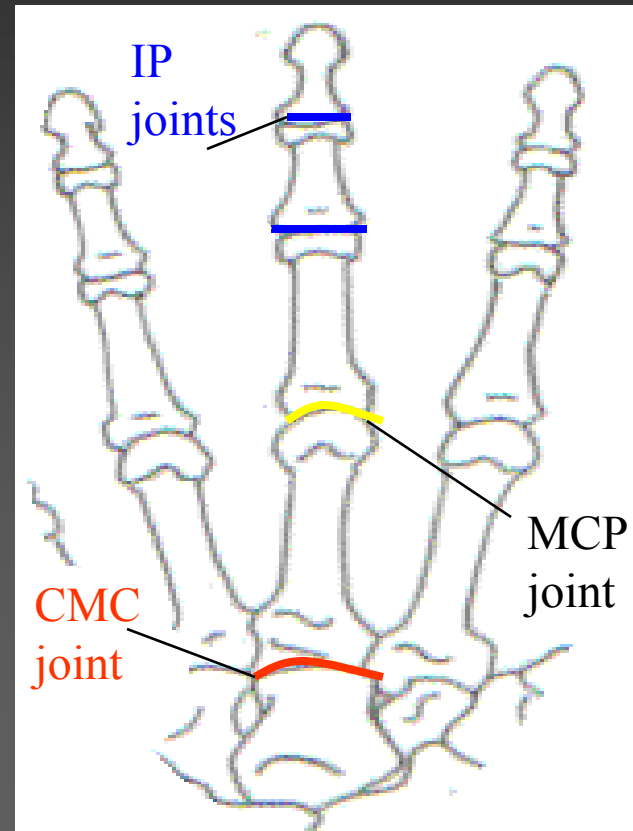
- **1st**: 53° flex/ext, 42° abd/ad and 17° rotation
- **2nd** and **3rd**: 2° general motion
- **4th**: approximately 5° motion
- **5th**: 10°-20° flex/adduction

Total **MCP** joint motion:

- **flexion**: 90°-110°; 50° (thumb)
- **extension**: 15°-25°; 50° (thumb)
- **abd/ad**: 20°-25°; 70° (thumb)

Total **IP** joint motion:

- **flexion**: PIP 100, DIP 90°; 80° (thumb)
- **extension**: 0° (slightly beyond); 80° (thumb)



Key Concepts of Motion:

The range of motion of the **CMC** joints of the fingers increases radially to ulnarly. The primary function is to assist with hollowing or cupping of the hand. The palm remains concave even at rest. This is known as the **carpal arch** which, with the help of the **flexor retinaculum**, forms the **carpal tunnel** (the tunnel through which the **median nerve** passes). The **CMC** joint of the thumb is a **saddle** joint which allows a greater degree of motion, in particular rotation. This results in the ability to perform **opposition**.

The range of motion of the **MCP** joint of the fingers also increases radially to ulnarly. **Closed-packed** position of the **MCP** joint is obtained in full flexion. The motion of the **MCP** joint of the thumb is more limited than the fingers and is reinforced by two **sesamoid bones** held in place by collateral and intersesamoid ligaments.

The range of motion at the **IP** joints of the fingers, again, increases radially to ulnarly. Also, the fingers are angled toward the thumb, during flexion, to increase grip strength and produce a tighter grip.

Because of the composition of the **flexor** and **extensor mechanisms**, there are three common **coupling actions** of the **PIP** and **DIP** joints:

- active extension of **PIP** = extension of **DIP** also.
- active/passive flexion of **DIP** = flexion of **PIP** also.
- full **PIP** flexion will prevent active **DIP** extension.

Prehensions

Prehensions:

Grasping an object between any two surfaces of the hand is known as **prehension**. **Prehension** is broken down into two categories: **power grip** and **precision handling**. The **power grip** is usually used to hold an object into the palm and involves a gross flexion of the fingers (e.g. holding a baseball). **Precision handling** requires more fine motor control and functional sensation. It usually involves the thumb and the surface of an opposing finger (e.g. picking up a coin). Let's review both:

Power grip

➤ **Cylindrical grip**: holding a glass



➤ **Spherical grip**: holding a ball



➤ **Hook grip**: carrying a briefcase



Precision handling

➤ **Pad to pad prehension**: holding a flower stem



➤ **Tip to tip prehension**: holding a sewing needle



➤ **Pad to side prehension**: handing out a letter



There is also a grasp called **lateral prehension**. Some texts categorize this type with the **power grip** while others argue it's **precision handling**. **Lateral prehension** is described as a side to side contact between two adjacent fingers (e.g. holding a cigarette).



Common Clinical Findings

Common Dysfunctions of the Wrist and Hand:

Now that we have reviewed and understand the basic structure and function of the wrist and hand, let's review some of the common clinical findings.

1. Colles' Fracture

- a fall on an outstretched hand produces a supinating force on the wrist as the forearm pronates under the weight of the body; results in a transverse fracture of the distal radius with a displacement of the hand backward and outward; this combination produces a dinner fork deformity
- Rx: ice (swelling), splint, cast (closed reduction) or pins (external fixation)

Common dysfunctions (cont.)

2. Carpal Tunnel Syndrome

- compression of the median nerve between the flexor tendons and the transverse carpal ligament; primarily found in patients with history of prolonged (repetitive) manual work with hands (specifically wrist flexion) which puts pressure on the flexor retinaculum; results in pain and/or numbness which may radiate up arm
- Phalen's Test: hold wrist hyperflexion x 1 minute; positive test if sensation changes result
- Tinel's Sign: tap flexor retinaculum; results in tingling sensation if median nerve is compressed
- Rx: rest, temporary splinting, surgery, NSAIDs, iontophoresis, ice, heat

Common dysfunctions (cont.)

3. **deQuervian's Disease (Syndrome)**

- a tenosynovitis (an irritation within the synovial sheath) as a result of a narrowing (stenosis) of the tendon sheath of the APL and EPB; area of the Anatomical Snuff Box (bordered radially by the APL and EPB and ulnarly by the EPL and floor of the navicular
- Finklestein's Test: thumb enclosed in palm and wrist is ulnarly deviated; test is positive if pain increases
- Rx: splinting, NSAIDs, steroidal injection, surgery

4. **Dupuytren's Contracture**

- a painless thickening and contracture of the palmar fascia due to fibrous proliferation; results in flexion deformities of the finger(s) into the palm with loss of function (extension) of the finger(s) involved; associated with liver disease and long term use of phenytoin
- Rx: surgery

Common dysfunctions (cont.)

5. Swan Neck Deformity

-hyperextension of the PIP joint and flexion of the DIP joint as a result of damage (frequently from rheumatoid arthritis) that causes hypermobility of the PIP joints and a migration of the lateral bands dorsally; results in a loss of the normal balance of forces around the PIP joint; may result in interossei muscles to become taunt.

6. Boutonniere Deformity (“button hole”)

-contracture of hand musculature which results in flexion of the PIP joint and hyperextension of the the DIP joint; results in a decrease of extensor power at the DIP joint.

Common dysfunctions (cont.)

7. Arthritic Changes

- **Osteoarthritis:** degeneration of articular cartilage so that the bony ends touch; friction between the bones worsens the condition; slow, symmetrical development of stiffness with minimal pain unless it is associated with trauma; usually associated with varus deformity in the IP joints distal to proximal
- **Rheumatoid Arthritis:** an autoimmune disease in which the immune system attacks its own cartilage and joint linings; usually occurs bilaterally; painful decreases in motion with varying degrees of inflammation; results in ulnar drift of fingers, crepitus and ankylosis (immobility of a joint) in wrist flexion

Conclusion:

- Therapists, and their patients, are constantly challenged with how to compensate for loss of function of the wrist and hand in order to accomplish activities of daily living.
- The wrist and hand are complicated structures that work together to produce various degrees of grasps which enable us to perform a wide variety of activities.
- The thumb is located 90° to the fingers and is of particular importance to the dexterity of the hand.
- Functional position of the wrist and hand (position at which the hand can be closed with the least amount of effort) has determined to be:
 - **wrist complex: 20° extension and 10° ulnar deviation**
 - **MCP joint: 45° flexion**
 - **PIP joint: 30° flexion**
 - **DIP joint: slight flexion**

Test:

There are **50** questions on this test. All answers can be found within the context of this program. The “hint” button located next to each question will provide you the information needed to answer the question. At any time during the test you may skip a question and return to it later. You must successfully answer 70% of the questions in order to receive credit for the course. To access the test, please close out of this course by clicking the “x” in the top right corner.

Good luck!!!

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