GROSS ANATOMY – SECOND HALF

Fall 2004

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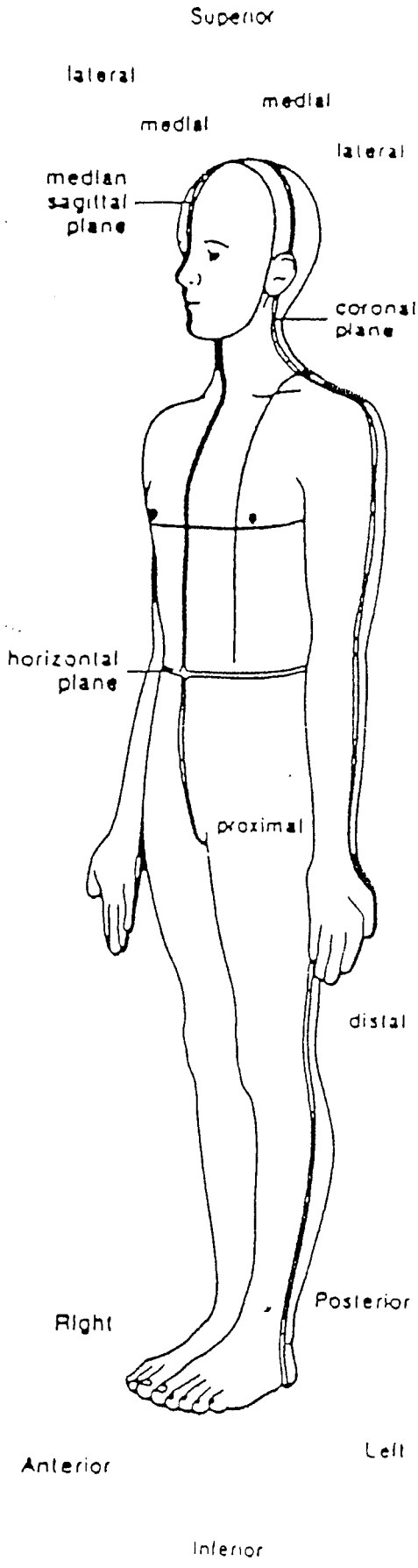

STRUCTURAL BASIS OF MEDICAL PRACTICE
Fall 2004

DATE	TOPIC	LECTURER	PAGES/CHAPTERS
24-Sep	Lec: Clinical Aspects of Limbs & Muscles (11 AM-12 PM)	Dr. Berlin	Langman: Chaps 8,9,18
	Lec Axilla & Brachial Plexus (1-3 PM)	Dr. Allar	
	Lec UG Development (3-5 PM)	Dr. R. Decter	Langman: Chap. 14
27-Sep	Lab: Axilla & Brachial Plexus/**Group A** (9 AM-12 PM)		129-133;185-193
	Lec: Shoulder/Scapula/Arm (1-2 PM)	Dr. Allar	
	Lab: Axilla & Brachial Plexus/**Group B** (2-5 PM)		129-133;185-193
	Lec: Clinical Correlate: UG/GI/Resp Devel/**Group A** (3-4 PM)	Dr . Berlin	Langman:Chap.12,13,14
28-Sep	Lec: Clinical Correlate: UG/GI/Resp Develop./**Group B** (8-9 AM)	Dr. Berlin	Langman:Chap.12,13,14
	Lab: Shoulder & Scapula/**Group A** (9 AM-12 PM)		193-199
	Lec: Elbow/Forearm/Hand (1-2 PM)	Dr. Allar	
	Lab: Shoulder/Scapula/Arm/**Group B** (2-5 PM)		193-199
29-Sep	Lab: Brachial & Cubital Region/**Group A** (9 AM-12 PM)		199-202
	Lec: Forearm and Hand (1-2 PM)	Dr. Naidu	
	Lab: Brachial & Cubital Region/**Group B** (2-5 PM)		199-202
30-Sep	Lab: Elbow/Forearm & Hand/**Group A** (10 AM-12 PM)		202-208
	Lec: Joints of the Upper Extremity (1-3 PM)	Dr. Allar	
	Lab: Elbow/Forearm & Hand/**Group B** (3-5 PM)		202-208
1-Oct	Lab: Ext.Region of Forearm, Dorsum-Palm of Hand/**Group A** (9-12 PM)		208-216
	Lec: Clinical Correlate: Upper Extremity (1-3 PM)	Dr. Black	
	Lab: Ext.Region of Forearm, Dorsum-Palm of Hand/**Group B** (2-5 PM)		208-216
4-Oct	Lab: Joints of Upper Extremity/**Group A** (9 AM-12 PM)		217-220
	Lec: Clinical Correlate: Clinical Aspects of the Hand (1-2 PM)	Dr. Hauck	
	Lab: Joints of Upper Extremity/**Group B** (2-5 PM)		217-220
5-Oct	Lab: Muscles of the Back/**Group A** (10 AM-12 PM)		132-136
	Lec: Vertebral Column, Muscles of Back (1-3 PM)	Dr. Weiner	
	Lab: Muscles of the Back/**Group B** (3-5 PM)		132-136
	Lab: Radiology/**Group A** (3-5 PM)	Dr. Mosher	
6-Oct	Lab: Lumbar Vertebral Column & Spinal Cord/**Group A** (9 AM-12 PM)		136-142
	Lab: Radiology/**Group B** (10 AM-12 PM)	Dr. Mosher	
	Lec: Skull, Foramina, Scalp, Face, Part I (1-2 PM)	Dr. Allar	
	Lab: Lumbar Vertebral Column & Spinal Cord/**Group B** (2-5 PM)		136-142
7-Oct	Lec: Head/Neck Development (10-11 AM)	Dr. Shapiro	Langman: Chap. 15
	Lec: Clinical Correlate: Upper Extremity (11 AM-12 PM)	Dr. Bollard	
	Lec: Skull, Foramina, Scalp, Face, Part II (1-2 PM)	Dr. Allar	
	Rev Optional Radiology Review (2-3 PM)	Dr. Mosher	
8-Oct	**SBMP EXAMS #5 and #6 (LR-A, LR-C, MDL) (1-5 PM)**		
11-Oct	Lab: Front of Skull & Face, Scalp/**Group B** (9 AM-12 PM)		221-229
	Lec: CNS and Functional Components (1-2 PM)	Dr. Evey	
	Lab: Front of Skull & Face, Scalp/**Group A** (2-5 PM)		221-229
12-Oct	Lab: Cranial Nerves, Fossae & Meninges/**Group B** (10 AM-12 PM)		229-237;240-244
	Lec: Orbit (1-3 PM)	Dr. Quillen	
	Lab: Cranial Nerves, Fossae & Meninges/**Group A** (3-5 PM)		229-237;240-244

STRUCTURAL BASIS OF MEDICAL PRACTICE
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DATE	TOPIC	LECTURER	PAGES/CHAPTERS
13-Oct	Lab: Orbit & Contents/**Group B** (9 AM-12 PM)		244-251
	Lec: Clinical Correlate: Head/Neck Devel/**Group A** (11 AM -12 PM)	Dr. Berlin	Langman: Chap. 15
	Lec: Cervical Fascia, Posterior Triangle, Cervical Plexus (1-2 PM)	Dr. Evey	
	Lab: Orbit & Contents/**Group A** (2-5 PM)		244-251
14-Oct	Lec: Clinical Correlate: Head & Neck #1 (11 AM-12 PM)	Dr. Bollard	
	Lec: Nervous System Development (1-3 PM)	Dr. Dias	Langman: Chap. 19
15-Oct	Lab: Cervical Fascia, Post. Tri., Cerv.Plexus/**Group B** (9 AM-12 PM)		251-254
	Lec: Autonomic Innervation of Head, Neck; Anterior Triangle; Root of Neck (1-2 PM)	Dr. Evey	
	Lab: Cervical Fascia, Post. Tri., Cerv. Plexus/**Group A** (2-5 PM)		251-254
18-Oct	Lab: Anterior Triangle & Root of Neck/**Group B** (9 AM-12 PM)		254-263
	Lec: TMJ, Muscles of Mastication, Parotid Region (1-2 PM)	Dr. Evey	
	Lab: Anterior Triangle & Root of Neck/**Group A** (2-5 PM)		254-263
	Lec: Clinical Correlate: Devel CNS/**Group B** (4-5 PM)	Dr. Berlin	Langman: Chap. 19
19-Oct	Lab: Parotid, Temp. & Mesenteric Reg./**Group B** (10 AM-11 AM)		263-267
	Lec: Clinical Correlate: Devel CNS/**Group A** (11 AM-12 PM)	Dr. Berlin	Langman: Chap. 19
	Lec: Infratemporal Region (1-3 PM)	Dr. Evey	
	Lab: Parotid, Temporal & Mesenteric Reg./**Group A** (3-5 PM)		263-267
20-Oct	Lab: Infratemporal Region/**Group B** (9 AM-12 PM)		267-276
	Lec: Larynx (1-2 PM)	Dr. McGinn	
	Lab: Infratemporal Region/**Group A** (2-5 PM)		267-276
21-Oct	**SBMP EXAM #7 (LR-A & LR-C) (10-11 AM)**		
	Lec: Clinical Correlate: Head & Neck #2 (11 AM-12 PM)	Dr. Bollard	
	Lec: Radiology of the Head & Neck (1-2 PM)	Dr. Iyriboz	
	Lab: Radiology (2-4:00 PM)		
22-Oct	Lab: Palate, Phary. Wall, Mouth, Tongue, Larynx/**Group B** (9AM-12 PM)		276-285
	Lec: Pharynx (1-2 PM)	Dr. Fedok	
	Lab: Palate, Phary. Wall, Mouth, Tongue, Larynx/**Group A** (2-5 PM)		276-285
25-Oct	Lab: Pharynx/**Group B** (9 AM-12 PM)		285-293
	Lec: Temporal Bone & Ear (1-2 PM)	Dr. Isaacson	
	Lab: Pharynx/**Group A** (2-5 PM)		285-293
26-Oct	Lab: Temporal Bone & Ear/**Group B** (10 AM-12 PM)		
	Lec: Clinical Correlate: Temporal Bone & Ear (1-3 PM)	Dr. G. Conner	
	Lab: Temporal Bone & Ear/**Group A** (3-5 PM)		293-295
27-Oct	Rev Review (LR-C & MDL) (1 PM)	Dr.Leure-duPree	293-295
28-Oct	Lab: Optional Radiology Review (1-2 PM)	Drs. Iyriboz	296
29-Oct	**SBMP EXAMS #8 and #9 (LR-A, LR-C, MDL) (10 AM-2 PM)**		

Page numbers refer to Grant's Dissector, 12th edition, by E. K. Sauerland, unless otherwise noted. Chapter numbers for Development refer to "Langman's Medical Embryology," 9th ed., Lippincott, Williams & Wilkins. All lectures in Gross Anatomy will be held in Lecture Room B at 1:00 P.M. unless otherwise noted. All laboratories will be held in Room C3762 (MDL Labs) unless otherwise noted. Bold print indicates exams or groups.

THE UPPER LIMB

The arm articulates with the girdle at the shoulder joint. The segment of the limb from the shoulder to the elbow is the arm, and from the elbow to the wrist, is the forearm.

General Movements of the Upper limb:

Scapula: retraction - movement of scapula toward midline
protraction - movement of scapula away from midline
depression
elevation
rotation - glenoid elevated or depressed

Arm: flexion, extension, adduction and abduction

Forearm: flexion, extension, adduction, and abduction

Hand at wrist: flexion, extension, adduction, and abduction

Digits: flexion, extension, adduction, abduction (thumb also has movement of opposition)

WHAT YOU SHOULD LEARN ABOUT THE LIMBS.

1. Osteology: The name of parts of bones making up the limbs;
What they articulate with;
What parts can be palpated;
Where major muscles attach.

2. Muscles: The name, major attachment, and nerve supply of each muscle;
The mamor movement caused by each;
The functional loss which will result if the muscle is paralyzed.

3. Joints: The parts of the bones in which they occur;
The type of joint and type of movement possible;
The major supporting ligament;
The muscles which cause specific movements.

4. Nerves: The name of each of the major nerves, and where or how they originate;
The motor and sensory distribution of each nerve.

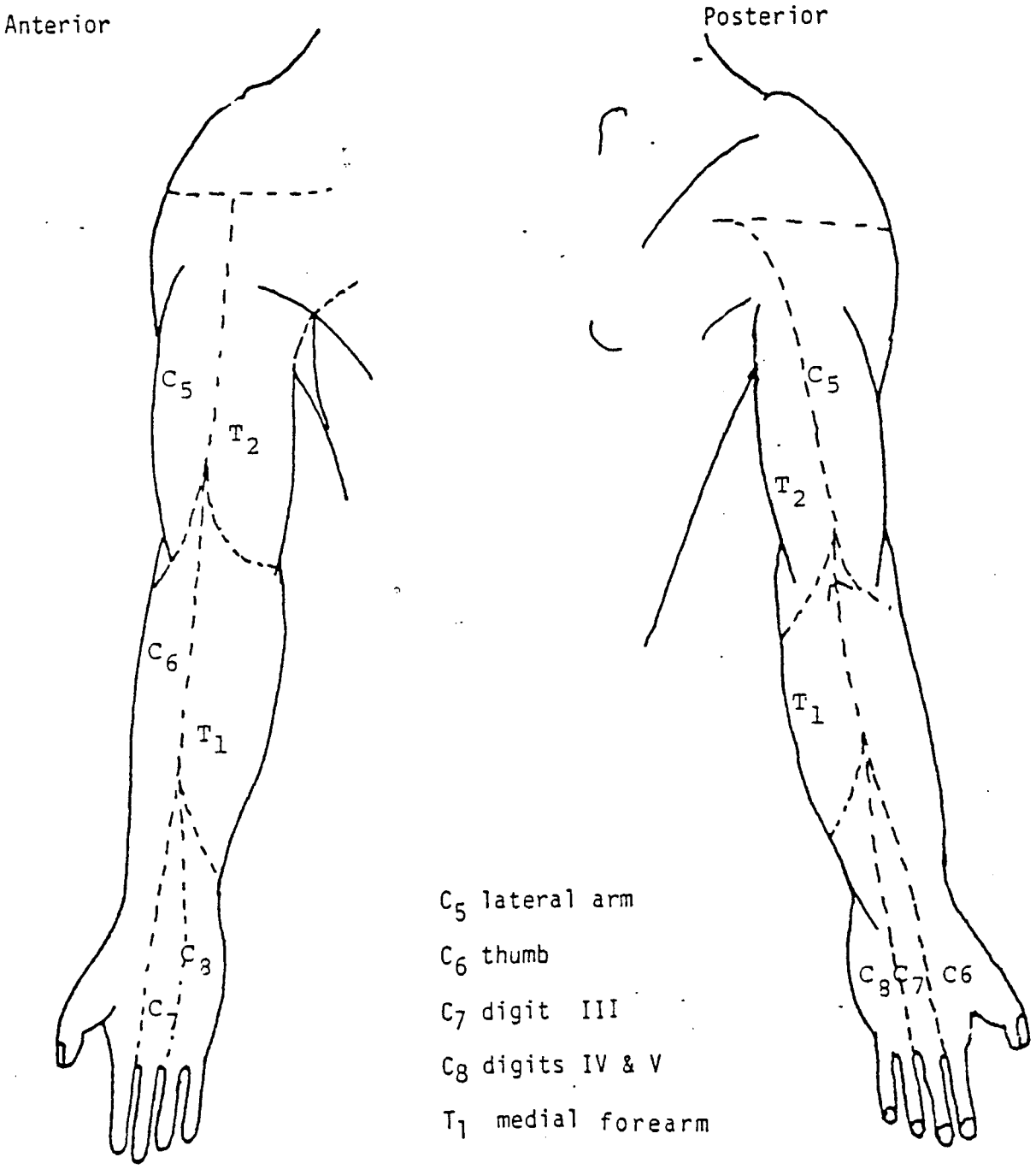
5. Vessels: The names of major arteries and their origin;
Their course and relationship, i.e., where you can find them, and most importantly, which one you can palpate in a living subject and/or in a vulnerable location.

Since each artery is accompanied by a vein or plexus of veins of the same name, the veins are ignored except for the superficial ones which are useful for purposes of injection.

6. Others: The boundaries and contents of the major intermuscular spaces, such as the axilla, cubital fossa.

THE DERMATOMES OF THE UPPER LIMB

An area of skin supplied by one segmental spinal nerve is called a dermatome. Knowledge of the dermatomes allows you to test the entire brachial plexus for damage with only a pin.



C_5 lateral arm

C_6 thumb

C_7 digit III

C_8 digits IV & V

T_1 medial forearm

N.B. note skin over shoulder is supplied by the cerival plexus.

Laboratory Assignment
Axilla and Brachial Plexus

- Clavicle
- Sternum
- Scapula
  - Acromion
  - Coracoid Process
  - Suprascapular Notch
  - Glenoid Cavity
  - Supraspinous Fossa
  - Infraspinous Fossa
  - Subscapular Fossa
  - Spine
  - Supraglenoid Tubercle
  - Infraglenoid Tubercle
  - Superficial Transverse Scapular Ligament
- Humerus
  - Humeral Head
  - Greater Tubercle
  - Lesser Tubercle
  - Intertubercular Groove
  - Deltoid Tuberosity
  - Spiral Groove
  - Medial and Lateral Supracondylar Ridges
  - Olecranon Fossa
  - Olecranon (Process)
  - Capitulum
  - Trochlea
- Deltopectoral Groove
- Cephalic Vein

- Axillary Artery
  - Superior Thoracic Artery
  - Thoracoacromial Trunk
    - Acromial Branch
    - Deltoid Branch
    - Clavicular Branch
    - Pectoral Branch
  - Lateral Thoracic Artery
  - Subscapular Artery
    - Circumflex Scapular A.
    - Thoracodorsal Art.
  - Anterior Humeral Circumflex Artery
  - Posterior Humeral Circumflex Artery
- Deep Brachial Artery (Profunda Brachii)
- Dorsal Scapular Artery
- Brachial Plexus
  - Upper, Middle and Lower Trunks
  - Anterior and Posterior Divisions
  - Medial, Lateral and Posterior Cords
  - Axillary Nerve
  - Radial Nerve
  - Musculocutaneous Nerve
  - Median Nerve
  - Ulnar Nerve
  - Dorsal Scapular Nerve
  - Long Thoracic Nerve
  - Suprascapular Nerve
  - Lateral Pectoral Nerve
  - Upper Subscapular Nerve
  - Thoracodorsal Nerve
  - Lower Subscapular Nerve
  - Medial Pectoral Nerve
  - Medial and Antebrachial Cutaneous Nerve

- Trapezius
  - Transverse Cervical Artery
  - Spinal Accessory Nerve
- Levator Scapulae
- Rhomboid Major and Minor
- Pectoralis Minor
- Serratus Anterior
- Teres Major
- Latissiumus Dorsi
- Rotator Cuff
  - Supraspinatus
  - Infraspinatus
  - Teres Minor
  - Subscapularis
- Triceps Brachii
  - Lateral Head
  - Long Head
- Anconeus
- Quadrangular Space
- Triangular Space
- Triangular Interval
- Deltoid
- Biceps Brachii
- Pectoralis Major
- Cephalic Vein

Bones of the Shoulder and Arm

- Clavicle
  - Articulates with sternum and acromion of scapula
  - Most frequently broken bone
- Scapula
  - Articulates with the clavicle and the humerus
  - Bony areas include the coracoid process, acromion, glenoid cavity, supraspinous fossa, infraspinous fossa, subscapularis fossa and the suprascapular (scapular) notch
- Humerus
  - Forms shoulder joint with the glenoid cavity
  - Important bony structures include the humeral head, greater and lesser tubercles, intertubercular (bicipital) groove, deltoid tuberosity and the spiral groove

Important Bony Areas of the Scapula

Acromion

Lateral end of the scapular spine. Articulates with the clavicle to form the acromioclavicular joint.

Coracoid Process

Means "beak-like," provides an origination point for the long head of the biceps and the coracobrachialis muscles, and an insertion point for pectoralis minor.

Subscapular Fossa

Anterior surface of the scapula. Provides origin for the subscapularis muscle.

Suprascapular (Scapular) Notch

Notch located at the superior aspects of the supraspinatus/subscapular fossa that is covered by the transverse scapular ligament. The suprascapular artery goes over top of the ligament, while the suprascapular nerve goes under the ligament.

Supraspinous Fossa

Fossa located superior to the spine of the scapula on the posterior surface. Origin of the supraspinatus muscle.

Infraspinous Fossa

Fossa situated inferior to the spine of the scapula on the posterior surface. Origin of the infraspinatus muscle.

Spine of the Scapula

Posterior landmark that separates the supraspinatus fossa from the infraspinatus fossa. Easily palpable and ends laterally as the acromion.

Glenoid Cavity

Cup-like expansion located on the lateral side of the scapula which articulates with the head of the humerus to form the glenohumeral joint (shoulder joint). Laxity of the fibrous capsule that surrounds this joint allows for a wide variety of movements.

Important Bony Areas of the Humerus

Humeral Head

Articulates with the glenoid cavity of the scapula to form the glenohumeral joint.

Greater Tubercle

Large bony protuberance located on the lateral aspect at the proximal end of the humerus. Point of insertion for the rotator cuff muscles.

Lesser Tubercle

Bony protuberance located medial to the greater tubercle. Point of insertion for the subscapularis muscle.

Intertubercular Groove

Area located between the greater and lesser tubercle in which the long head of the biceps lies as it originates from the supraglenoid tubercle.

Spiral or Radial Groove

Bony ridge that begins on the posterior aspect of the humerus and winds around to the anterior surface. This structure provides an origination point for the triceps and also demarcates the path of the radial nerve

Deltoid Tuberosity

The deltoid tuberosity is the insertion site for the deltoid muscle. This site lies inferior to the greater tubercle and is located on the lateral aspect of the humerus.

Olecranon Fossa

Fossa located on the posterior aspect of the distal end of the humerus that articulates with the olecranon process of the ulna

Capitulum

Rounded area located on the anterior distal end of the humerus that articulates with the radial head.

Trochlea

"Spool" located on the anterior distal end of the humerus that articulates with the olecranon process of the ulna.

Boundaries of Axilla

- Apex
- Base
- Anterior Wall
- Posterior Wall
- Medial Wall
- Lateral Wall

Boundaries of the Axilla

Apex
- -Entrance from neck to axilla
- -Located between the first rib, clavicle and superior edge of subscapularis
- -Contains arteries, veins, nerves and lymphatics

Base
- -Skin
- -Subcutaneous tissue
- -Axillary fascia extending from arm to the thoracic wall

Anterior Wall
- -Pectoralis major and minor
- -Pectoral and clavipectoral fascia

Posterior Wall
- -Scapula and Subscapularis
- -Inferiorly by the teres major and latissimus dorsi

Medial Wall
- -Thoracic wall (Ribs 1-4)
- -Serratus anterior

Lateral Wall
- -Intertubercular groove of humerus

Axillary Artery

- Begins at the lateral border of the first rib
- Ends at the inferior border of teres major and becomes the brachial artery
- Consists of three parts

1st part: Extends from the clavicle to the medial edge of the pectoralis minor and gives off the ***superior thoracic artery*** which supplies the first and second intercostal spaces

2nd part: Lies deep to the pectoralis minor and give off the ***thoracoacromial (deltoid, pectoral, acromial and clavicular branches)***and ***lateral thoracic arteries***

3rd part: Extends from the lateral border of pectoralis minor to the inferior edge of the teres major and gives off the ***subscapular (circumflex scapular and thoracodorsal arteries), anterior and posterior humeral circumflex arteries***

Brachial Plexus

- Nerve network which supplies the upper limb
- Formed by the union of the ventral rami of C5 through C8 and T1
- Ventral rami form the roots of the brachial plexus which pass between the anterior and middle scalene muscles with the subclavian artery

Trunks of the Brachial Plexus

- Upper Trunk
  - Formed by the union of C5 and C6 roots
- Middle Trunk
  - Continuation of C7 root
- Lower Trunk
  - Formed by the union of C8 and T1 roots

Divisions of the Brachial Plexus

- Each trunk of the brachial plexus divides into anterior and posterior divisions posterior to the clavicle
- Anterior divisions supply the anterior or flexor compartments of the upper limb, and the posterior divisions supply the posterior or extensor compartments

Cords of the Brachial Plexus

- The divisions of the brachial plexus unite to form three cords which are so named due to their relationship with the second part of the axillary artery
  - Lateral Cord formed by the anterior divisions of the superior and middle trunks
  - Medial Cord is the continuation of the anterior division of the inferior trunk
  - Posterior Cord is formed by the union of all three posterior divisions

Branches of the Brachial Plexus

- Lateral Cord splits into two branches
  - Musculocutaneous nerve
  - 1/2 of the Median nerve
- Posterior Cord splits into two branches
  - Axillary nerve
  - Radial nerve
- Medial Cord splits into two branches
  - Ulnar nerve
  - 1/2 of the Median nerve

Brachial Plexus

Nerves from Roots

Dorsal Scapular Nerve
Levator Scapulae
Rhomboids Major and Minor

Long Thoracic Nerve
Serratus Anterior

Nerve from Trunks

Nerve to Subclavius
Subclavius

Suprascapular Nerve
Supraspinatus
Infraspinatus

Brachial Plexus

Nerves from Cords

Upper Subscapular
Subscapularis
Lower Subscapular
Subscapularis
Teres Major
Thoracodorsal
Latissimus Dorsi
Medial Pectoral Nerve
Pectoralis Major
Pectoralis Minor
Medial Brachial Cutaneous N.
Medial Antebrachial Cutaneous N.

Nerves from Branches

Lateral Pectoral Nerve
Pectoralis Major
Musculocutaneous
Coracobrachialis
Biceps Brachii
Brachialis
Axillary Nerve
Deltoid
Teres Minor
Radial Nerve
Triceps Brachii
Anconeus
Median Nerve
Ulnar Nerve

Muscles Which Act on the Scapula

Trapezius **Origin:**
External occipital protuberance and the superior nuchal line and the spinous processes of C1-T12.
Insertion: Lateral 1/3 of the clavicle, acromion process, and the spine of the scapula.
Action: Extension of the head, medial rotation of the scapula, retraction of the scapula and also depression of the scapula. Unilateral contraction allows for lateral flexion of the cervical spine, contralateral rotation of the head, and bilateral contraction allows for extension of the head and the cervical spine.
Innervation: Spinal accessory nerve (Cranial Nerve XI)

Levator Scapulae **Origin:**
Transverse processes of C1-C4. **Insertion:** Vertebral border of the scapula from the superior angle to the root of the spine.
Action: Elevation of the scapula, retraction (adduction) of the scapula and medial rotation.
Innervation: Dorsal scapular nerve

Rhomboids major and minor **Origin:**
Rhomboid major originates on the spinous processes of T2-T5, Rhomboid minor originates on the spinous processes of C7-T1.
Insertion: Rhomboid major inserts at the inferior angle to the root of the scapular spine, Rhomboid minor inserts from the superior angle to the root of the scapular spine.
Actions: Elevation, retraction (adduction) and medial rotation of the scapula
Innervation: Dorsal scapular nerve

Pectoralis Minor
Origin: Ribs 3-5 lateral to the costal cartilage
Insertion: Coracoid process of the scapula
Action: Depression, protraction (abduction) and lateral rotation of the scapula
Innervation: Medial pectoral nerve

Serratus Anterior
Origin: Ribs 1-9 just lateral to the costal cartilage
Insertion: Anterior vertebral border and inferior angle of the scapula
Action: Protracts and laterally rotates the scapula
Innervation: Long thoracic nerve

Muscles Which Work at the Shoulder Joint

Latissimus Dorsi (Swimmer's Muscle) **Origin:**
Spinous processes of T6-L5, the lower 4 ribs, posterior iliac crest, and the sacrum **Insertion:** Intertubercular groove of the humerus
Actions: Extends and medially rotates the arm and adducts the shoulder
Innervation: Thoracodorsal nerve

Teres Major
Origin: Inferior half of the lateral border of the scapula
Insertion: Medial lip of the intertubercular groove of the humerus **Actions:**
Synergist with the latissimus dorsi.
Extends and medially rotates the arm and adducts the shoulder.
Innervation: Lower subscapular nerve

Supraspinatus
Origin: Supraspinatus fossa
Insertion: Superior facet of the greater tubercle
Action: First 15° of abduction at the shoulder joint
Innervation: Suprascapular nerve

Infraspinatus **Origin:**
Infraspinatus fossa
Insertion: Middle facet of the greater tubercle
Action: Lateral rotator of the humerus
Innervation: Suprascapular nerve

Teres Minor **Origin:**
Middle half of the lateral border of the scapula along with portions from the infraspinatus and teres major **Insertion:** Inferior facet of the greater tubercle **Action:** Lateral rotator of the humerus **Innervation:** Axillary nerve

Subscapularis **Origin:**
Anterior surface of the scapula in the subscapularis fossa
Insertion: Lesser tubercle
Action: Medial rotator of the humerus
Innervation: Upper and lower subscapular nerves

Muscles of the Rotator Cuff

- "SITS"
  - Supraspinatus
  - Infraspinatus
  - Teres Minor
  - Subscapularis

Muscles of the Arm and Shoulder Joint

Triceps Brachii

Origin: The long head of the triceps arises from the infraglenoid tubercle and passes over the glenohumeral joint and proceeds inferiorly between the teres minor and the teres major. The lateral head of the triceps arises from the superior half of the posterior surface of the humerus inferior to the humeral head. The medial head of the humerus arises from the distal two-thirds of the posterior surface of the humerus.

Insertion: All three of the triceps heads fuse and insert on the olecranon process of the ulna.

Actions: All three heads of the triceps working together extend the elbow joint. The long head of the triceps can also extend and adduct the shoulder joint. This muscle can be palpated on the posterior and lateral aspects of the humerus.

Innervation: Radial nerve

Anconeus

Origin: Lateral epicondyle of the humerus

Insertion: Lateral side of the olecranon and a portion of the ulnar body.

Action: Synergist with the triceps during elbow extension.

Innervation: Radial Nerve

Posterior Shoulder Spaces

- **Quadrangular Space**
  - Bounded superiorly by the teres minor, medially by the long head of the triceps, laterally by the humerus and lateral head of the triceps and inferiorly by the teres major
  - Axillary nerve and Posterior circumflex humeral vessels pass backwards through this space
- **Triangular Space**
  - Bounded superiorly by the teres minor, inferiorly by the teres major and laterally by the long head of the triceps
  - Contains the circumflex scapular artery
- **Triangular Interval**
  - located between the lateral and long heads of the triceps inferior to teres minor
  - Radial nerve and Deep brachial artery can be seen in this interval

Muscles Which Work at the Shoulder Joint

Deltoid

Origin: Lateral 1/3 of the clavicle, acromion, and the spine of the scapula

Insertion: Deltoid tuberosity of the humerus

Action: The deltoid can be divided up into three distinct areas. The anterior fibers flex and medially rotate the shoulder. The middle fibers abduct the shoulder, and the posterior fibers extend and laterally rotate the shoulder

Innervation: Axillary nerve

Pectoralis Major

Origin: Medial 2/3 of clavicle, sternum, and ribs 1-6 lateral to the costal cartilage

Insertion: Outer (lateral) lip of the intertubercular groove

Action: Flexes the shoulder joint, medially rotates the humerus, and adducts the humerus

Innervation: Medial and lateral pectoral nerve

Biceps Brachii ("Corkscrew muscle")

Origin: Long head originates on the supraglenoid tubercle of the scapula, while the short head originates on the coracoid process of the scapula

Insertion: Both heads join together and then insert into the radial tuberosity by way of the bicipital tendon/aponeurosis

Action: Primary supinator of the forearm, elbow flexion, and flexion at the shoulder joint

Innervation: Musculocutaneous nerve

Subclavius

Origin: First costal cartilage

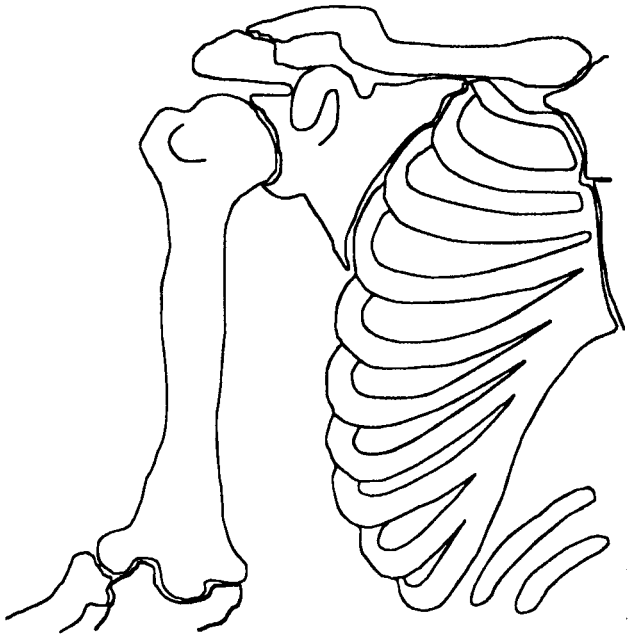
Insertion: Clavicle

Action: Depresses the clavicle and steadies this bone during movements of the shoulder girdle

Innervation: Nerve to subclavius

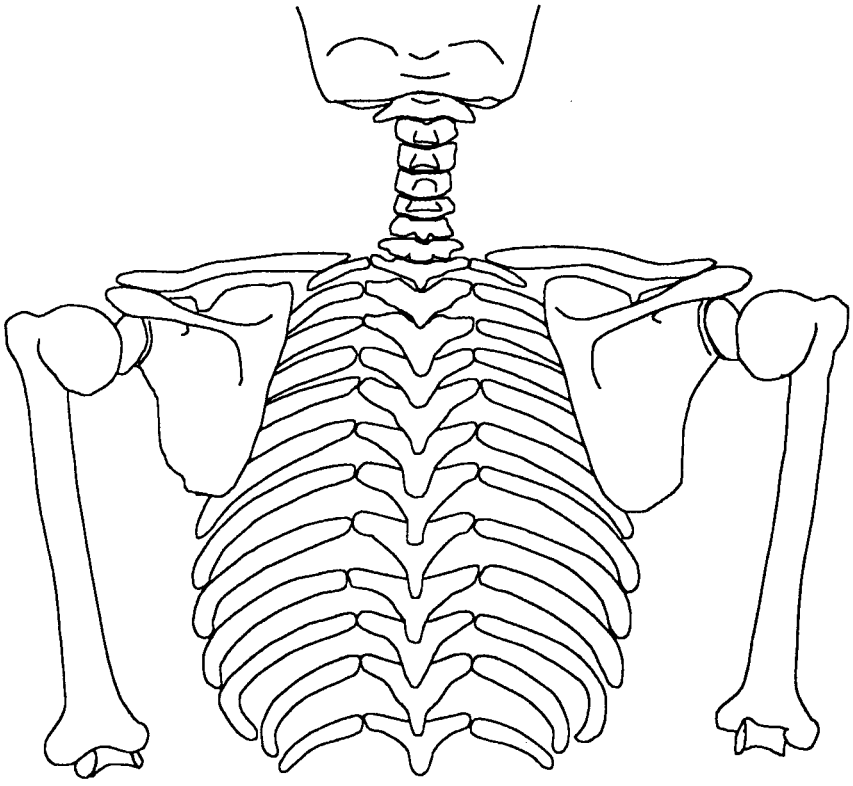
Bony Structures of Shoulder

Lateral



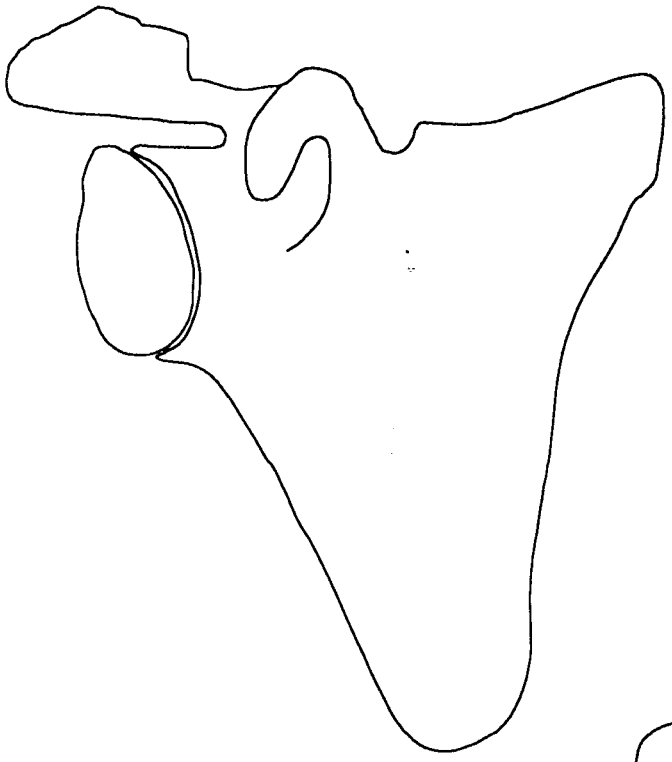
Medial

Anterior View

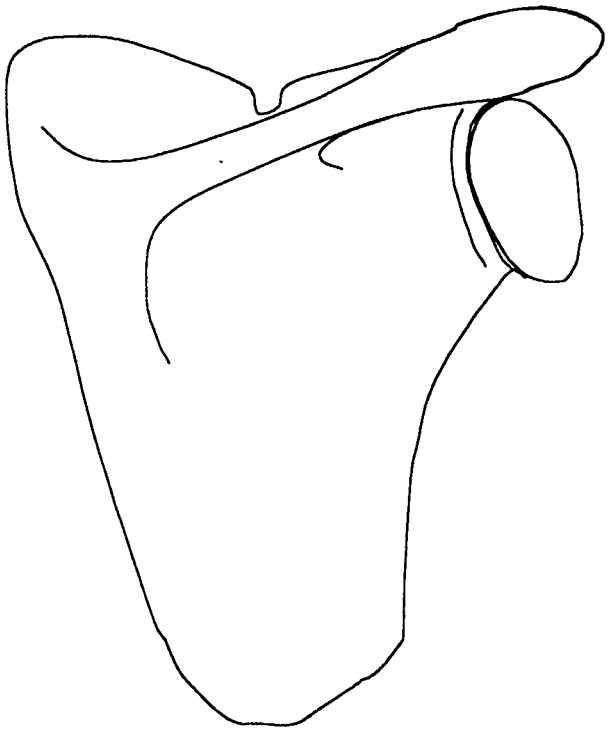


Posterior View

Scapula

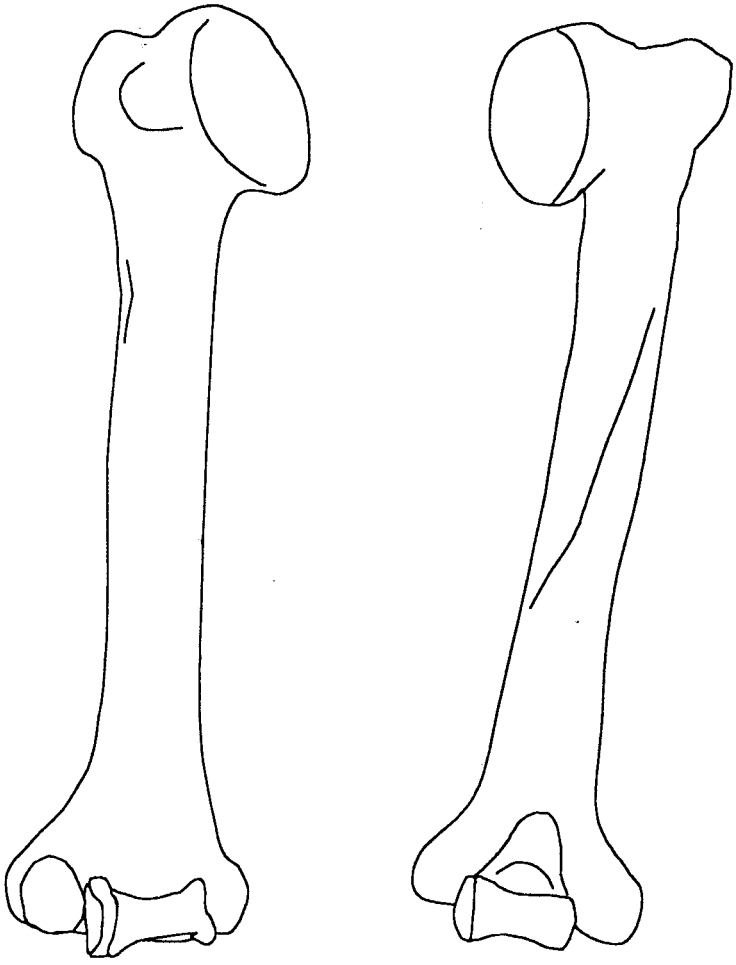


Anterior View



Posterior View

Humerus

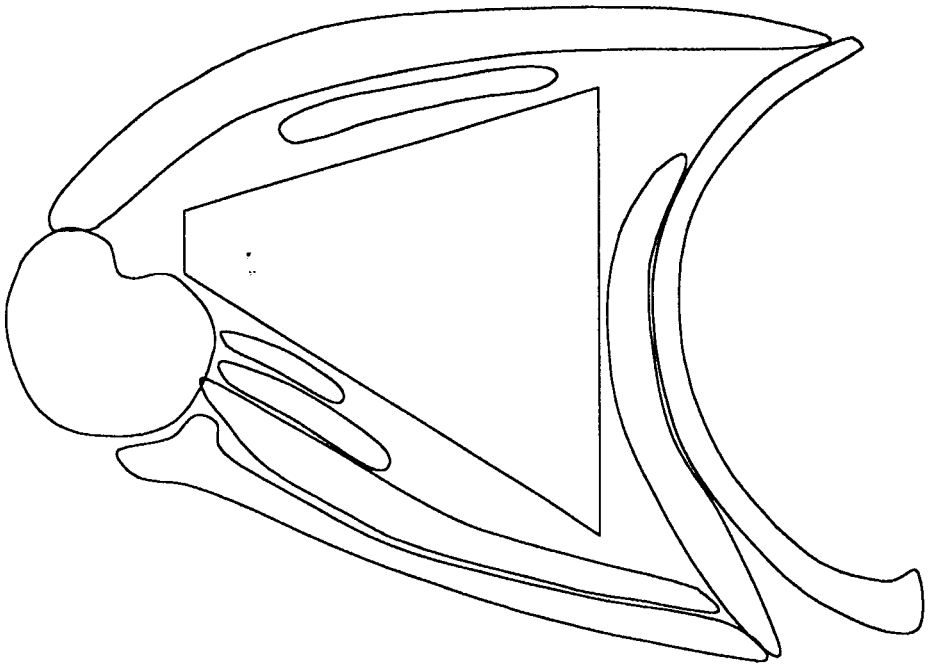


Anterior **Posterior**

Axilla Boundaries

Anterior

Lateral

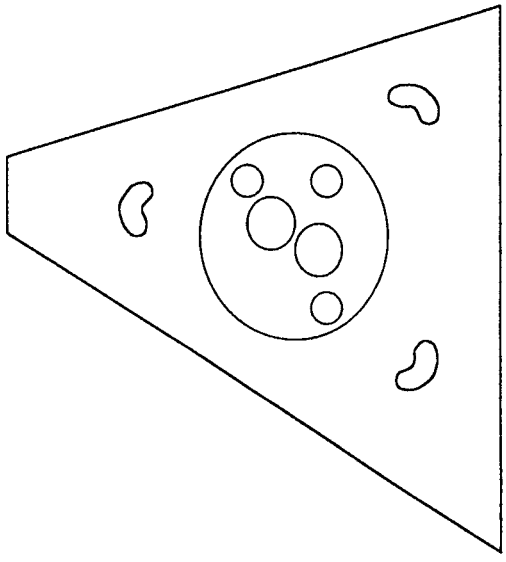


Medial

Posterior

Anterior

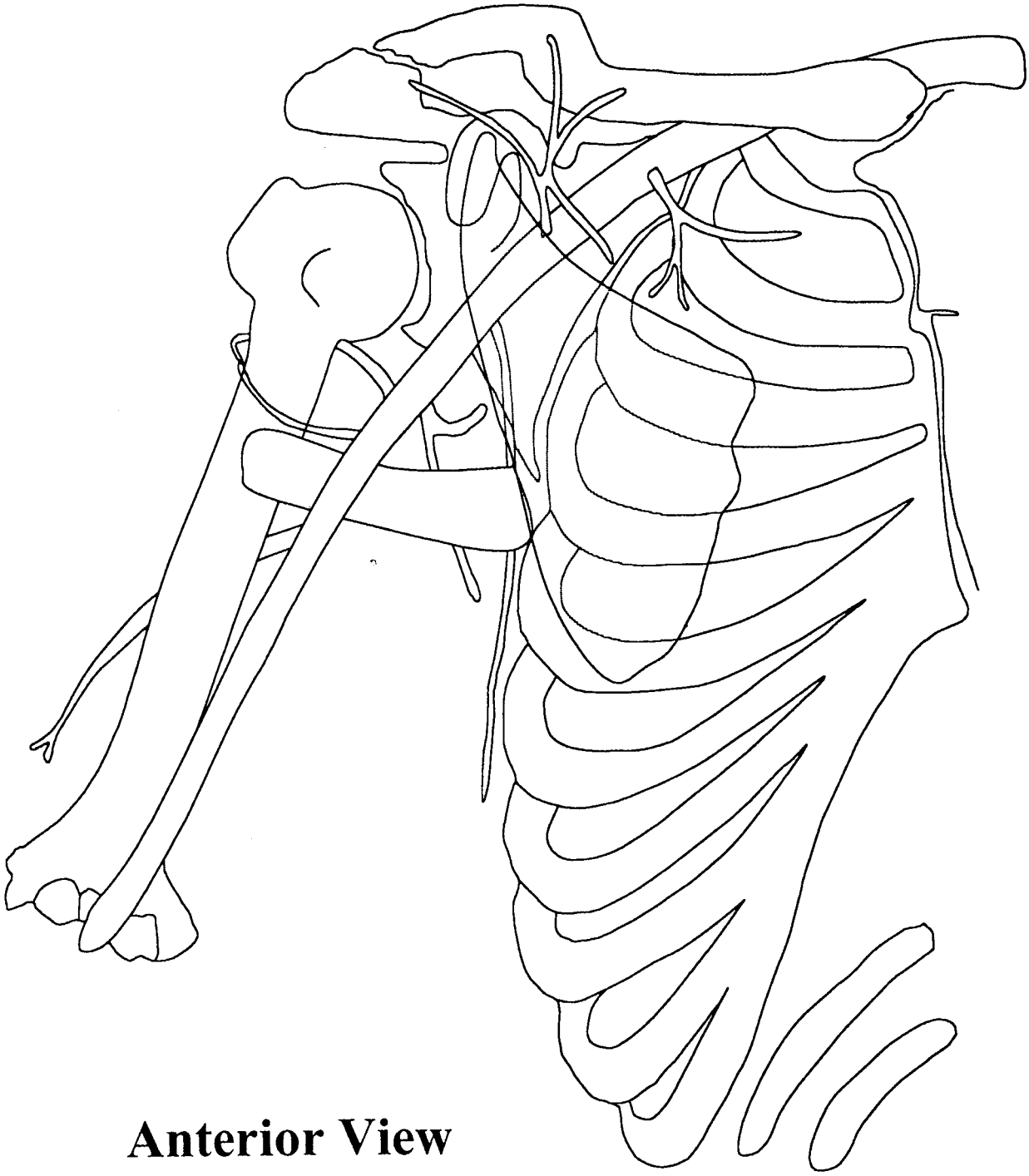
Lateral



Medial

Posterior

Axillary Artery

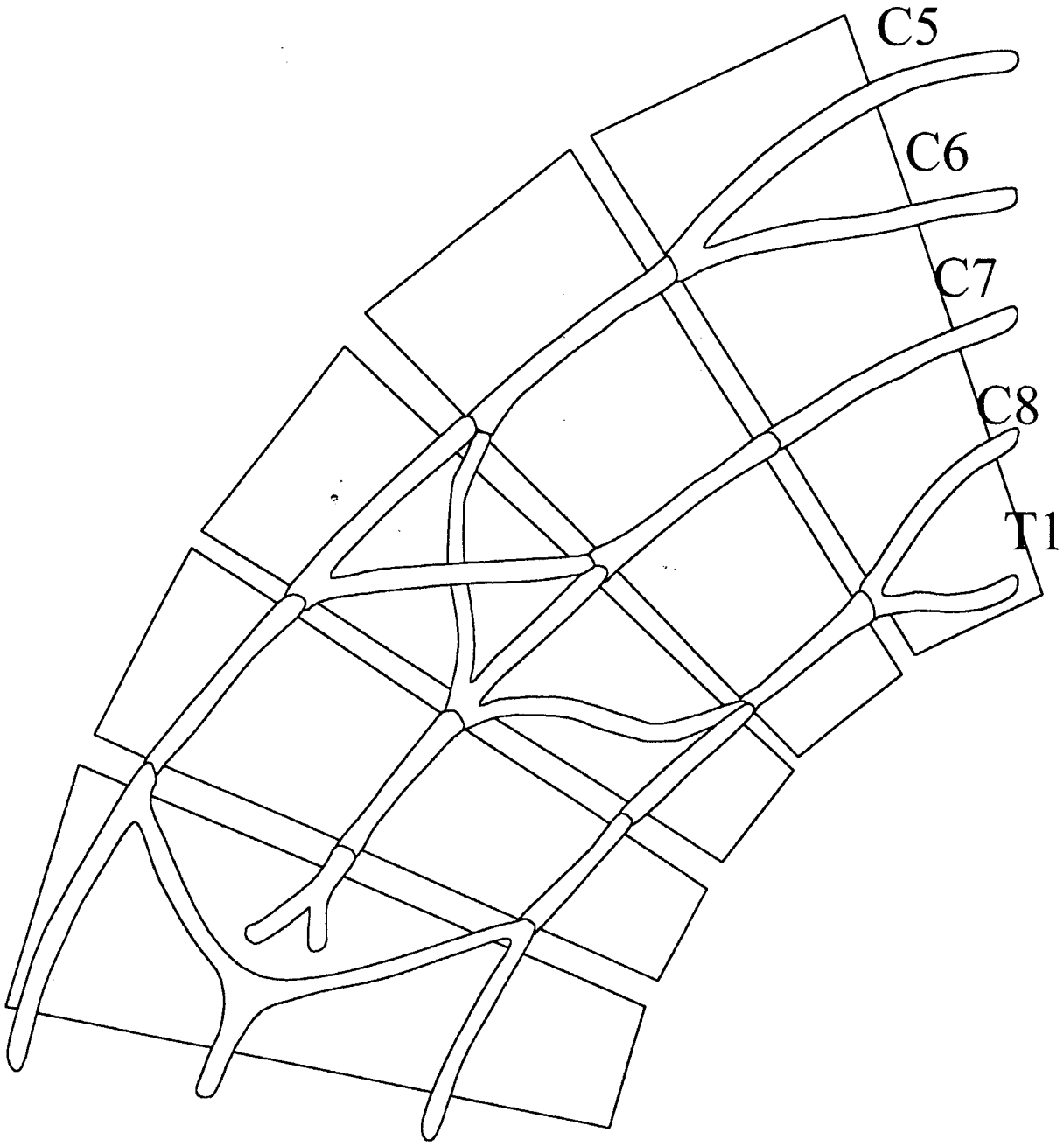


Anterior View

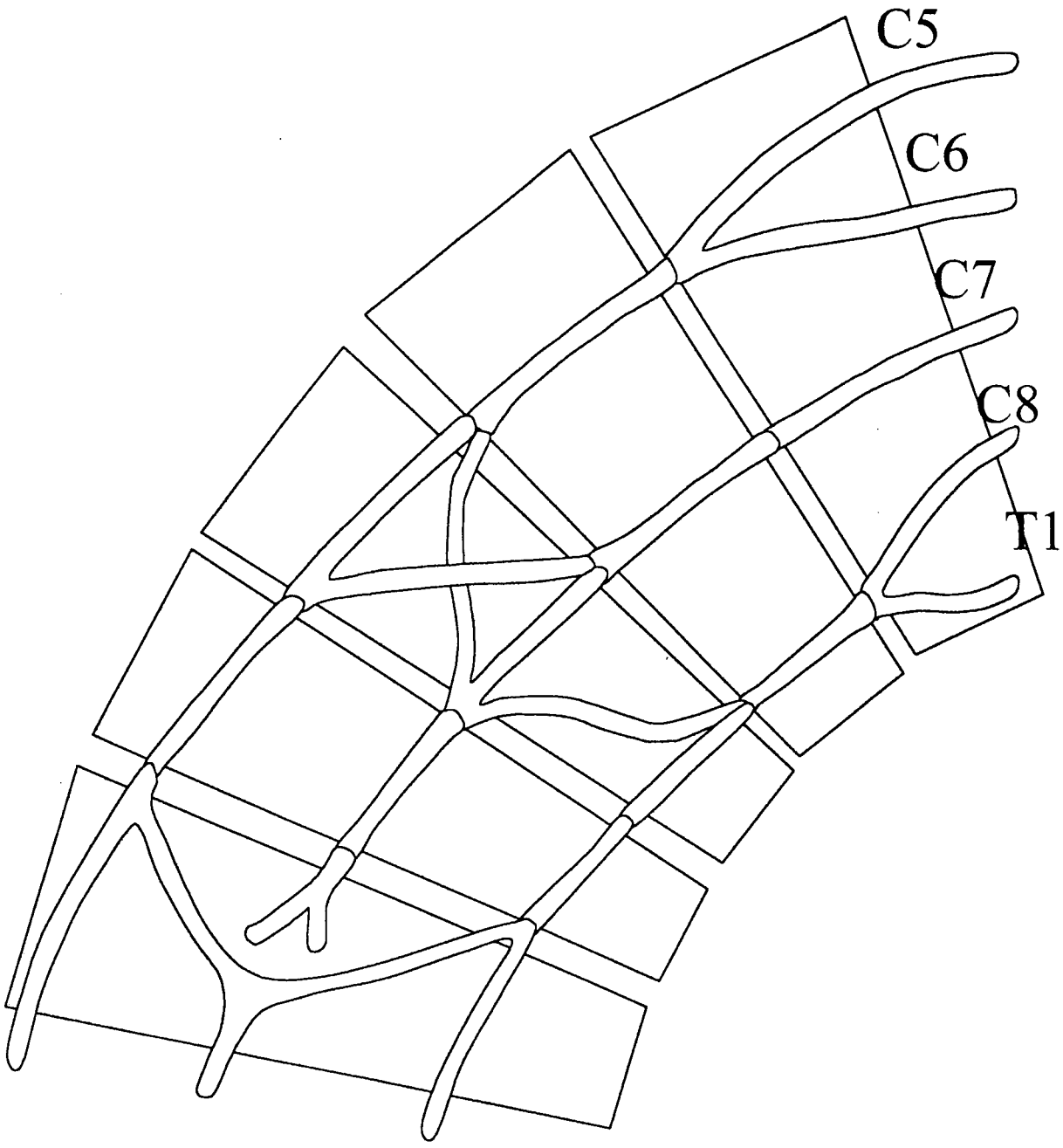
Shoulder Anastomoses

Posterior View

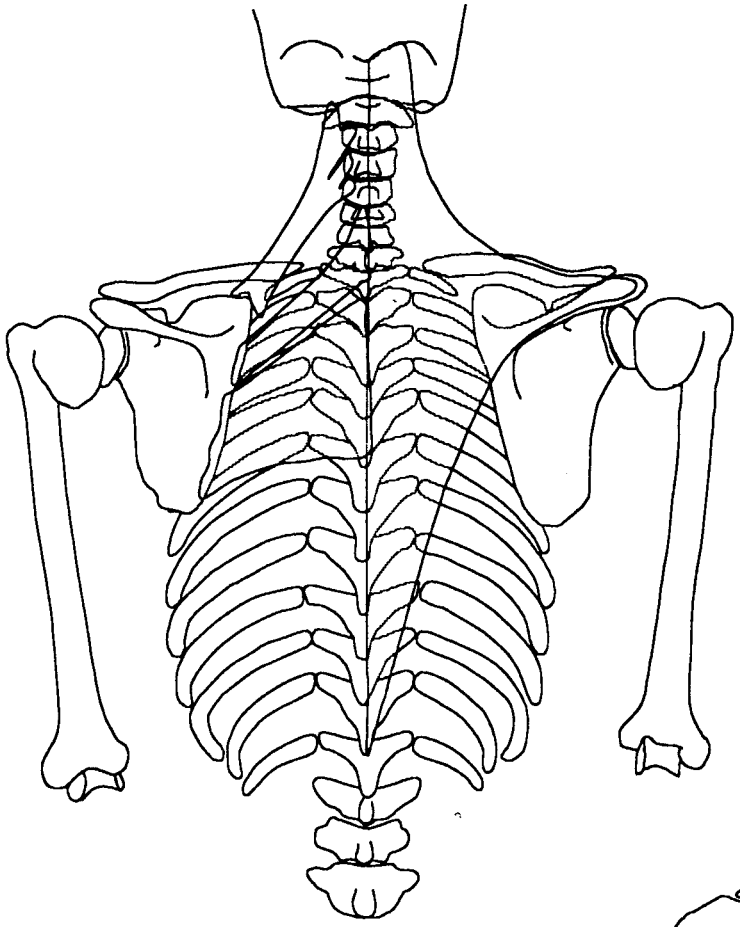
Brachial Plexus



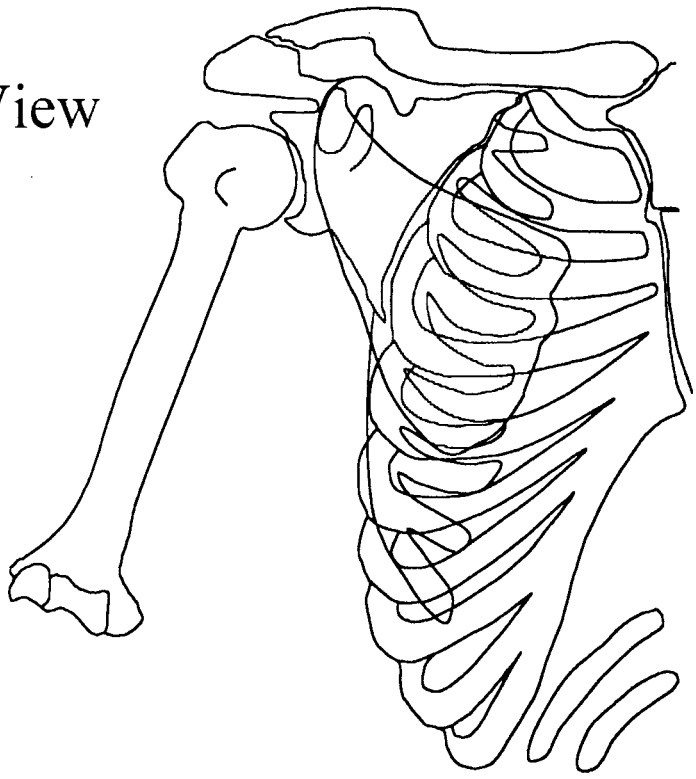
Brachial Plexus



Muscles Which Move the Scapula

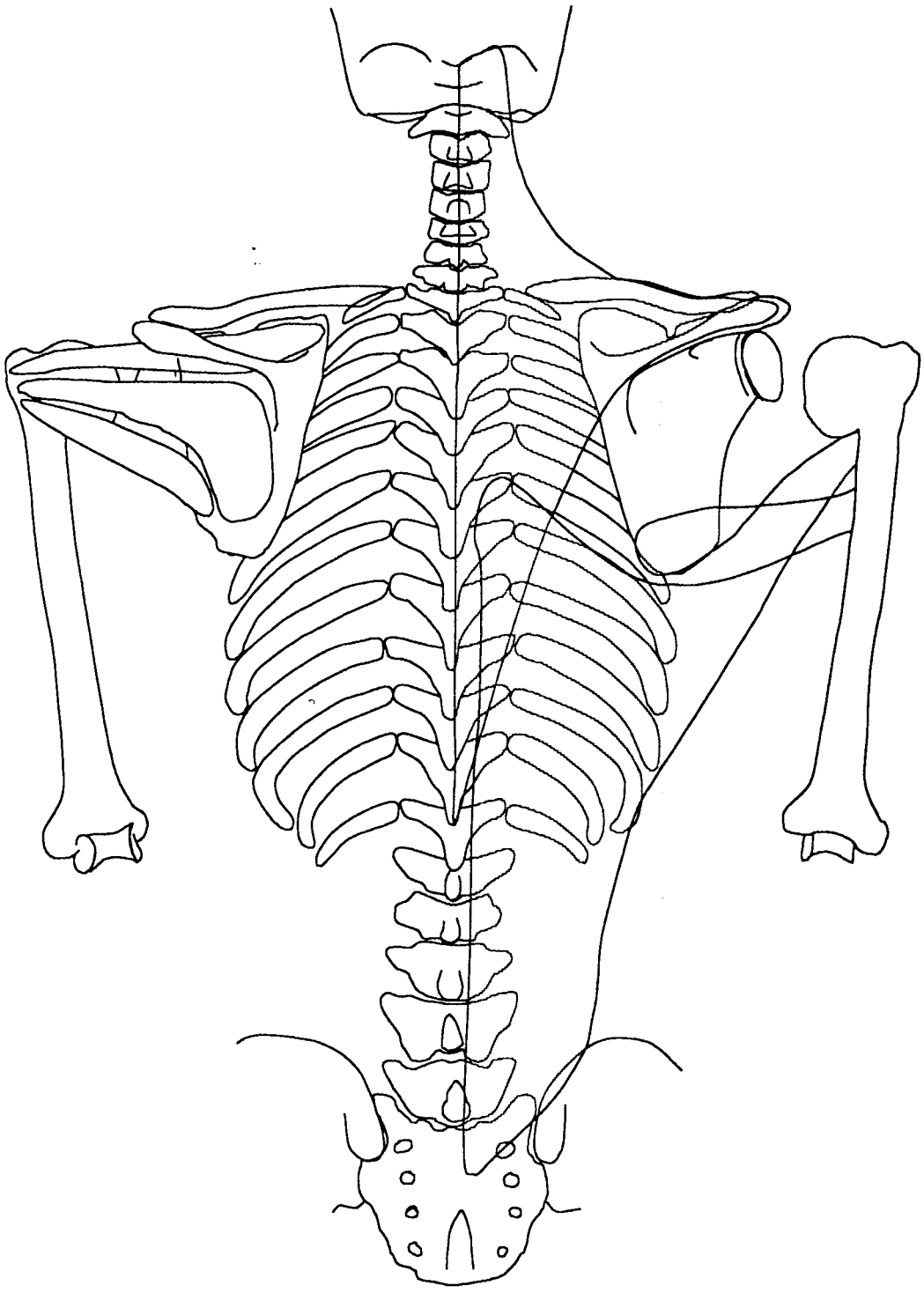


Posterior View



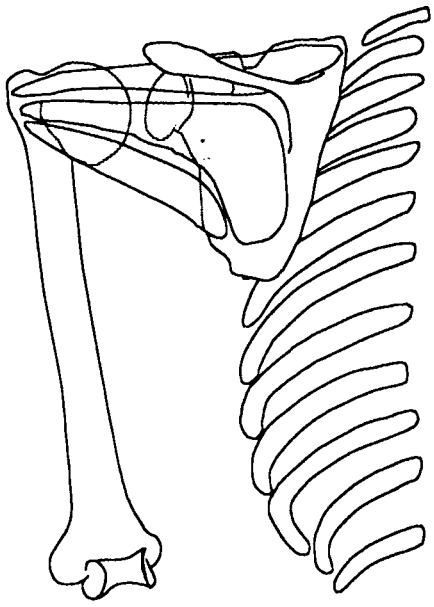
Anterior View

Muscles Which Act on the Humerus

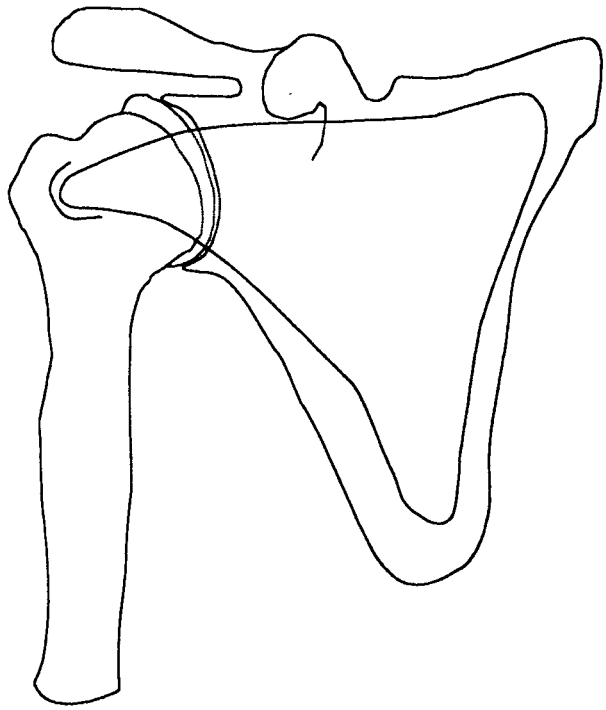


Posterior View

Muscles of the Rotator Cuff

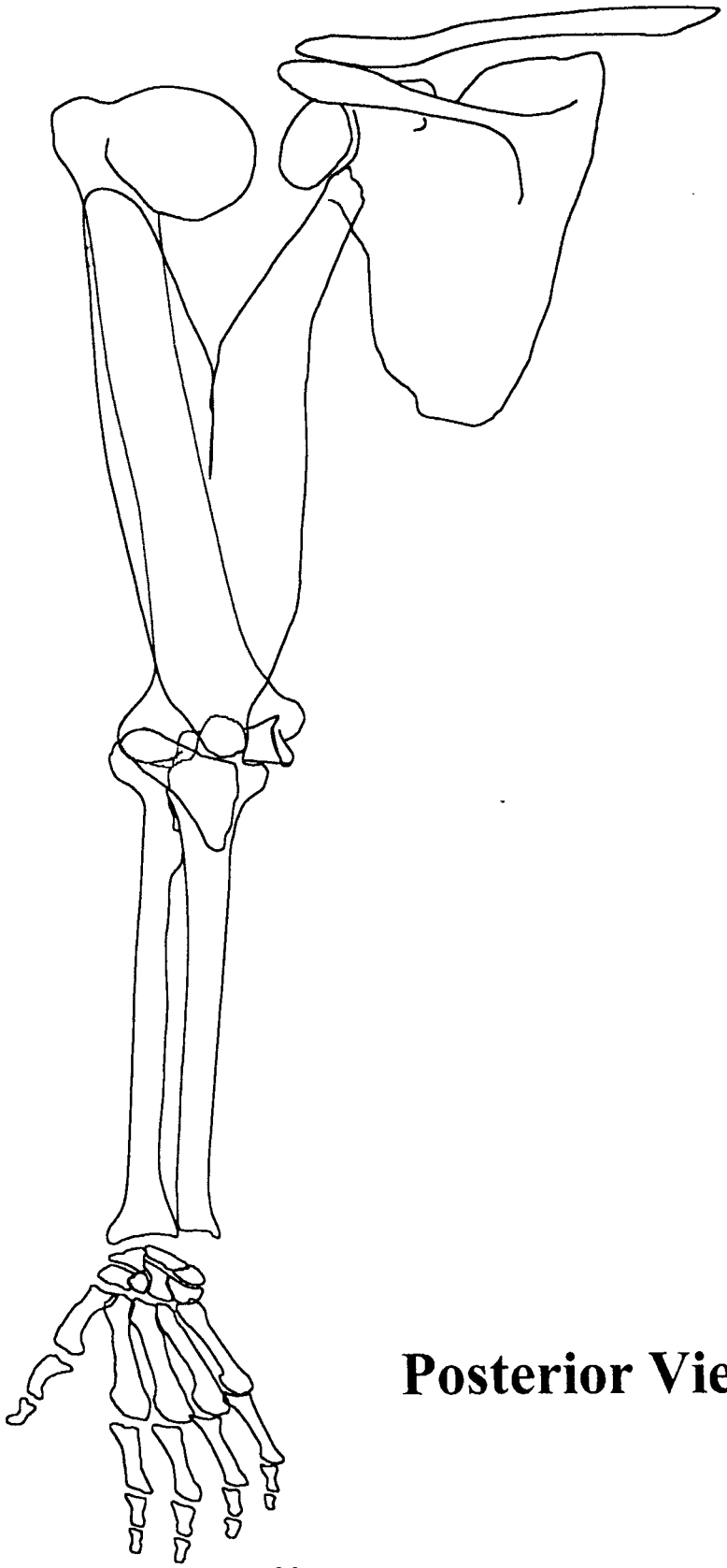


Posterior View



Anterior View

Posterior Arm Musculature

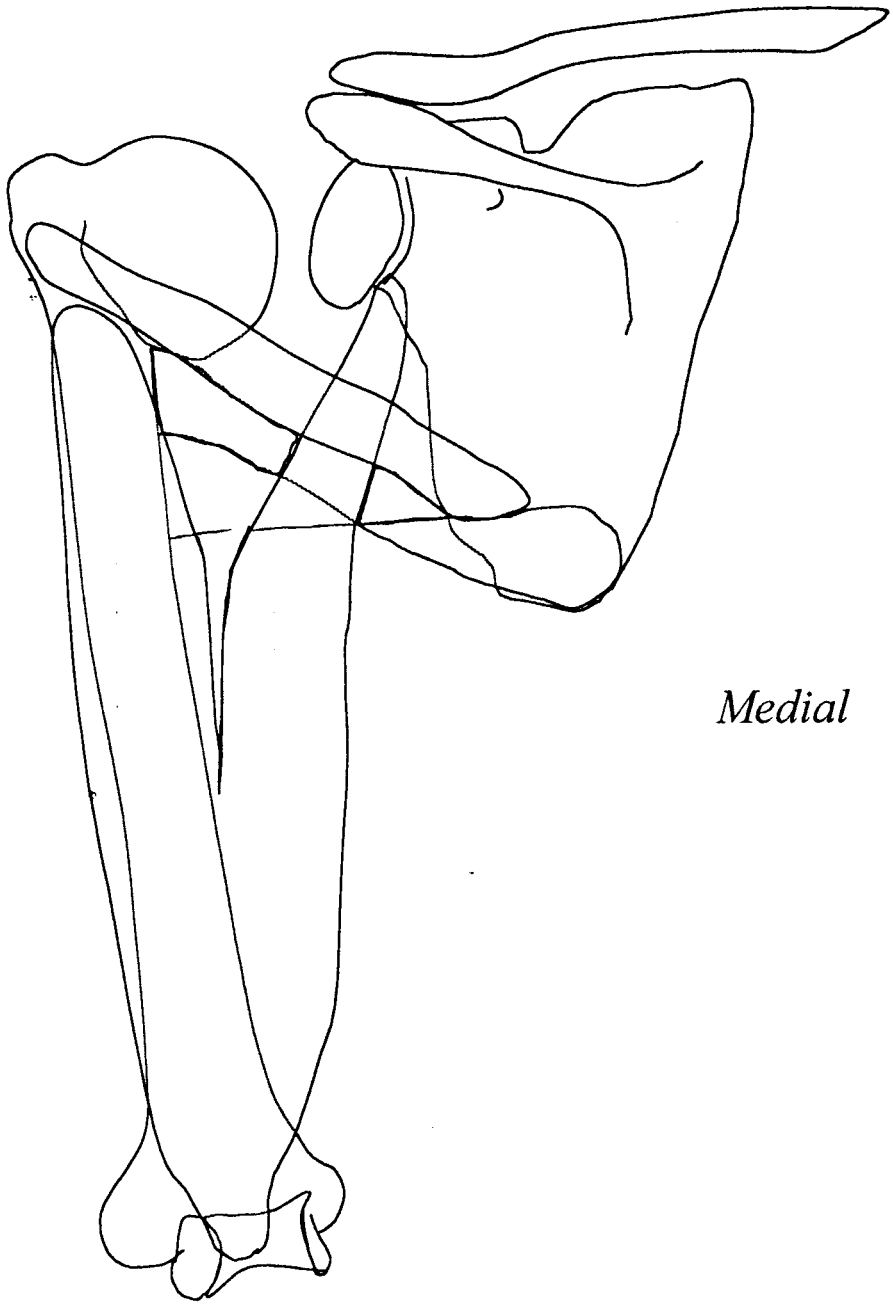


Lateral

Medial

Posterior View

Posterior Shoulder Spaces

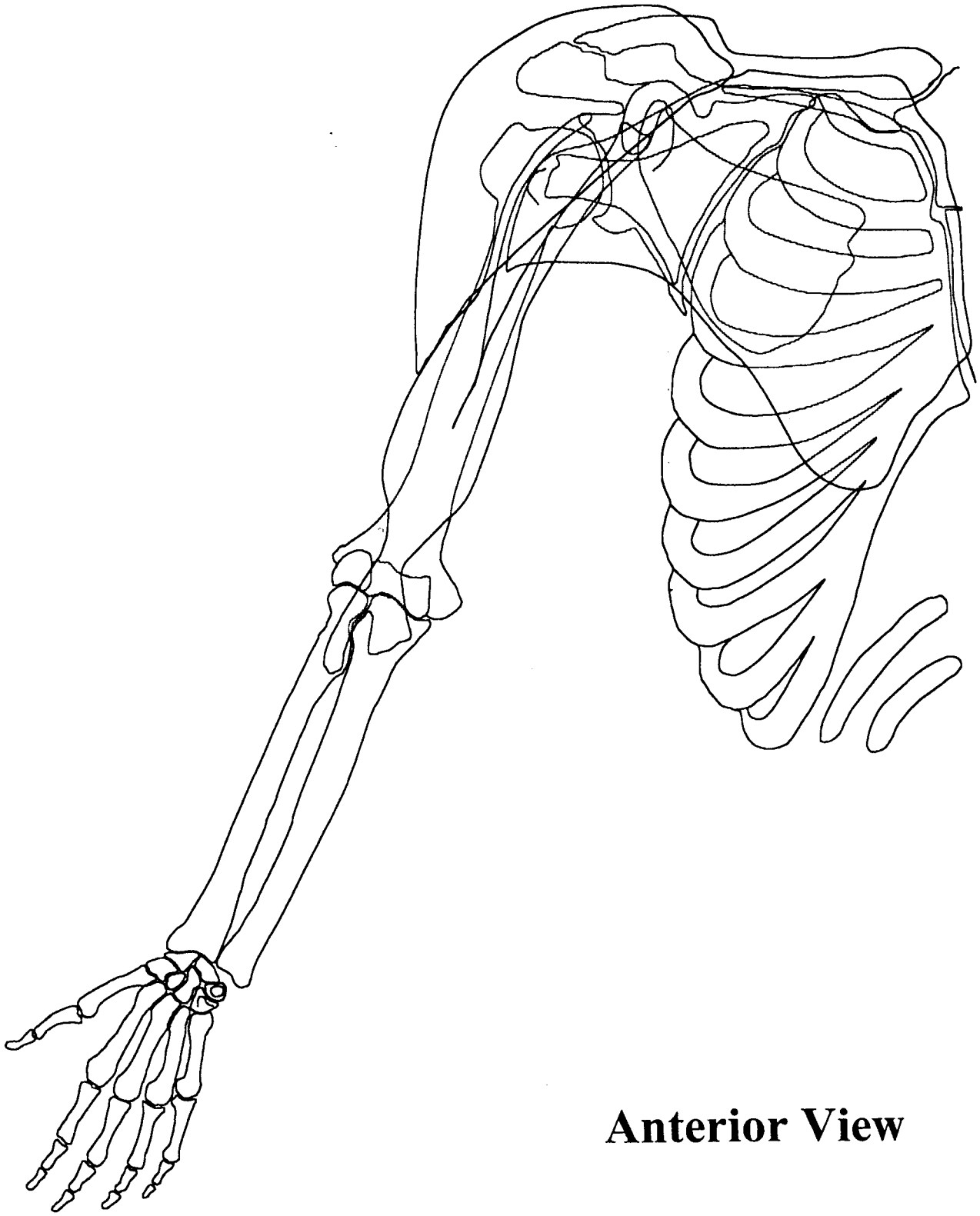


Lateral

Medial

Posterior View

Anterior Shoulder Musculature



Anterior View

Laboratory Assignment
Arm and Elbow

Humerus
- Capitulum
- Trochlea
- Olecranon Fossa

Interosseous Membrane
Oblique Cord
Radius
- Radial Head
- Radial Neck
- Radial Tuberosity
- Styloid Process

Ulna
- Olecranon
- Trochlear Notch
- Coronoid Process
- Ulnar Tuberosity
- Styloid Process

Subclavius
Coracobrachialis
Brachialis
Brachioradialis
Biceps Brachii
Musculocutaneous Nerve
Intermuscular Septum

Nutrient Artery
Middle Collateral Artery
Deep Brachial Artery
Superior Ulnar Collateral Art.
Inferior Ulnar Collateral Art.
Recurrent Interosseous Art.
Radial Recurrent Artery
Posterior Ulnar Recurrent Art.
Anterior Ulnar Recurrent Art
Radial Artery
Ulnar Artery
Common Interosseous Art.
Anterior Interosseous Art.
Posterior Interosseous Art.
Supinator
Pronator Teres
Biceps Tendon
Bicipital Aponeurosis
Radial Nerve
- Superficial Branch
- Deep Branch

Overview of Arm and Forearm

- **Humerus**
  - Arm bone that participates in the elbow joint
- **Radius**
  - Lateral bone of the forearm
- **Ulna**
  - Medial bone of the forearm
- **Interosseous Membrane and Oblique Cord**
  - Tendinous structures that connect the radius and ulna
- **Styloid Process of the Radius and Ulna**
  - Distal bony projections of the radius and ulna

Bony Structures of the Radius

- **Radial Head**
  - Proximal end of the radius that articulates with the capitulum of the humerus
- **Radial Neck**
  - Located between the radial head and the radial tuberosity
- **Radial Tuberosity**
  - Insertion point for the biceps brachii tendon
- **Styloid Process**
  - Distal bony enlargement of the radius

Bony Structures of the Ulna

- **Olecranon**
  - Distal bony prominence of the elbow
- **Trochlear Notch**
  - Notch between the olecranon and the coronoid process that articulates with the trochlea of the humerus
- **Coronoid Process**
  - Anterior bony portion of the trochlear notch
- **Ulnar Tuberosity**
  - Bony protuberance inferior to the coronoid process
- **Styloid Process**
  - Distal bony enlargement of the ulna

Articulations at the Elbow

- Elbow joint is a hinge type joint that consists of three distinct articulations
  - (1) Spool shaped trochlea of the humerus with the olecranon process of the ulna
  - (2) Spheroidal capitulum articulates with the head of the radius
  - (3) Proximal radioulnar joint (pivot joint) that allows for movement of the head of the radius on the ulna during pronation-supination of the forearm

Muscles of the Arm and Shoulder Joint

Coracobrachialis
Origin: Coracoid process of the scapula
Insertion: Medial mid-shaft of the humerus
Action: Flexion and adduction of the upper extremity and medial rotation of the shoulder
Innervation: Musculocutaneous nerve

Brachialis
Origin: Distal half of the anterior surface of the humerus
Insertion: Ulnar tuberosity
Action: Primary flexor at the elbow joint
Innervation: Musculocutaneous nerve

Brachioradialis
Origin: Distal two-thirds of the lateral epicondyle (supracondylar ridge) of the humerus
Insertion: Distal end of the radius at the styloid process.
Action: Flexion of the elbow, pronation from a supinated position to neutral and supination from the pronated position to neutral. This muscle can be palpated on the lateral anterior side of the forearm. **Innervation:** Radial nerve

Biceps Brachii ("Corkscrew muscle")
Origin: Long head originates on the supraglenoid tubercle of the scapula, while the short head originates on the coracoid process of the scapula
Insertion: Both heads join together and then insert into the radial tuberosity. Also, the bicipital aponeurosis fuses with the deep fascia over the upper medial side of the forearm
Action: Primary supinator of the forearm, elbow flexion, and flexion at the shoulder joint
Innervation: Musculocutaneous nerve

Elbow Anastomoses

- Superior Ulnar Collateral with the Posterior Ulnar Recurrent
- Inferior Ulnar Collateral with the Anterior Ulnar Recurrent
- Deep Brachial (Profunda Brachii) with the Radial Recurrent
- Middle Collateral with the Recurrent Interosseous

Cubital Fossa

- Triangular depression on the anterior elbow surface
- Boundaries include:
  - ***Base:*** Imaginary line drawn between the two epicondyles of the humerus
  - ***Laterally:*** Brachioradialis muscle
  - ***Medially:*** Pronator teres muscle
  - ***Floor:*** Supinator muscle laterally and the brachialis muscle medially
  - ***Roof:*** Roof is formed by the skin and fascia and is reinforced by the bicipital aponeurosis

Contents of the Cubital Fossa

- From Lateral to Medial
  - Radial nerve
  - Tendon of the Biceps Brachii
  - Brachial artery (Bifurcation into the radial and ulnar arteries)
  - Median nerve

Additional Muscles at Elbow

Supinator
Origin: Lateral epicondyle and the radial collateral and annular ligaments
Insertion: Lateral side of proximal radius
Action: Supinates forearm
Innervation: Deep Radial nerve

Pronator Teres
Origin: Arises from two heads. Humeral head arises from the upper part of the medial condyle, and the ulnar head arises from the coronoid process of the ulna
Insertion: Lateral side of the middle radius
Action: Pronates forearm
Innervation: Median nerve as it dives between the two heads

Notes at Elbow

- Brachial Artery
- Radial Nerve
- Musculocutaneous Nerve
- Median Nerve
- Ulnar Nerve

Brachial Artery

- Direct continuation of the Axillary artery
- Brachial artery and the median nerve enter the cubital fossa on the anterior surface of Brachialis
- Accompanied by two brachial veins
- Will split into the Radial and Ulnar arteries
- Radial artery gives off the Radial Recurrent
- Ulnar artery gives off the Common Interosseous which will eventually give off the Recurrent Interosseous, Posterior Interosseous and Anterior Interosseous arteries

Radial Nerve

- Traverses the spiral groove on the posterior aspect of the humerus
- Gives off the Posterior Antebrachial Cutaneous Nerve before exiting the axilla
- Pierces the lateral intermuscular septum proximal to the elbow and lies against brachialis
- Innervates the Brachioradialis and Extensor Carpi Radialis Longus
- Splits into a deep (motor) and superficial branch (cutaneous)
- Deep Radial Nerve will innervate Supinator, Extensor Carpi Radialis Brevis, Extensor Digitorum, Extensor Digiti Minimi, and Extensor Carpi Ulnaris and becomes the Posterior Interosseous Nerve

Musculocutaneous Nerve

- Pierces Coracobrachialis
- Emerges at the elbow lateral to the tendon of the biceps
- Continues into the forearm as the lateral antebrachial cutaneous nerve

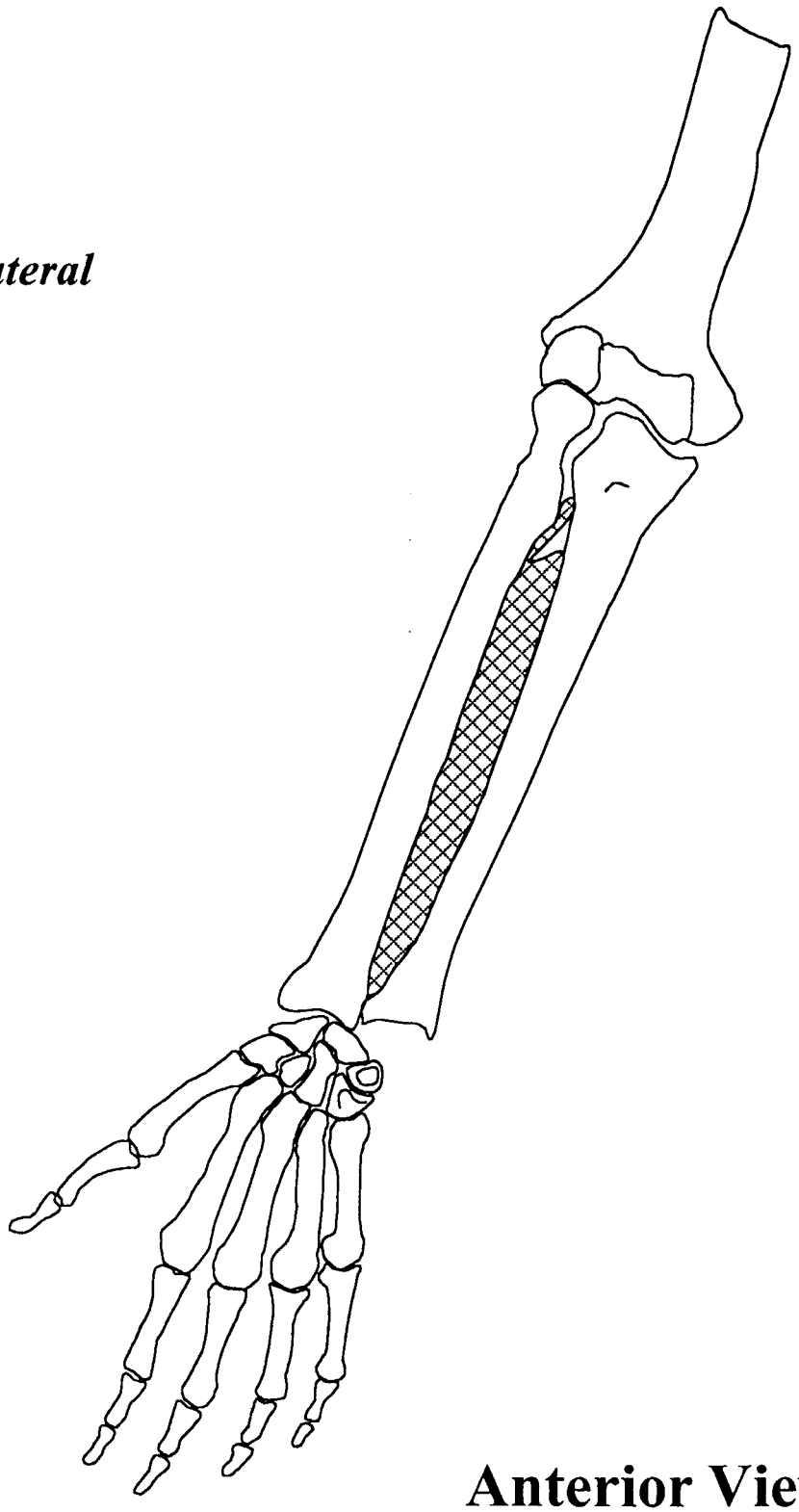
Median nerve

- Runs downward on the axillary and brachial arteries
- Crosses anteriorly to the brachial artery and lies medial to the brachial artery and will lie on the anterior surface of Brachialis
- No branches in the arm
- First muscular branch is to Pronator Teres as it dives between the two heads of origin
- Provides majority of innervation to forearm flexors
- Gives off the Anterior Interosseous nerve as it proceeds posterior to Flexor Digitorum Superficialis

Ulnar Nerve

- Proceeds down the arm posteromedially to the brachial artery
- Passes through the medial intermuscular septum in the middle of the arm and will lie on the medial aspect of the Triceps brachii
- Passes behind the medial epicondyle ("Funny Bone") and between the two heads of Flexor Carpi Ulnaris

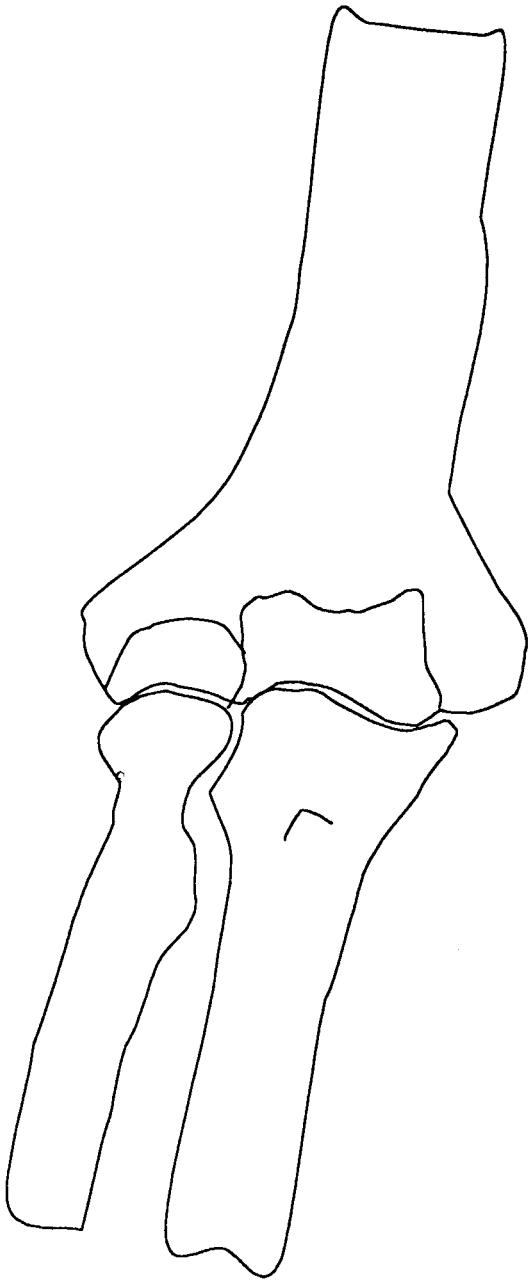
Arm, Elbow and Forearm



Anterior View

Close-up Elbow

Lateral

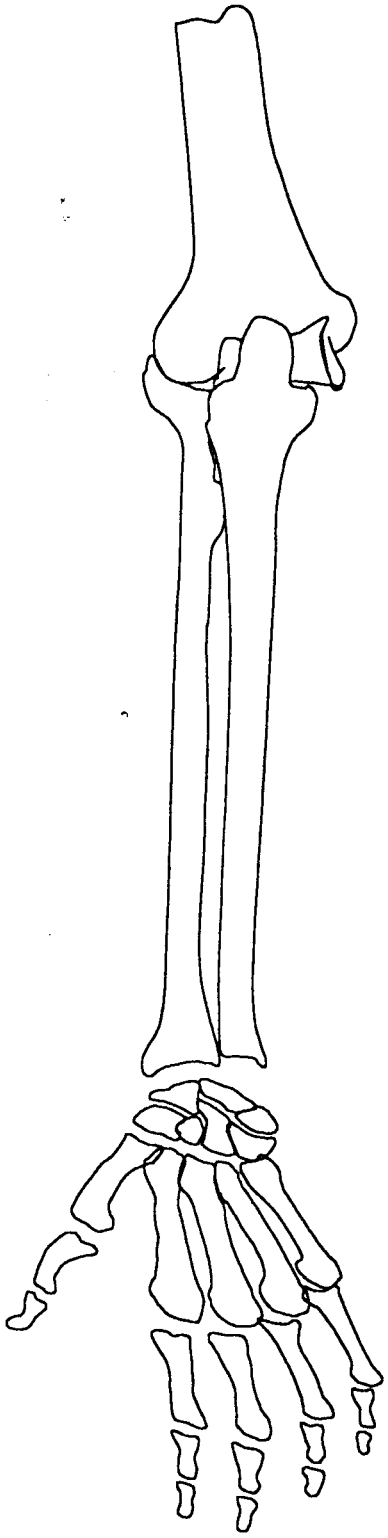


Medial

Anterior View

Elbow

Lateral

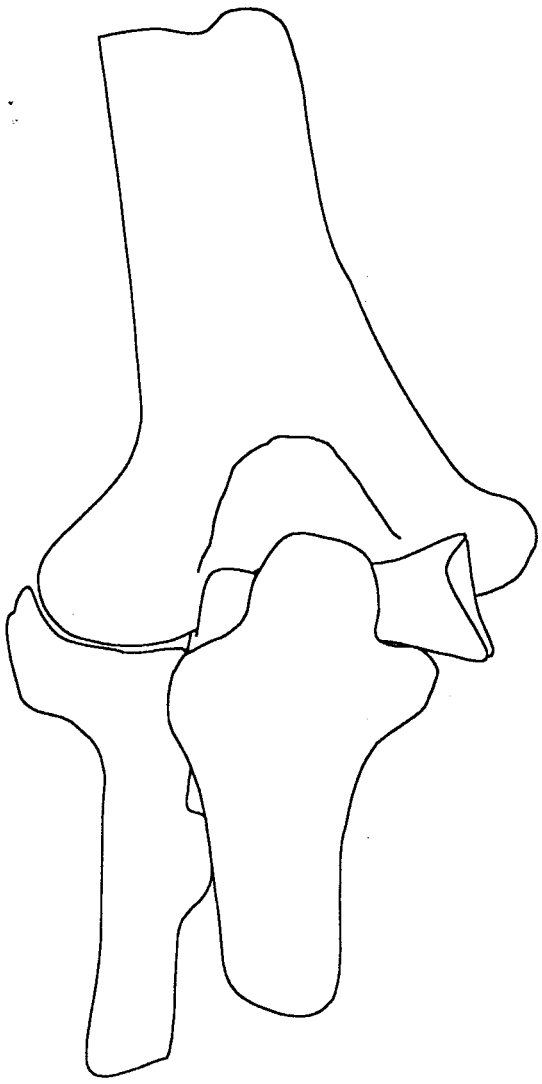


Medial

Posterior View

Close-up Elbow

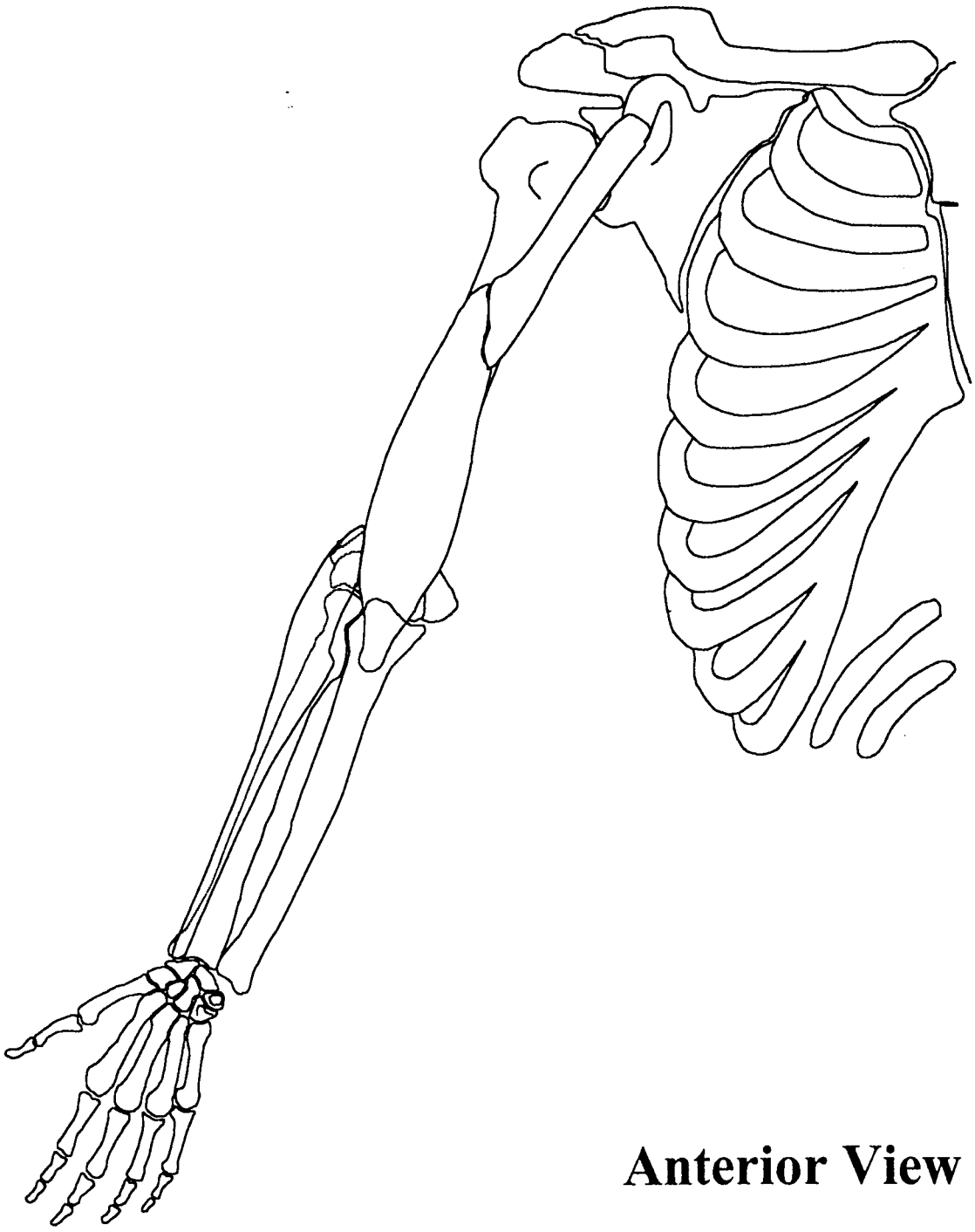
Lateral



Medial

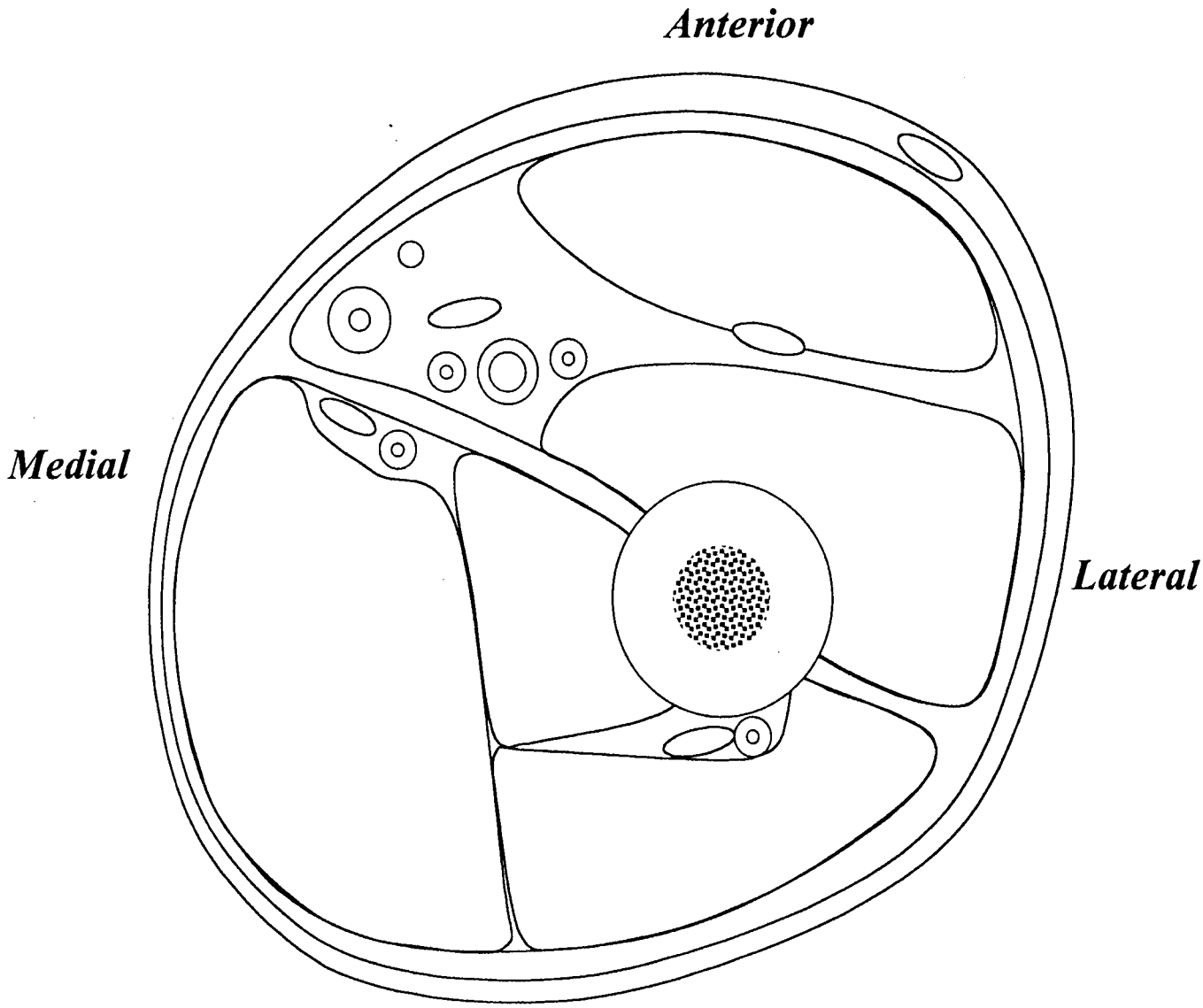
Posterior View

Arm



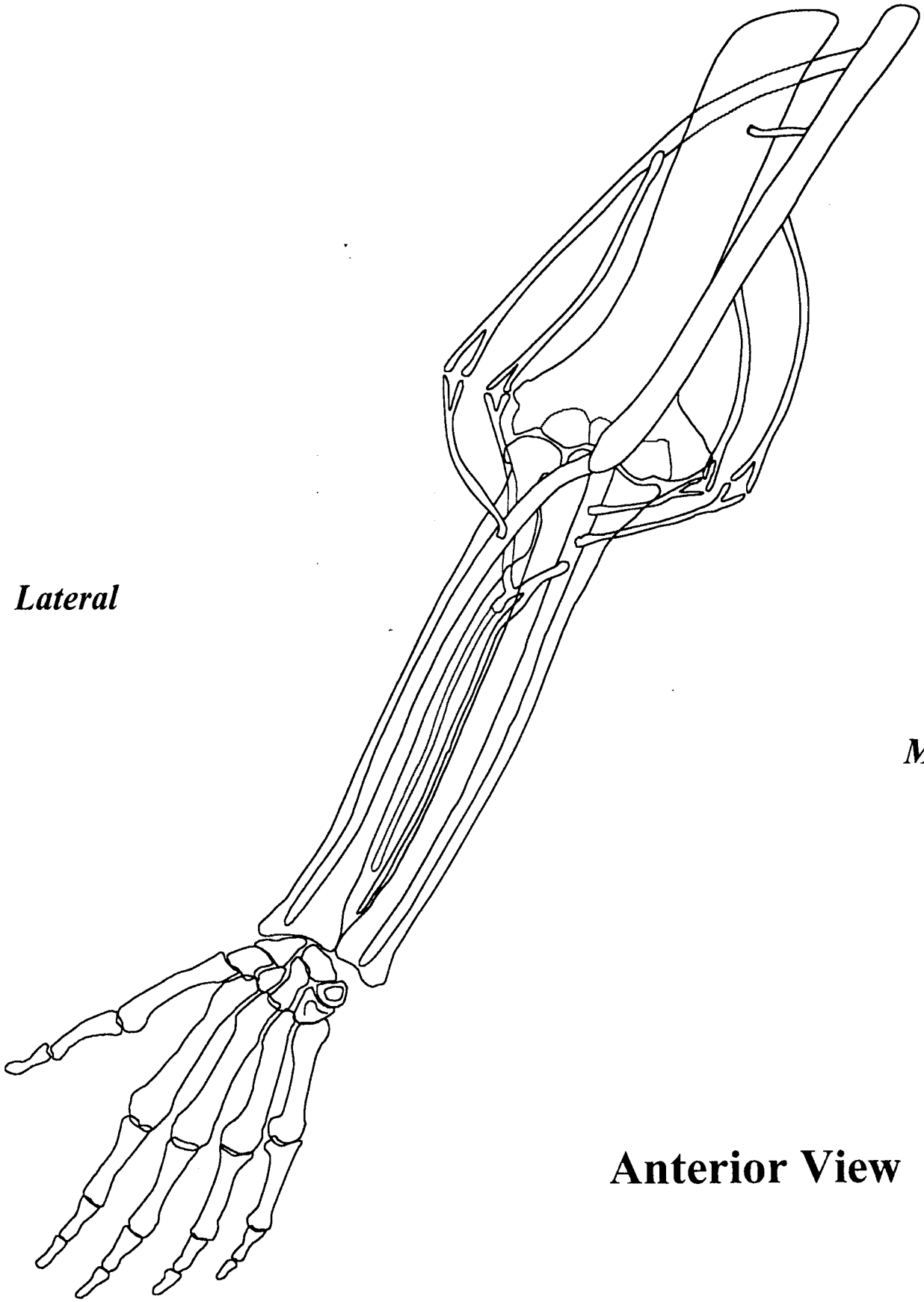
Anterior View

Right Arm



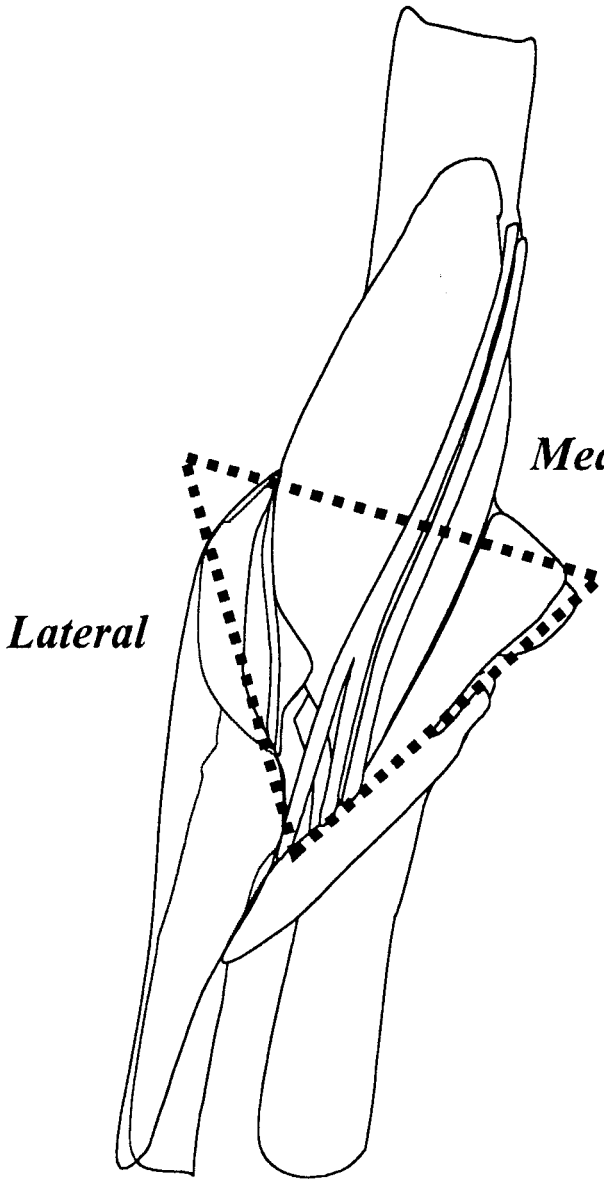
Cross section at Mid-humerus

Elbow Anastomoses

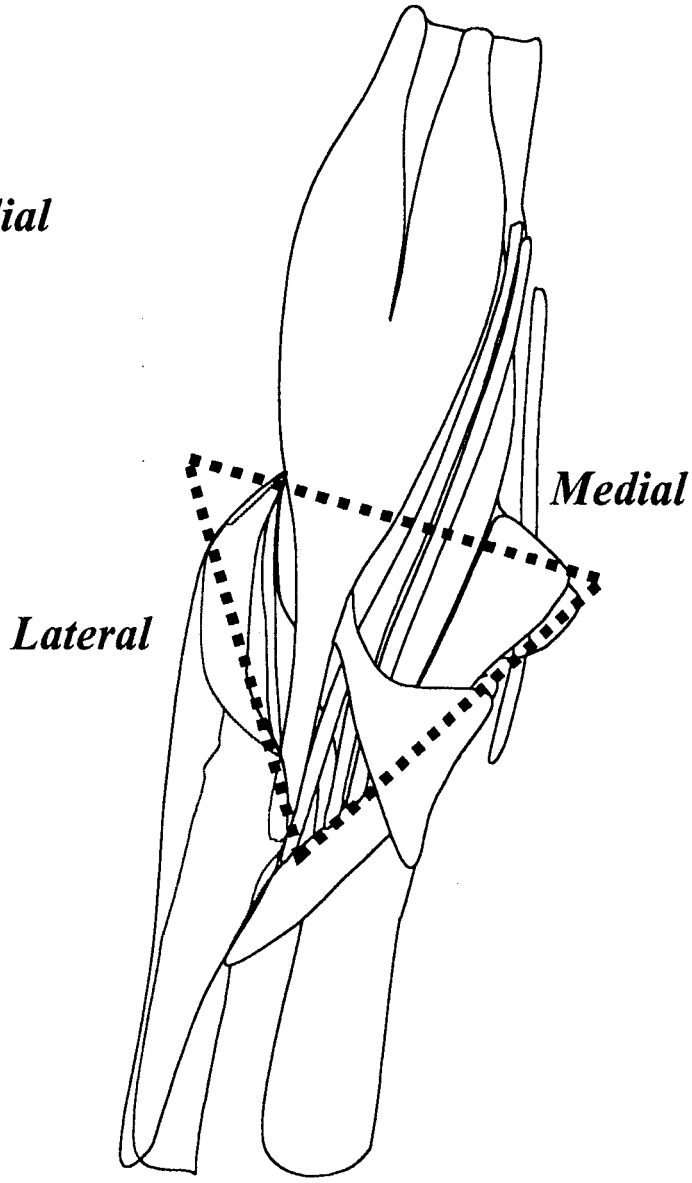


Anterior View

Cubital Fossa



Anterior View



Anterior View

Laboratory Assignment
Forearm

Flexor Components

Medial Epicondyle
Ulnar nerve
Median Nerve
Interosseous Membrane
Pronator Teres
Palmaris Longus
Flexor Carpi Radialis
Flexor Carpi Ulnaris
Flexor Digitoum Superficialis
Flexor Digitorum Profundus
Flexor policies Longus
Pronator Quadratus
Anterior Interosseous Nerve
Anterior Interosseous Artery
Flexor Retinaculum

Extensor Components

Brachioradialis
Extensor Carpi Radialis Longus
Extensor Carpi Radialis Brevis
Extensor Carpi Ulnaris
Extensor Digitorum
Extensor Digiti Minimi
Supinator
Extensor Indicis
Abductor Pollicis Longus
Extensor Pollicis Brevis
Extensor Pollicis Longus
Radial Nerve
Superficial Branch of the Radial Nerve
Deep Branch of the Radial Nerve
Posterior Interosseous Nerve

Superficial Flexor Muscles of the Forearm

Layer 1: Superficial Group

Pronator Teres
Origin: (Humeral Head) Common flexor tendon on the medial epicondyle and on the (Ulnar Head) medial side of the ulna
Insertion: Superior one-third to middle of the lateral surface of the radius
Action: Pronator of the forearm and a flexor of the elbow joint. Very prominent when the forearm is strongly flexed and pronated
Innervation: Median nerve

Palmaris Longus
Origin: Deep fascia and common flexor tendon of the medial epicondyle of the humerus
Insertion: Palmar aponeurosis of the second, third, fourth and fifth metacarpals
Action: Flexion of the wrist and weak flexion of the elbow
Innervation: Median nerve

Flexor Carpi Radialis
Origin: Medial epicondyle of the humerus
Insertion: Base of the second and third metacarpal
Action: Wrist flexion and abduction, and also weak elbow flexion. This muscle can be palpated on the anterior surface of the wrist in line with the second and third metacarpals
Innervation: Median nerve

Flexor Carpi Ulnaris
Origin: Two heads of origin. One from the common flexor tendon on the medial epicondyle of the humerus and the other head of origin from the posterior superior aspect of the proximal ulna
Insertion: Pisiform, hamate and the base of the fifth metacarpal
Action: Wrist flexion, wrist adduction with the extensor carpi ulnaris and weak elbow flexion
Innervation: Ulnar nerve

Intermediate Flexor Muscles of the Forearm

Intermediate Layer of Forearm Flexors
The intermediate layer of the forearm flexors consists of one muscle, the flexor digitorum superficialis. This muscle will be responsible for flexion of the wrist and also flexion of the fingers at the MP and PIP joints, but not the DIP joints.

Flexor Digitorum Superficialis
Origin: Two heads of origin. The Humeroulnar head arises from the common flexor tendon on the medial epicondyle and from the the medial portion of the coronoid process of the ulna. The radial head arises from the superior anterior portion of the radius
Insertion: At the insertion points, each tendon splits and attaches to the sides of the middle phalanx of the four fingers
Action: Wrist flexion, weak flexion of the elbow, and flexion of the fingers at the metacarpophalangeal and proximal interphalangeal joints
Innervation: Median nerve

Deep Flexor Muscles of the Forearm

Deep Layer of Forearm Flexors
The deep layer of the forearm flexors consists of three muscles flexor pollicis longus, flexor digitorum profundus and pronator quadratus. The flexor pollicis longus and the flexor digitorum profundus are responsible for flexing the MP, PIP and DIP joints of the fingers and thumb. The pronator quadratus lies deep to the flexor pollicis longus and the flexor digitorum profundus and helps bind the distal ends of the radius and ulna together and also assists with pronation of the forearm. The anterior interosseous nerve (Median nerve) innervates the flexor pollicis longus, pronator quadratus and the lateral (radial) half of the flexor digitorum profundus.

Deep Flexor Muscles of the Forearm

Layer 3: Deep Group

Flexor Pollicis Longus
Origin: Middle anterior surface of the radius and the adjacent interosseous membrane
Insertion: Distal phalanx of the thumb
Action: Flexion of the thumb at the carpometacarpal, metacarpophalangeal, and interphalangeal joints, and weak flexion at the wrist, and can be palpated on the anterior surface of the thumb
Innervation: Anterior interosseous nerve (Median Nerve)

Pronator Quadratus
Origin: Distal fourth of the anterior surface of the ulna
Insertion: Distal fourth of the anterior surface of the radius
Action: The pronator quadratus helps bind the radius and ulna together and pronates the forearm
Innervation: Anterior interosseous nerve (Median Nerve)

Flexor Digitorum Profundus
Origin: Proximal three-fourths of the anterior and medial surface of the ulna
Insertion: Distal phalanges of the four fingers
Action: Flexion of the four fingers at the metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints, and also wrist flexion.
Innervation: The medial half is innervated by the Ulnar nerve and the lateral half is innervated by the Anterior interosseous nerve (Median Nerve).

Median Nerve

- Leaves cubital fossa by passing through the two heads of Pronator Teres and innervating Flexor Carpi Radialis, Palmaris Longus, and Flexor Digitorum Superficialis
- Gives off the Anterior Interosseous nerve that supplies the radial side of Flexor Digitorum Profundus, Flexor Pollicis Longus and Pronator Quadratus
- Passes deep to the flexor retinaculum (carpal tunnel) and enters the hand

Ulnar Nerve

- Enters the forearm by passing between the two heads of the Flexor Carpi Ulnaris
- Emerges with the Ulnar artery just proximal to the wrist and crosses the anterior surface of the flexor retinaculum
- Will innervate the Flexor Carpi Ulnaris and the medial (ulnar) half of Flexor Digitorum Profundus

Superficial Forearm Extensors

Superficial Group

Extensor Carpi Radialis Longus
Origin: Lower third of the lateral supracondylar side of the humerus and lateral epicondyle
Insertion: Base of the second metacarpal
Action: Abduction and extension of the wrist and also weak extension at the elbow
Innervation: Radial nerve

Extensor Carpi Radialis Brevis
Origin: Lateral epicondyle of the humerus from the common extensor tendon
Insertion: Base of the third metacarpal
Action: Wrist extension and abduction and also weak extension at the elbow
Innervation: Deep Radial/Posterior Interosseous Nerve

Extensor Carpi Ulnaris
Origin: Lateral epicondyle of the humerus and posterior border of the ulna
Insertion: Medial base of the fifth metacarpal
Action: Extension and adduction of the wrist and also weak wrist extension
Innervation: Deep Radial/Posterior Interosseous Nerve

Extensor Digitorum
Origin: Lateral epicondyle of the humerus from the common extensor tendon
Insertion: Divides into four tendons as it crosses the wrist. Each of these tendons proceeds over the dorsal surface of the fingers and inserts on the middle and distal phalanges of each finger
Action: Extend the MP joint of digits 2-5 and extension at the wrist along with weak extension of the elbow
Innervation: Deep Radial/Posterior Interosseous

Extensor Digiti Minimi
Origin: Lateral epicondyle of the humerus and the ulnar side of extensor digitorum
Insertion: Base of the middle and distal phalanges of the little finger
Action: Extension of the little finger at the MP joint and also weak wrist extension.
Innervation: Deep Radial/Posterior Interosseous

Deep Forearm Extensors

Deep Extensors

Supinator
Origin: Lateral epicondyle of the humerus, oblique line of the ulna and the elbow joint
Insertion: Proximal lateral surface of the radius
Action: Supinates the forearm
Innervation: Deep Branch of the Radial nerve

Extensor Indicis
Origin: Middle to distal one third of the posterior ulna and the interosseous membrane
Insertion: Base of the distal phalanx of the index finger
Action: Extension of the index finger at the MP joint and weak wrist extension
Innervation: Posterior Interosseous Nerve (Radial Nerve)

Abductor Pollicis Longus
Origin: Posterior aspect of the radius, midshaft of the ulna and the interosseous membrane
Insertion: Base of the dorsal/radial surface of the first metacarpal
Action: Abduction of the thumb at the carpometacarpal joint and abduction of the wrist
Innervation: Posterior Interosseous Nerve (Radial Nerve)

Extensor Pollicis Brevis
Origin: Posterior surface of the lower middle radius and the interosseous membrane
Insertion: Base of the proximal phalanx of the thumb on the dorsal surface
Action: Extension of the thumb at the MP joint and weak wrist extension
Innervation: Posterior Interosseous Nerve (Radial Nerve)

Extensor Pollicis Longus
Origin: Posterior lateral surface of the lower middle ulna and the interosseous membrane
Insertion: Base of the distal phalanx of the thumb
Action: Extension of the wrist and thumb
Innervation: Posterior Interosseous Nerve (Radial Nerve)

Radial Nerve

- Supplies all the extensor muscles of the forearm
- Innervates Brachioradialis and Extensor Carpi Radialis Longus
- Splits into Deep and Superficial branches

Deep Branch of the Radial Nerve

- Pierces Supinator and will then supply Extensor Carpi Radialis Brevis, Extensor Digitorum, Extensor Digiti Minimi and Extensor Carpi Ulnaris
- Remaining portion is now called the Posterior Interosseous Nerve
- Posterior Interosseous nerve will innervate Abductor Pollicis Longus, Extensor Pollicis Brevis, Extensor Pollicis Longus and Extensor Indicis
- No motor branches to the hand

Superficial Radial Nerve

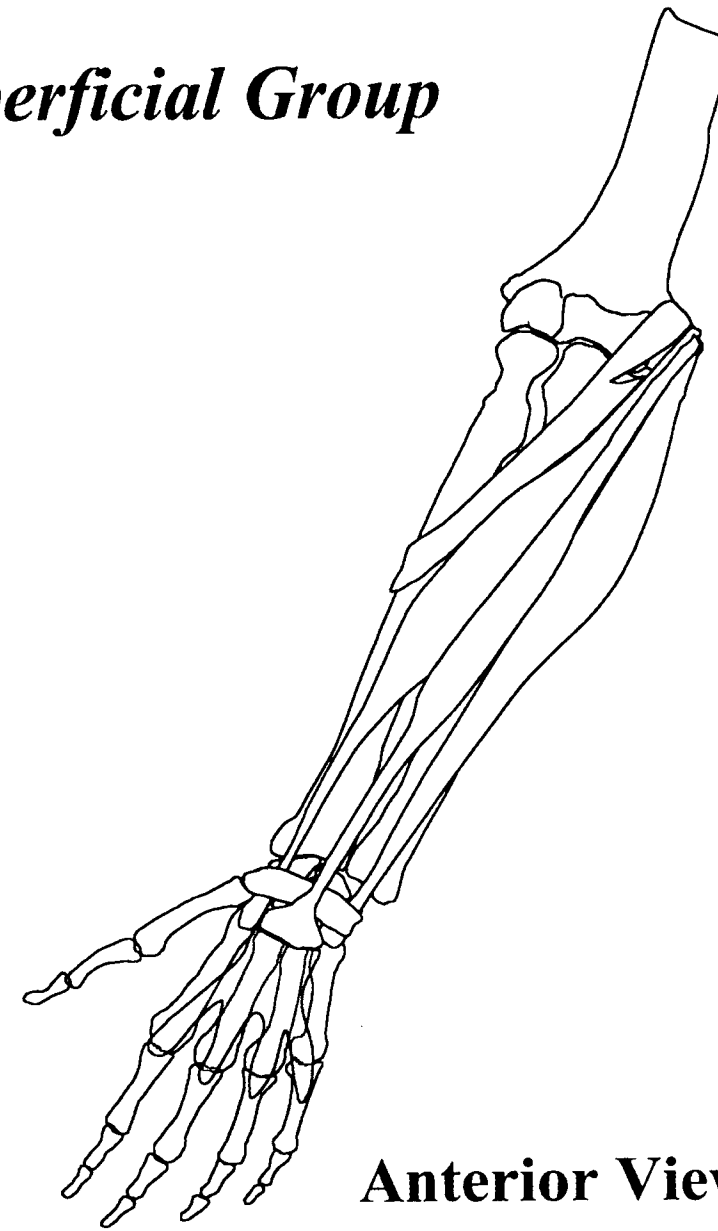
- Runs between Brachioradialis and Extensor Carpi Radialis Longus
- Passes posteriorly around the radius at the wrist
- Provides cutaneous innervation on the dorsal surface to the thumb and the adjacent two and one-half fingers as far as the nail beds

Superficial Flexor Muscles of the Forearm

Layer 1: Superficial Group

Lateral

Medial

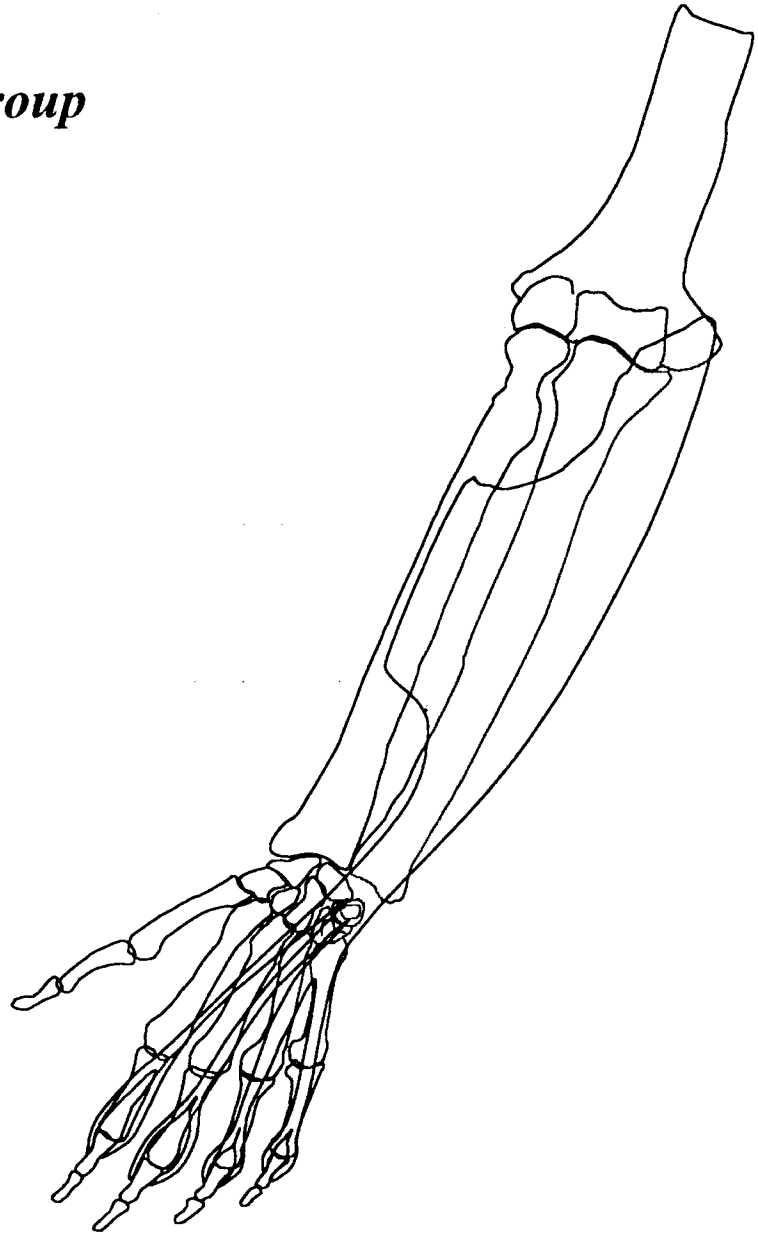


Anterior View

Intermediate Flexor Muscles of the Forearm

Layer 2
Intermediate Group

Lateral

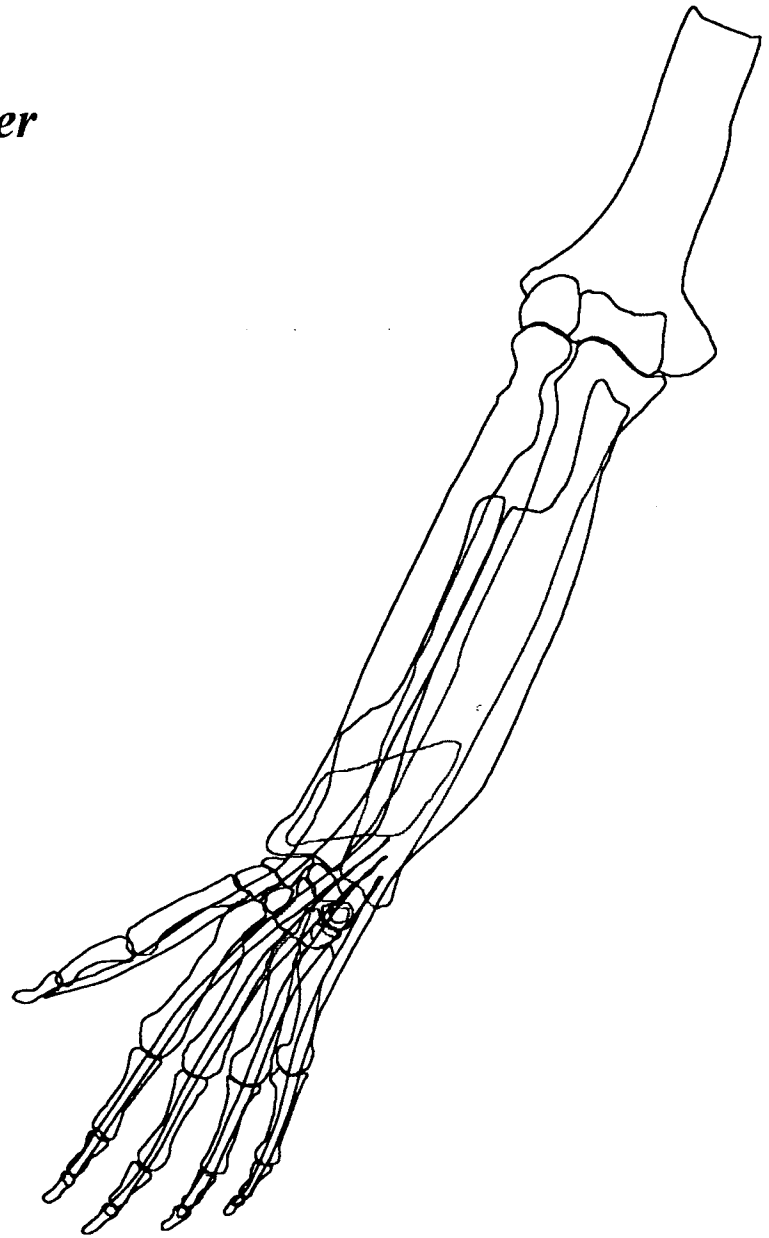


Medial

Deep Flexor Muscles of the Forearm

Layer 3
Deep Layer

Lateral



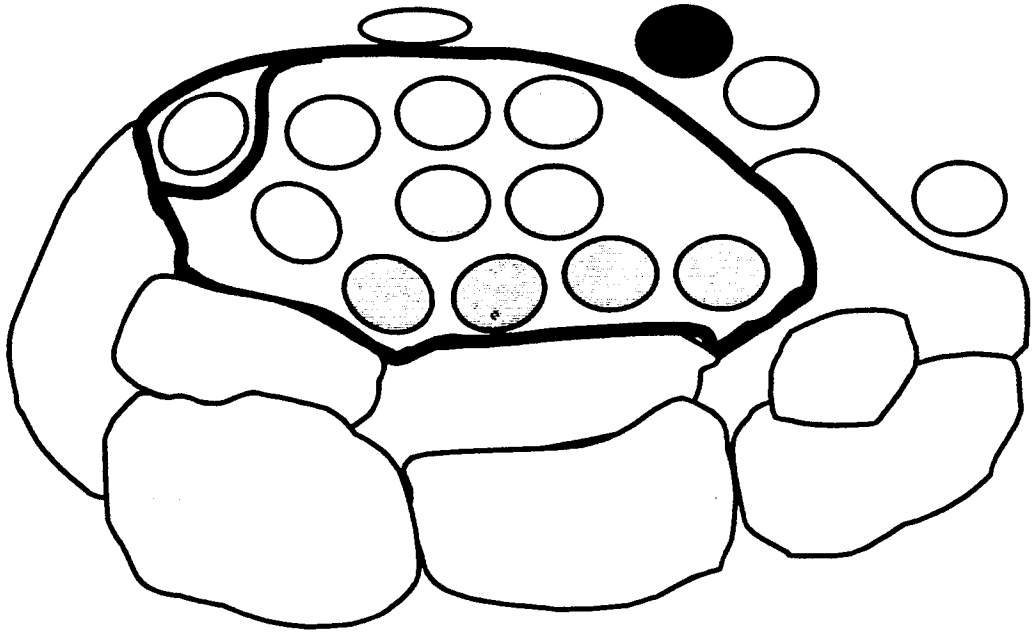
Medial

Anterior View

Carpal Tunnel

Anterior

Lateral

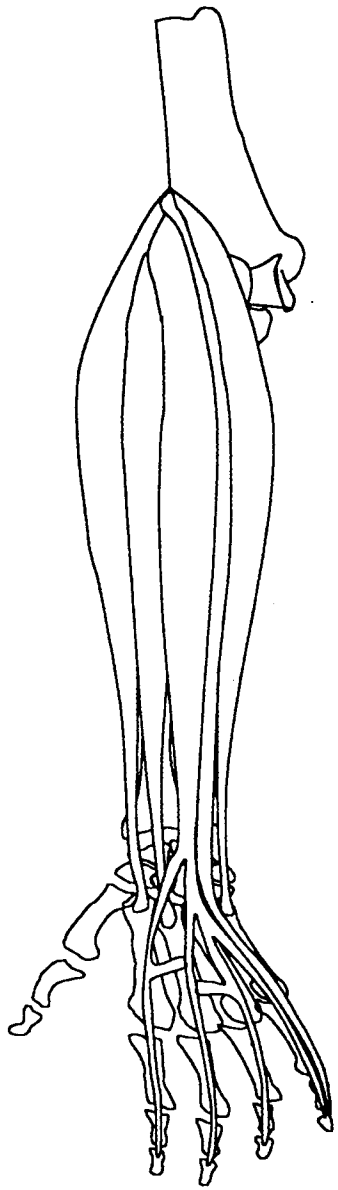


Medial

Posterior

Superficial Extensor Muscles of the Forearm

Superficial Group

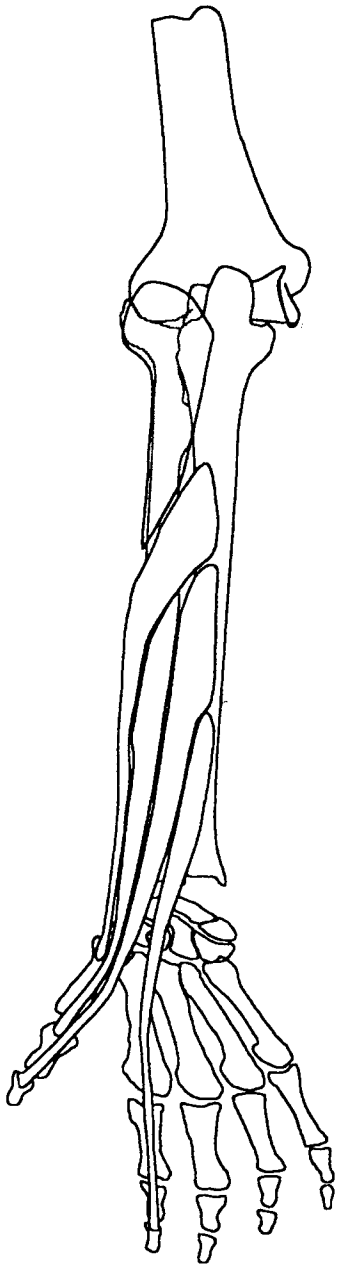


Posterior View

Deep Forearm Extensors

Deep Extensors

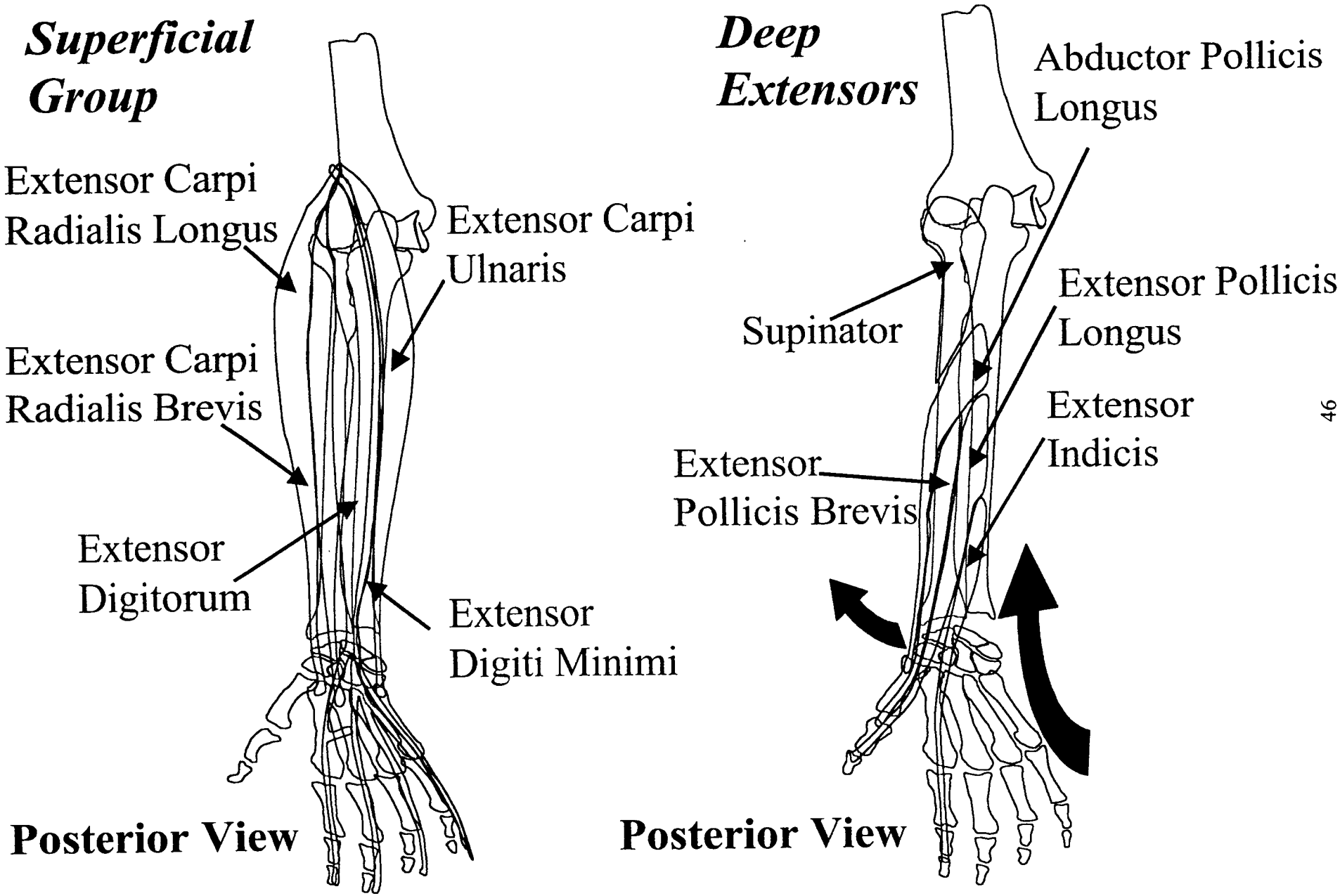
Lateral



Medial

Posterior View

Forearm Extensor Innervation



Laboratory Assignment
Hand and Wrist

- Flexor Retinaculum
- Median Nerve
- Recurrent Branch of the Median Nerve
- Thenar Muscles
  - Abductor Pollicis Brevis
  - Opponens Pollicis
  - Flexor Pollicis Brevis
- Adductor Pollicis
- Ulnar Nerve
- Deep branch of the Ulnar Nerve
- Hypothenar Muscles
  - Abductor Digiti Minimi
  - Opponens Digiti Minimi
  - Flexor Digiti Minimi Brevis
- Interossei
  - (3) Palmar Interossei
  - (4) Dorsal Interossei
- Anatomical Snuff Box
  - Extensor Pollicis Longus tendon
  - Extensor Pollicis Brevis tendon
  - Abductor Pollicis Longus tendon
  - Radial Artery
  - Scaphoid Bone

- Anterior Interosseous Artery
- Dorsal carpal branches from the radial and ulnar arteries
- Dorsal Metacarpal arteries
- Dorsal digital arteries
- Ulnar artery
  - Superficial Palmar Arch
- Radial artery
  - Deep palmar arch
  - Superficial palmar branch of the radial artery
  - Palmar metacarpal arteries
  - Princeps pollicis
  - Radial indicis
- Common Digital arteries
- Proper Digital arteries
- Proper Digital nerves

- Carpal bones
  - Scaphoid
  - Lunate
  - Triquetral
  - Pisiform
  - Trapezium
  - Trapezoid
  - Capitate
  - Hamate
- Metacarpals
- Phalanges

Thenar Compartment

Thenar Muscles

The three thenar muscles act on the thumb, and include the abductor pollicis, the flexor pollicis brevis and the opponens pollicis. These muscles cross the MP and PIP joints of the thumb but not the DIP. All of these muscles are innervated by the Recurrent Branch of the Median Nerve (Median Nerve).

Abductor Pollicis Brevis

Origin: Most superficial of the thenar muscles. Covers the flexor pollicis brevis and the opponens pollicis and originates from the lateral aspects of the flexor retinaculum and the trapezium.

Insertion: Radial side of the base of the proximal phalanx of the thumb

Action: Abduction at the CMC joint

Innervation: Recurrent branch of the median nerve

Opponens Pollicis

Origin: Originates on the flexor retinaculum, trapezium and the floor of the carpal tunnel.

Insertion: Radial side of the first metacarpal

Action: CMC opposition of the thumb is the main action of the opponens pollicis

Innervation: Recurrent branch of the median nerve

Flexor Pollicis Brevis

Origin: Dual origin and is partly covered by the abductor pollicis brevis. The larger superficial head arises from the flexor retinaculum and the trapezium, while the smaller deep head arises from fibers that arise from the floor of the carpal tunnel.

Insertion: The flexor pollicis brevis inserts on the radial side of the flexor surface of the base of the proximal phalanx **Action:** Flexion and abduction at the CMC joint and flexion and the MCP joint **Innervation:** Superficial head by the recurrent branch of the median nerve, while the deep head is innervated by the deep branch of the ulnar nerve.

Hypothenar Compartment and Adductor Pollicis

Hypothenar Muscles and Adductor Pollicis

The Hypothenar muscles act upon the little finger and are composed of the abductor digiti minimi, flexor digiti minimi brevis, and the opponens digiti minimi. Each of these muscles are innervated by the deep branch of the ulnar nerve

Abductor Digiti Minimi

Origin: Pisiform bone and the adjacent tendon of the flexor carpi ulnaris

Insertion: Medial side of the base of the fifth proximal phalanx with flexor digiti minimi

Action: Abducts the little finger

Innervation: Deep branch of the Ulnar Nerve

Opponens Digiti Minimi

Origin: Originates from the hook of the hamate and the distal border of the flexor retinaculum

Insertion: Medial border of the 5th metacarpal

Action: Flexion and lateral rotation of the little finger at the MCP joint for rotation into opposition

Innervation: Deep branch of the Ulnar Nerve

Flexor Digiti Minimi Brevis

Origin: Flexor retinaculum and the apex of the hamulus of the hamate bone

Insertion: Palmar/medial surface of the proximal fifth phalanx

Action: Flexor at the metacarpophalangeal joint

Innervation: Deep branch of the Ulnar Nerve

Adductor Pollicis

Origin: Arises by two heads deep to the thenar muscles and looks like the "7 ". The transverse head originates on the 3rd metacarpal, and the oblique head arises from the bases of the 1st, 2nd, and 3rd metacarpals and the floor of the carpal tunnel. **Insertion:** Ulnar side of the base of the proximal phalanx of the thumb **Action:** Adduction of the thumb and flexion at the MCP joint **Innervation:** Deep branch of the Ulnar Nerve

Interossei

Interossei

The interossei fill in the gaps between the metacarpal bones. At their proximal ends the interossei are crossed by the deep branch of the ulnar nerve and the deep palmar arterial arch from the radial artery. The interossei are innervated by the deep branch of the ulnar nerve

Palmar Interossei

There are three palmar interossei and their main action is adduction (3 PAD). The palmar interossei lie on the palmar surface in the metacarpal spaces.

Origin: The first palmar interossei arises from the ulnar side of the second metacarpal and the second and third palmar interossei arise from the radial sides of the fourth and fifth metacarpals.

Insertion: Each interossei inserts into the corresponding bases of the second, fourth and fifth proximal phalange and the extensor hood/expansion.

Action: MCP adduction of the 2nd, 4th and 5th phalanges and assist lumbricals in flexing MP joints and extending the IP joints.

Innervation: Deep branch of the Ulnar nerve

Dorsal Interossei

There are 4 dorsal interossei and there main action is abduction (4 DAB). The dorsal interossei lie on the dorsal surface of the hand in the metacarpal spaces.

Origin: Each of the four dorsal interossei has two heads of origin that arise from each of the two metacarpal bones between where the body of each muscle lies. The dorsal interossei are responsible for abduction of the fingers ("spreading").

Insertion: The first dorsal interossei inserts into the base of the proximal phalanx of the index finger on the radial side of this finger. The second dorsal interossei inserts on the radial side of the base of the proximal phalanx of the third finger, and the third and fourth dorsal interossei insert on the ulnar side of the proximal phalanx of the third or fourth finger respectively. The second, third and fourth dorsal interossei also insert into the extensor hood/expansion of each finger.

Action: MCP flexion and abduction, and PIP/DIP extension of the second, third and fourth phalanges, and assist the lumbricals in flexing MP joints and extending the IP joints.

Innervation: Deep branch of the Ulnar nerve

Anatomical Snuff Box

- Boundaries
  - Tendons of Extensor Pollicis Longus, Extensor Pollicis Brevis and Abductor Pollicis Longus
- Contents
  - Radial artery
- Floor
  - Formed by the Scaphoid bone

Dorsum Blood Supply

- Dorsal carpal branches from both the radial and ulnar arteries form the dorsal carpal rete
- Anterior interosseous anastomoses with the dorsal carpal rete
- Dorsal metacarpal arteries run down the metacarpals and then branch into the dorsal digital arteries along the sides of the digits
- Perforating branches from the deep palmar arch project through the proximal portions of the dorsal interossei to anastomose with the dorsal metacarpal arteries
- Radial artery dives through the first dorsal interossei to form the deep palmar arch on the palmar surface

5

Dorsum Innervation

- Superficial radial nerve passes superior to the extensor retinaculum
- Will provide cutaneous innervation to the dorsal surface of the thumb, the index finger, middle finger and half of the ring finger
- However, the median nerve is responsible for innervating the tips of the thumb and the corresponding fingers
- The remaining one and a-half fingers are innervated by the ulnar nerve

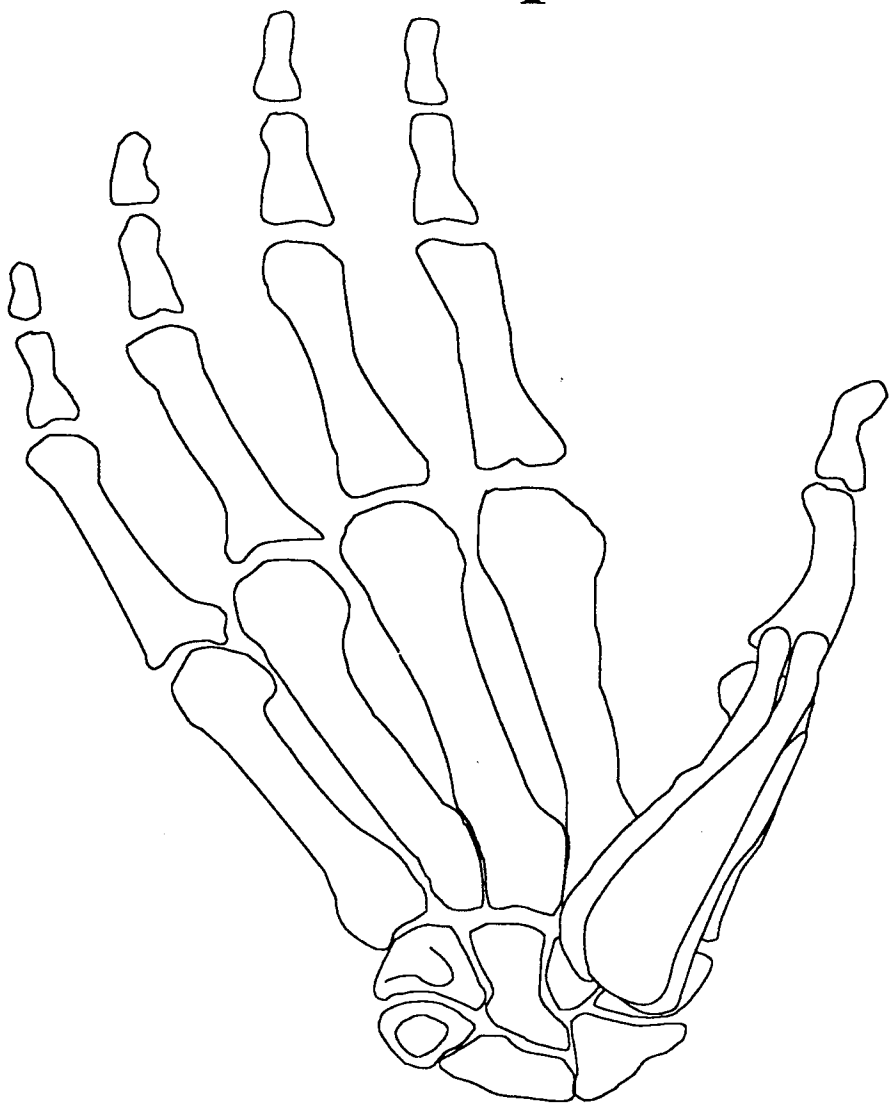
6

Palmar Surface

- Superficial Palmar Arch formed by the Ulnar Artery
- Deep Palmar Arch formed by the Radial Artery
- Innervation to the medial one and a half digits by way of the ulnar nerve
- Innervation to the lateral three and one-half fingers is by way of the median nerve

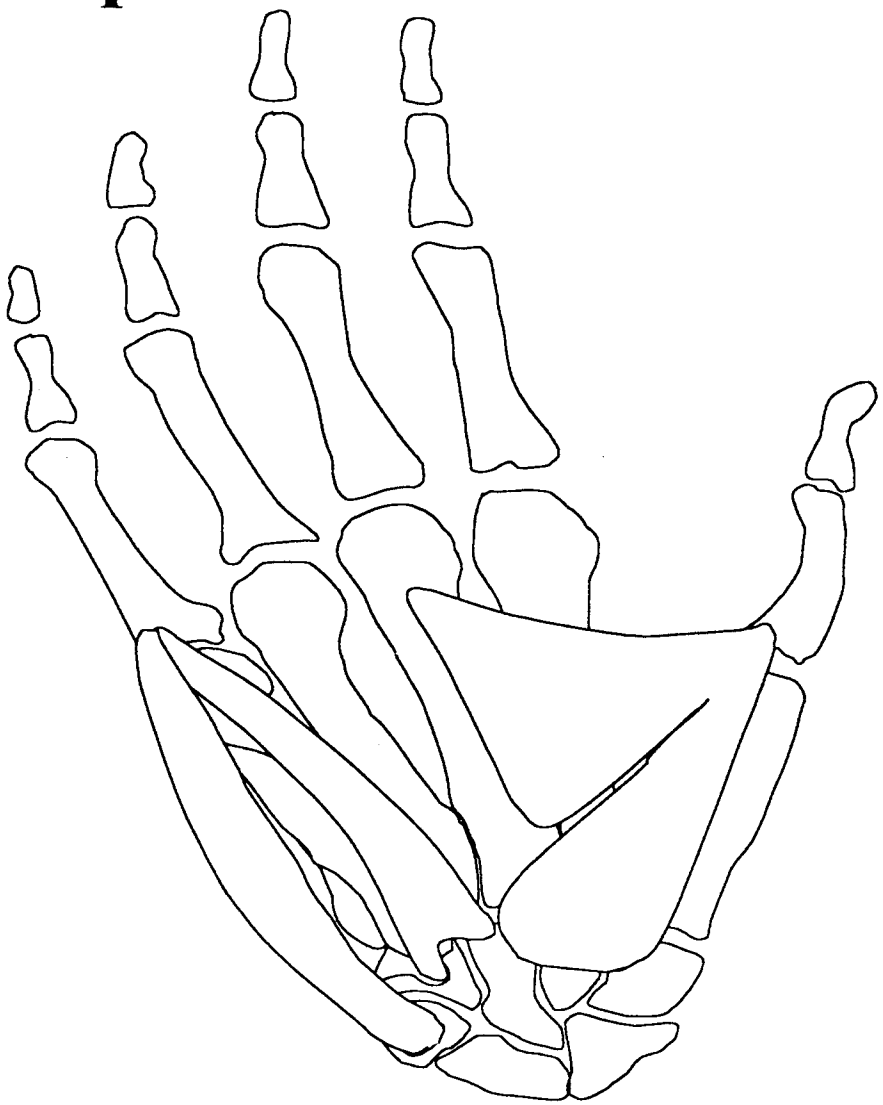
7

Thenar Compartment



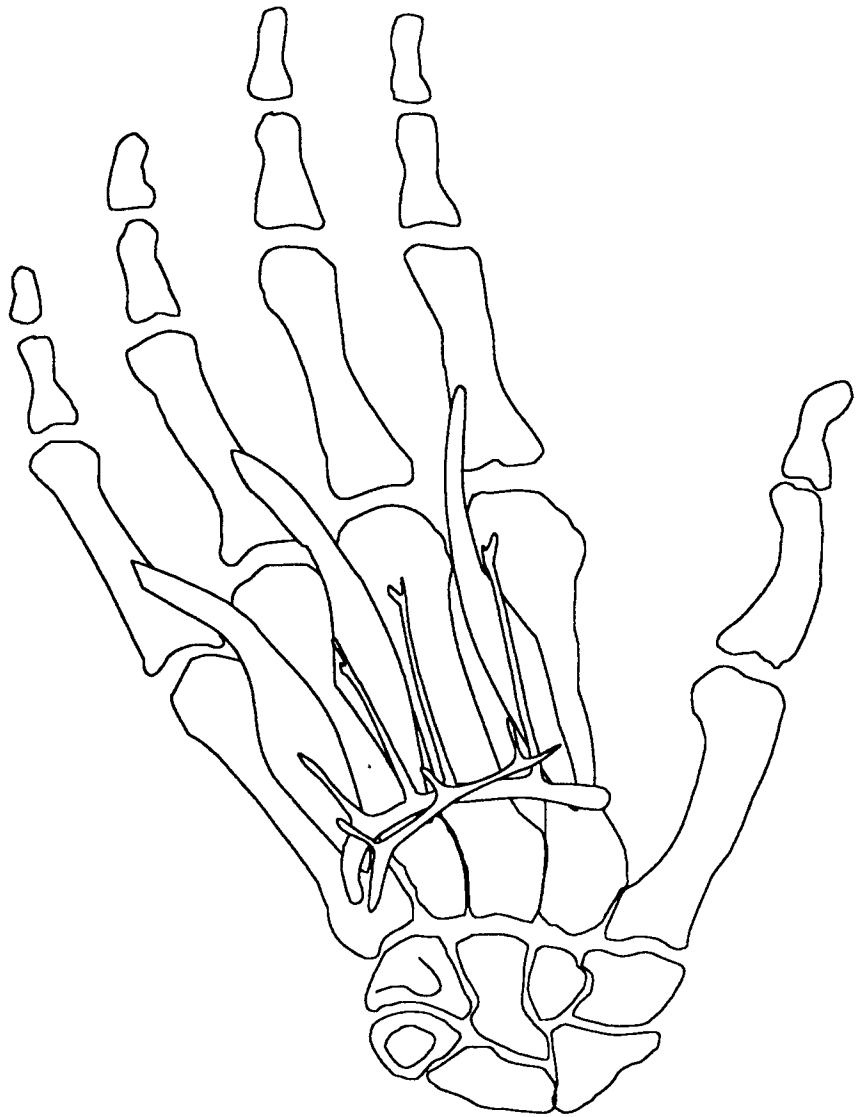
Palmar View

Hypothenar Compartment and Adductor Pollicis

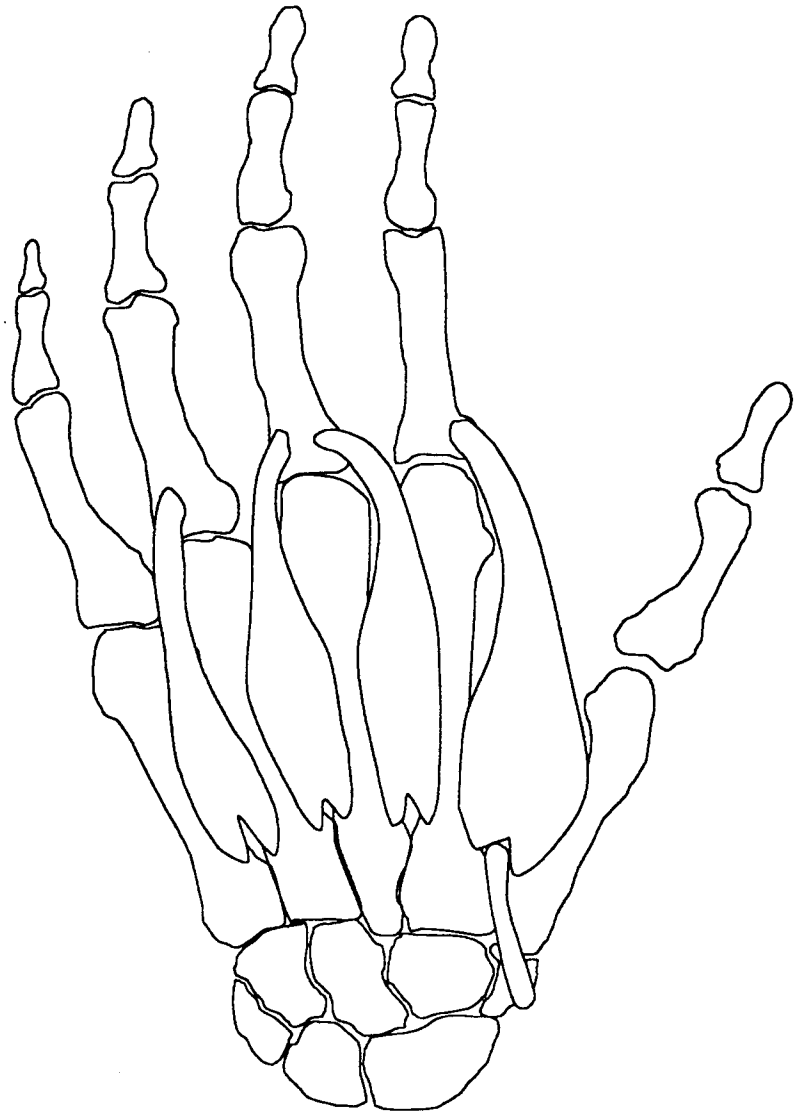


Palmar View

Interossei



Palmar View



Dorsal View

Lumbricals

Lumbricals

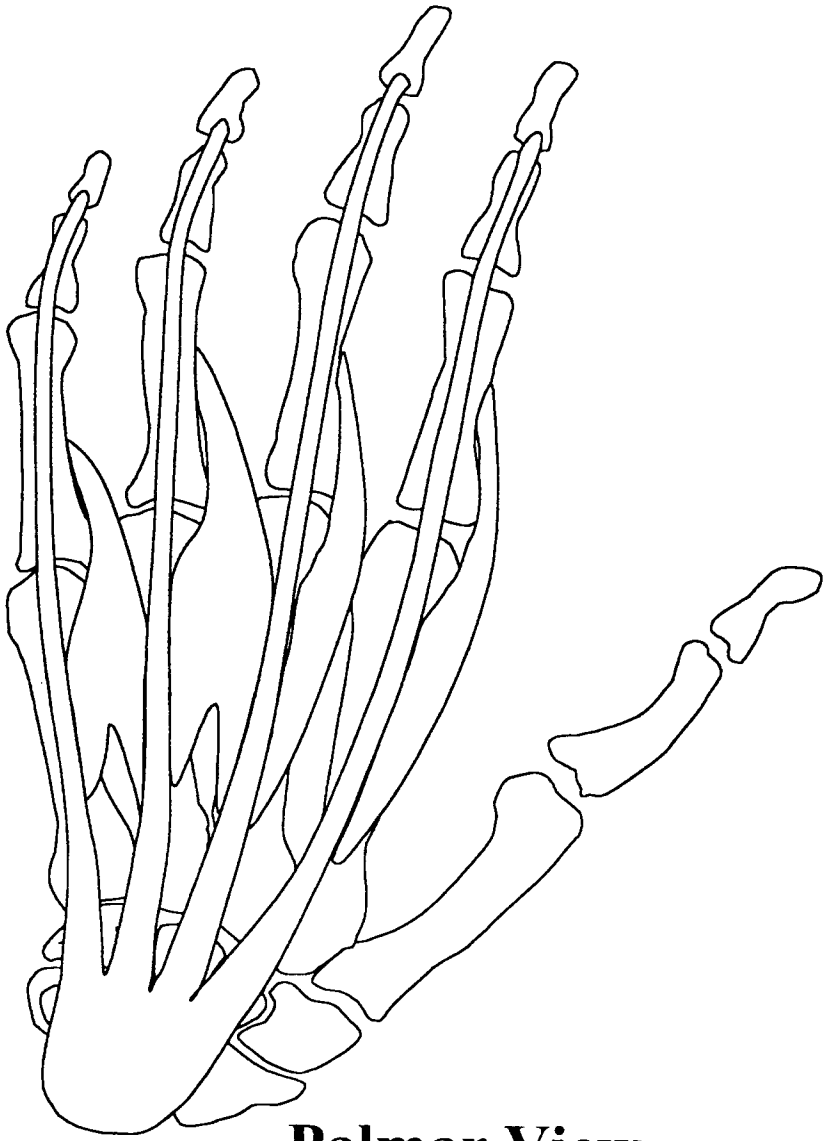
Each of the four lumbricals arises from the tendon of the flexor digitorum profundus. Lumbricals 3 and 4 are bipennate since each arise from two tendons of the flexor digitorum profundus, while lumbricals 1 and 2 are unipennate.

Origin: The four lumbricals arise from the flexor digitorum profundus tendon

Insertion: Extensor expansions on the radial sides of the 2nd, 3rd, 4th, and 5th proximal phalanges

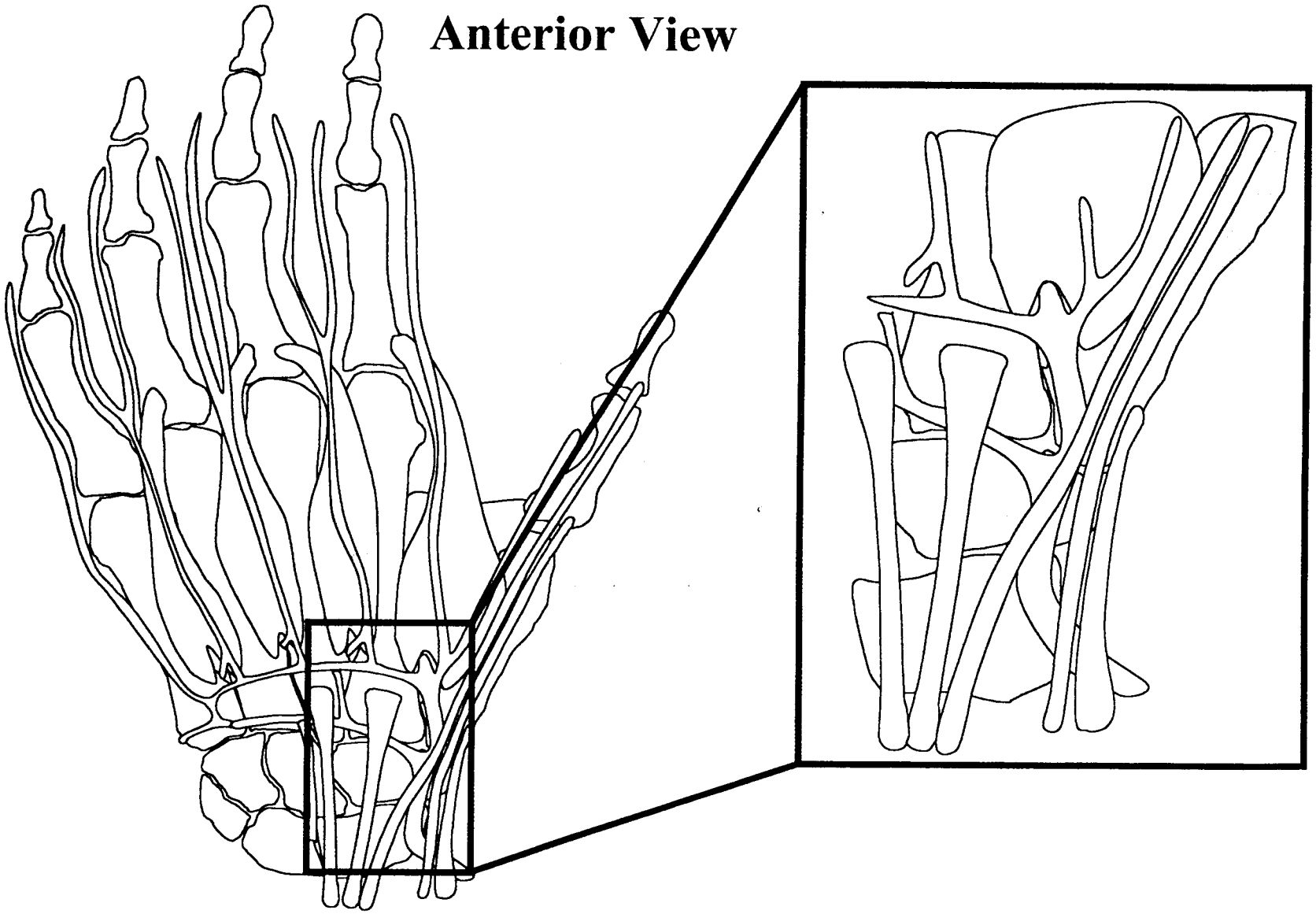
Action: Each lumbrical is capable of MCP flexion, and PIP/DIP extension of the 2nd, 3rd, 4th, and 5th phalanges

Innervation: The first and second lumbricals are innervated by the median nerve (digital branches), and the third and fourth lumbricals are innervated by the deep branch of the ulnar nerve.

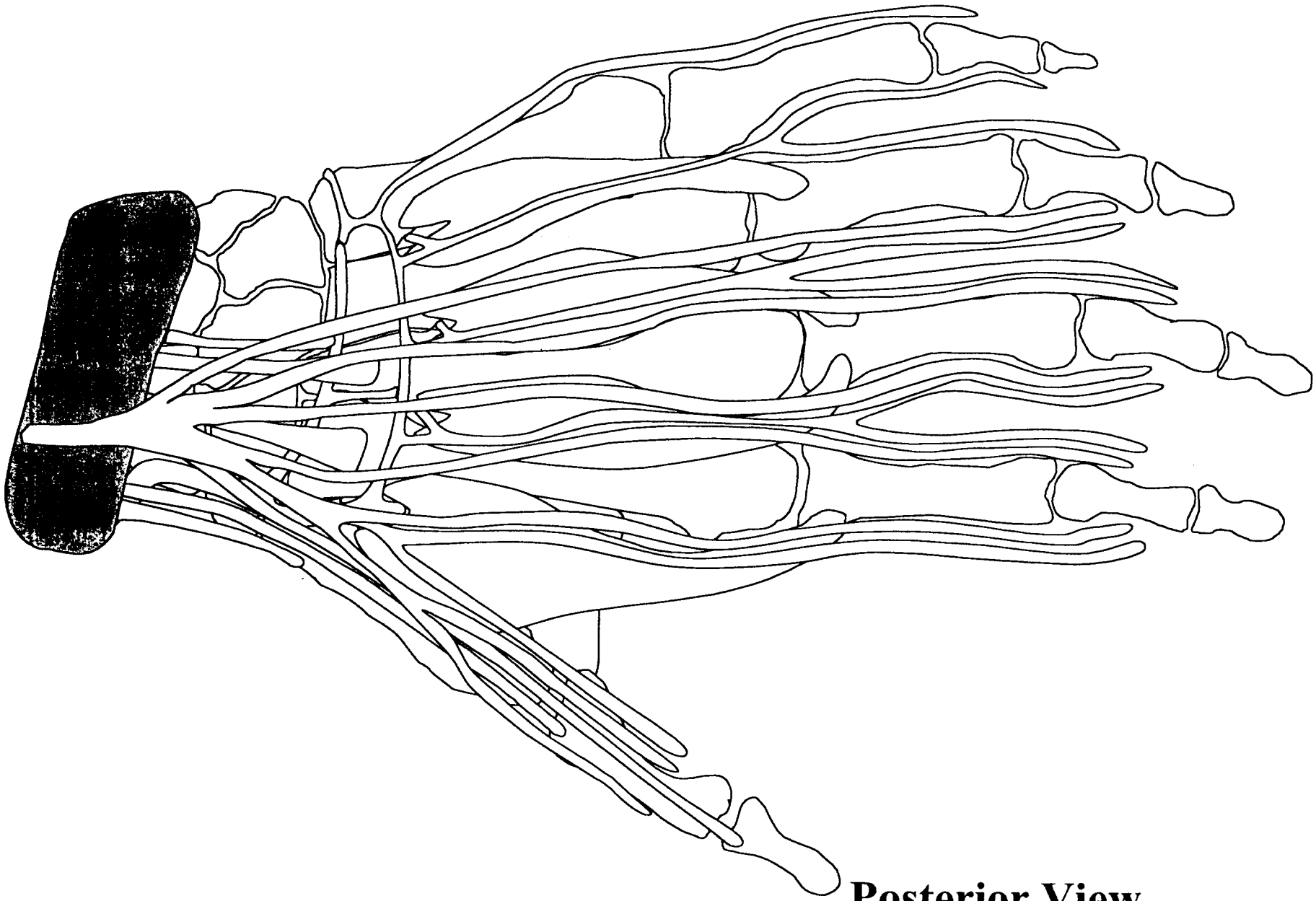


Palmar View

Anatomical Snuff Box

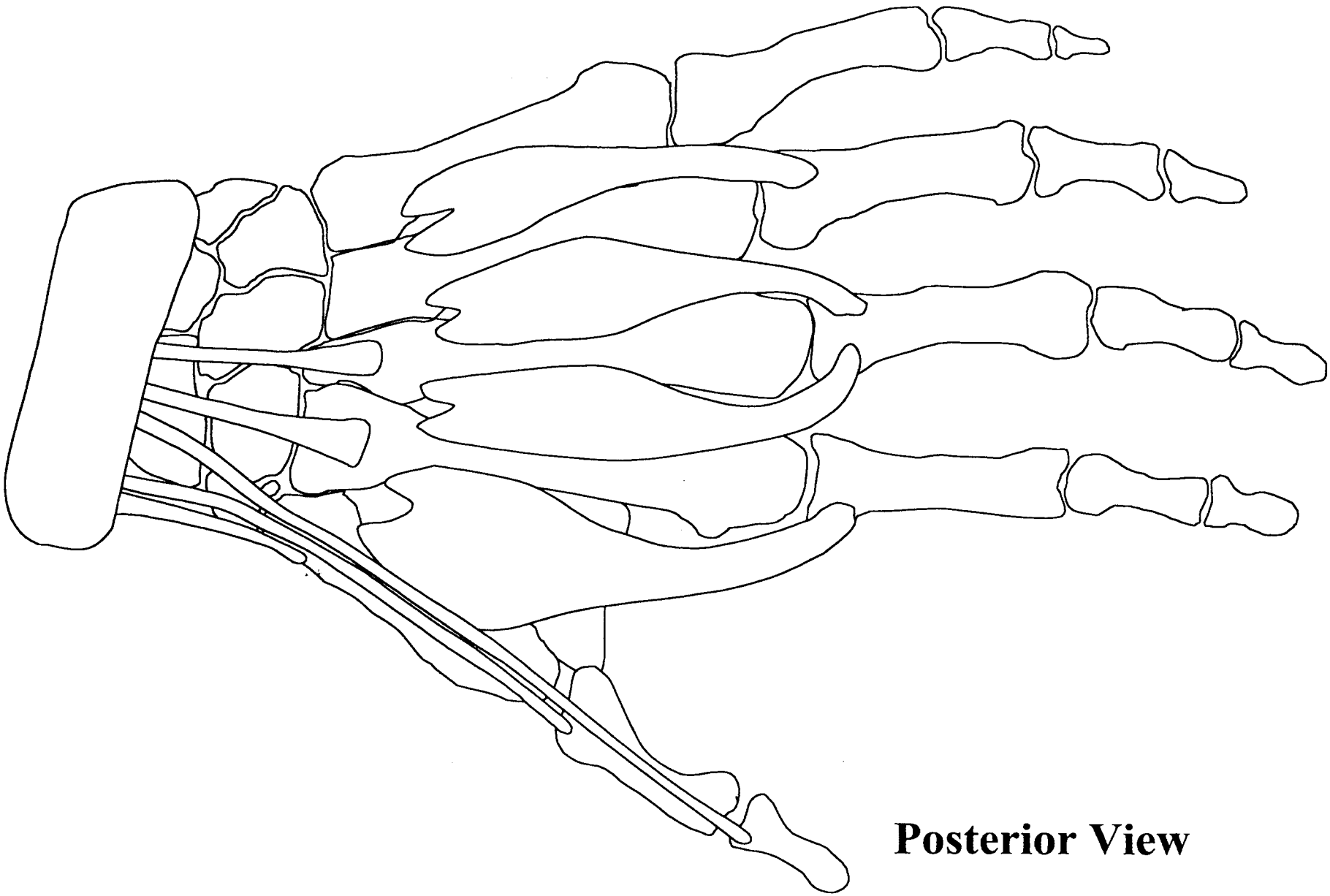


Dorsum of the Hand



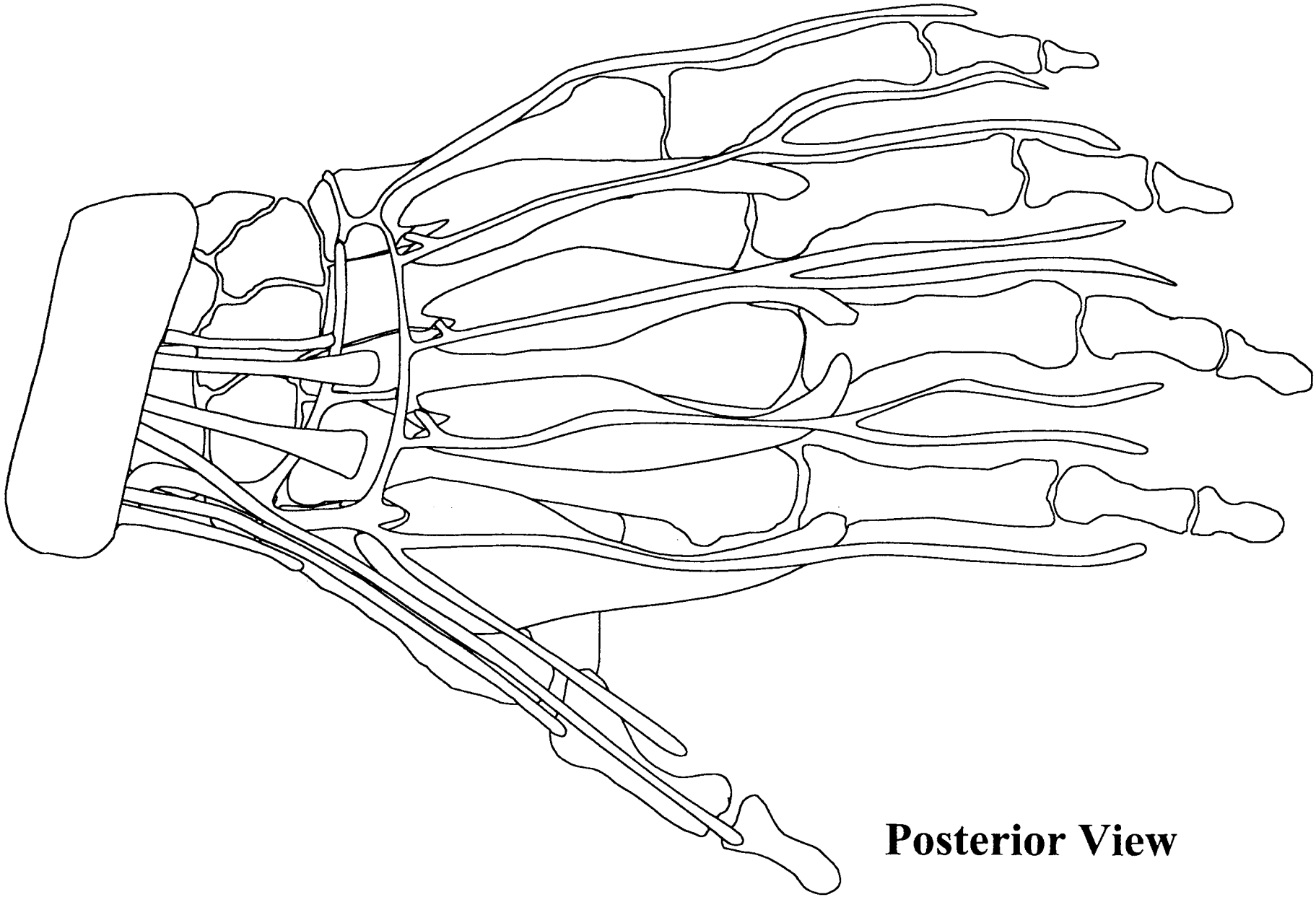
Posterior View

Dorsum of the Hand



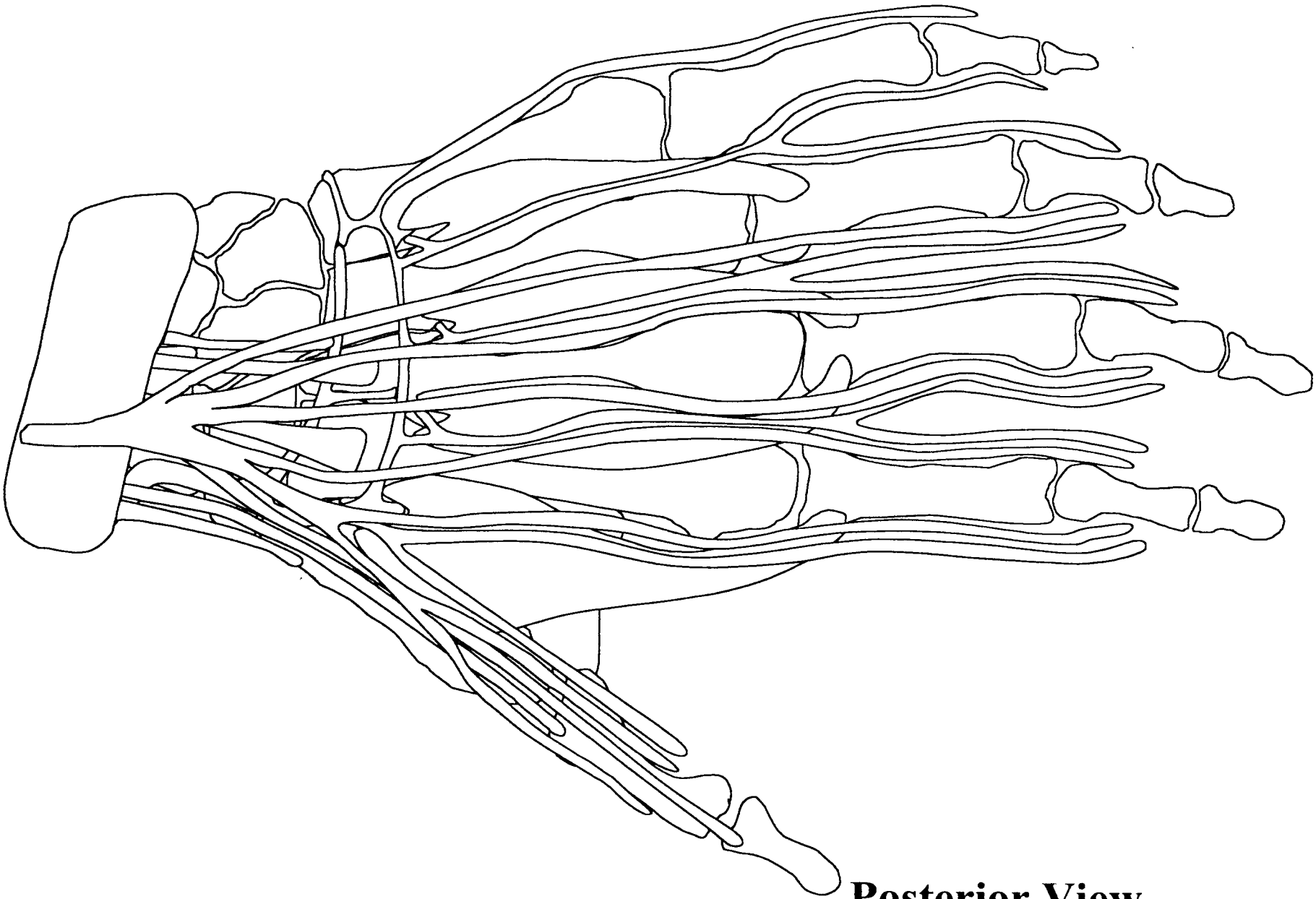
Posterior View

Dorsum of the Hand (Dorsal Carpal Rete)



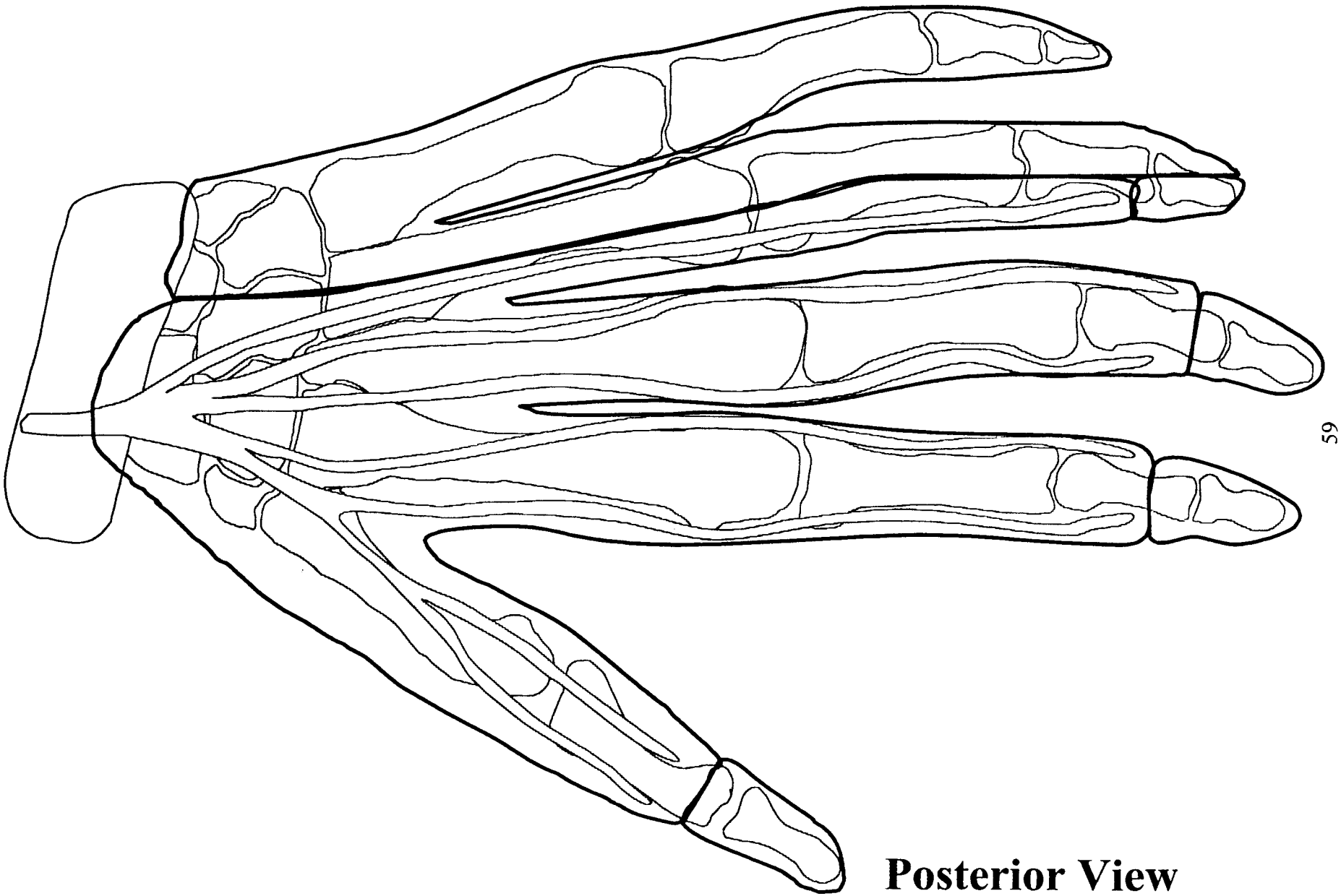
Posterior View

Dorsum of the Hand



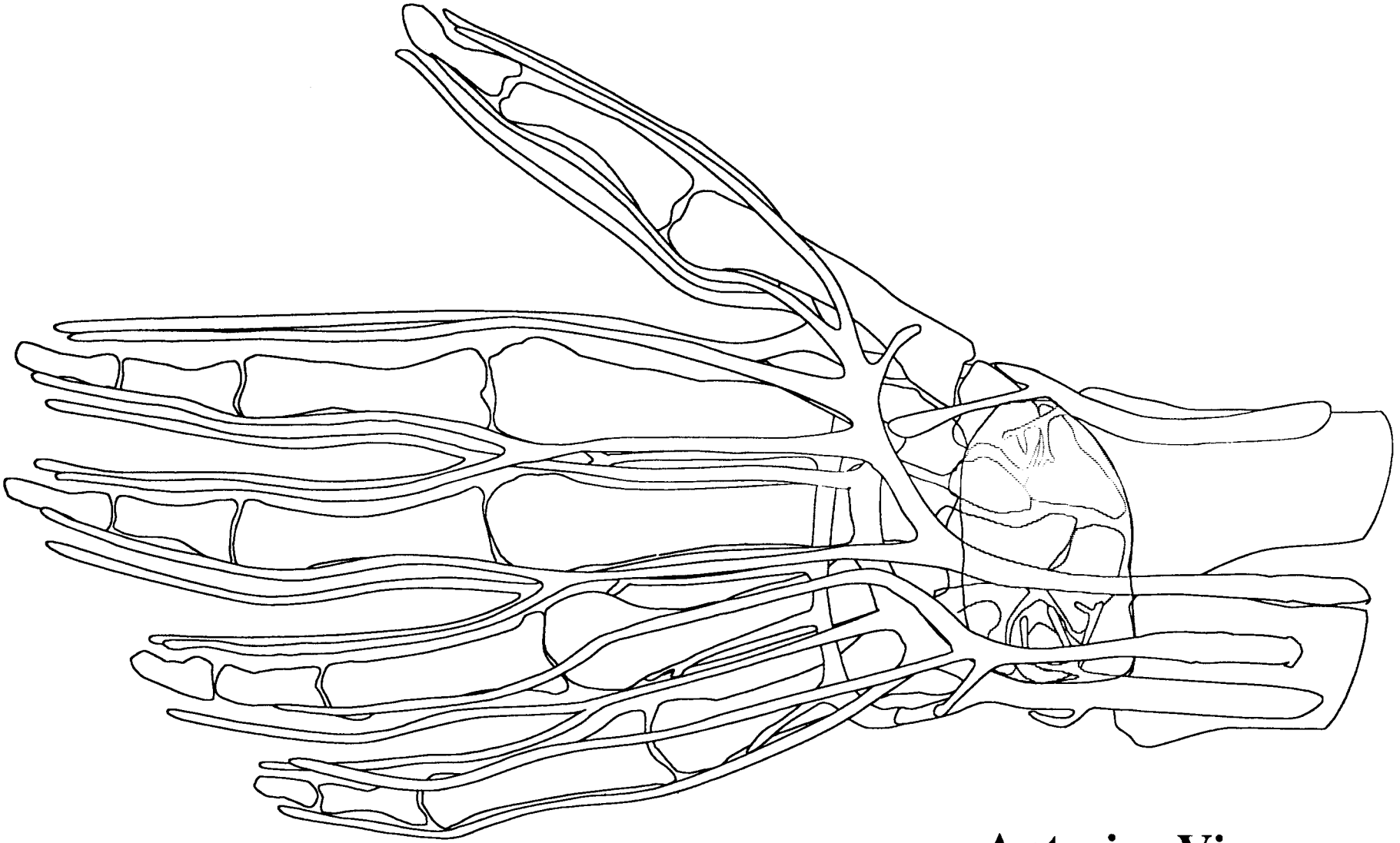
Posterior View

Dorsum Innervation



Posterior View

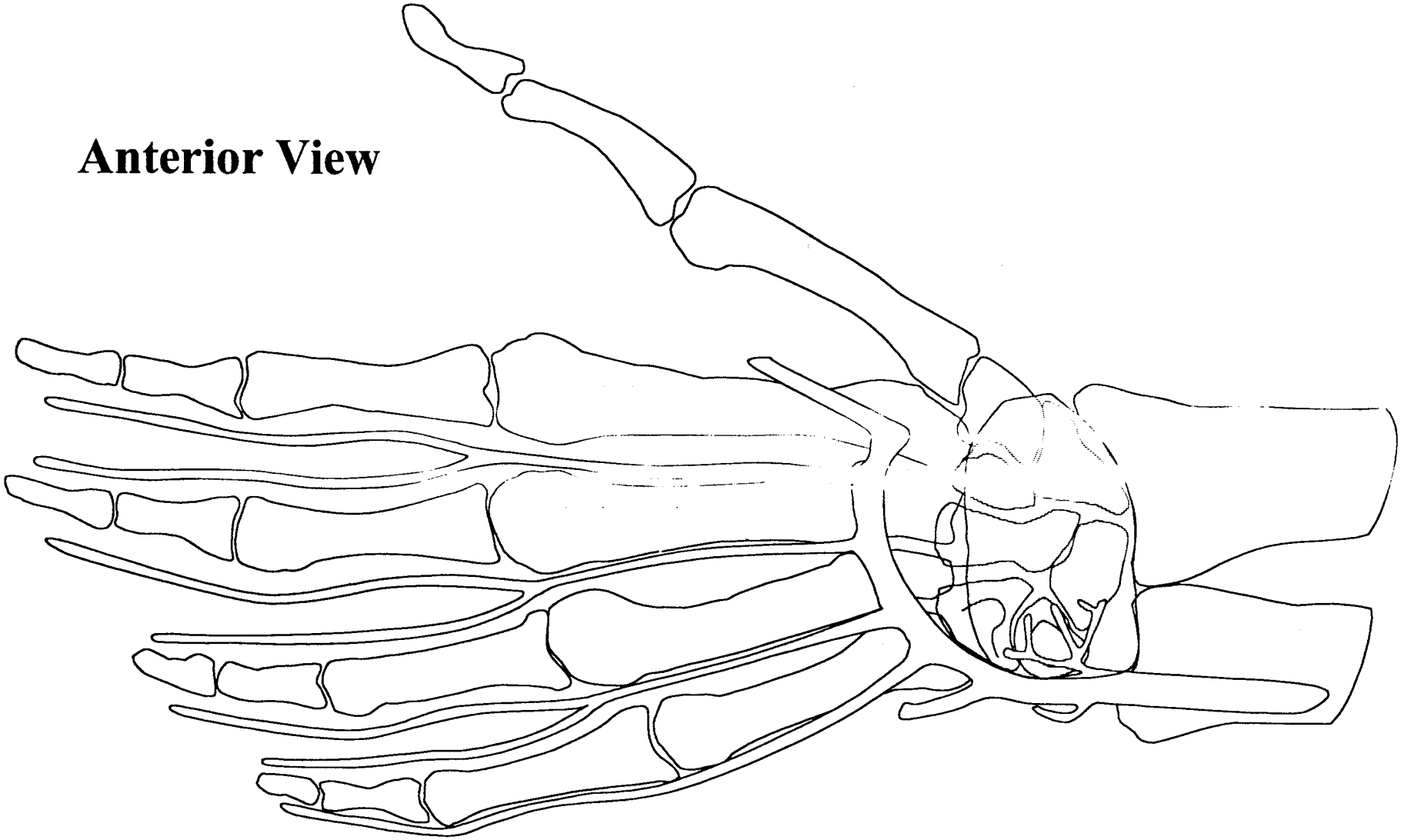
Palmar Surface of the Hand



Anterior View

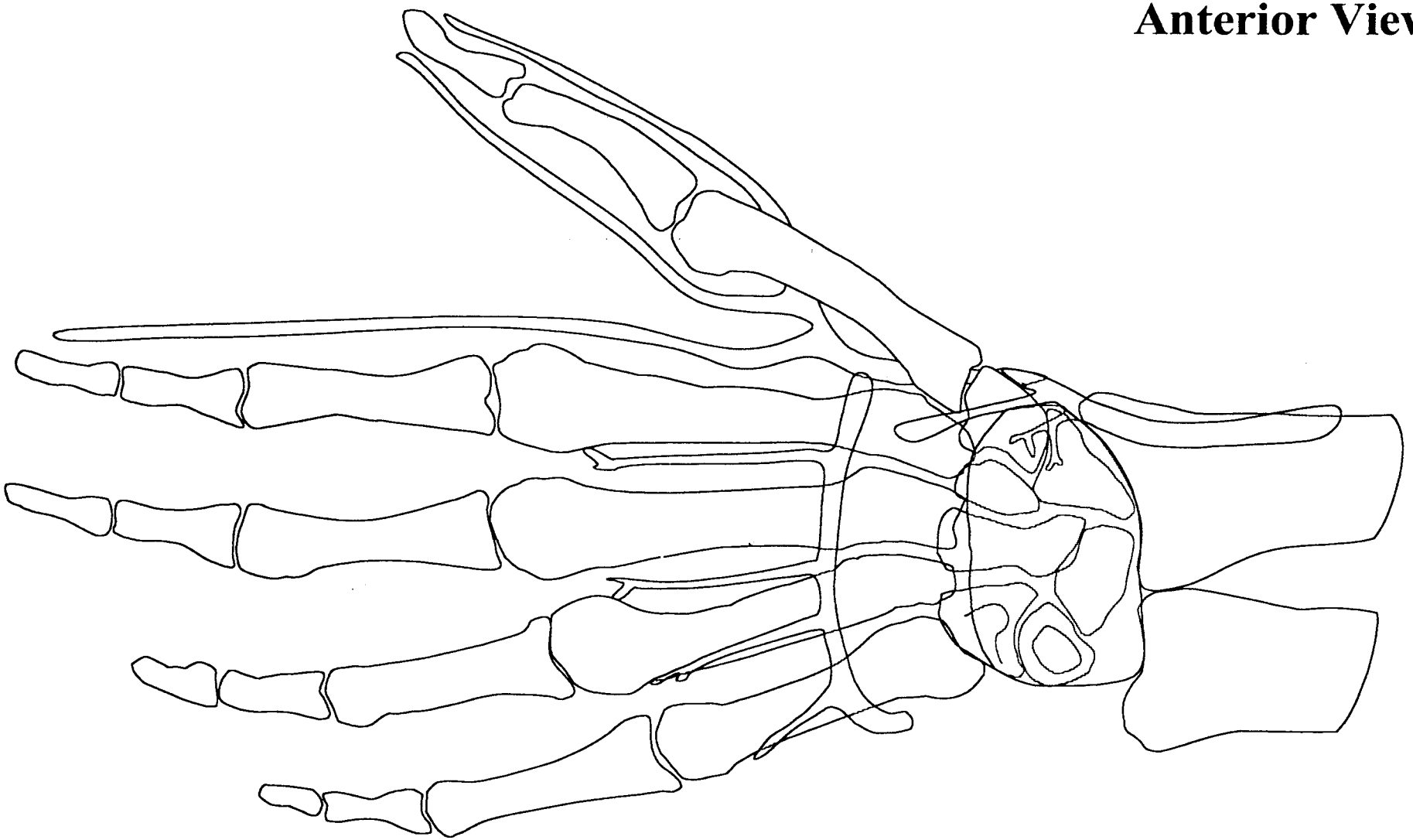
Arterial Supply of the Palmar Surface of the Hand

Anterior View



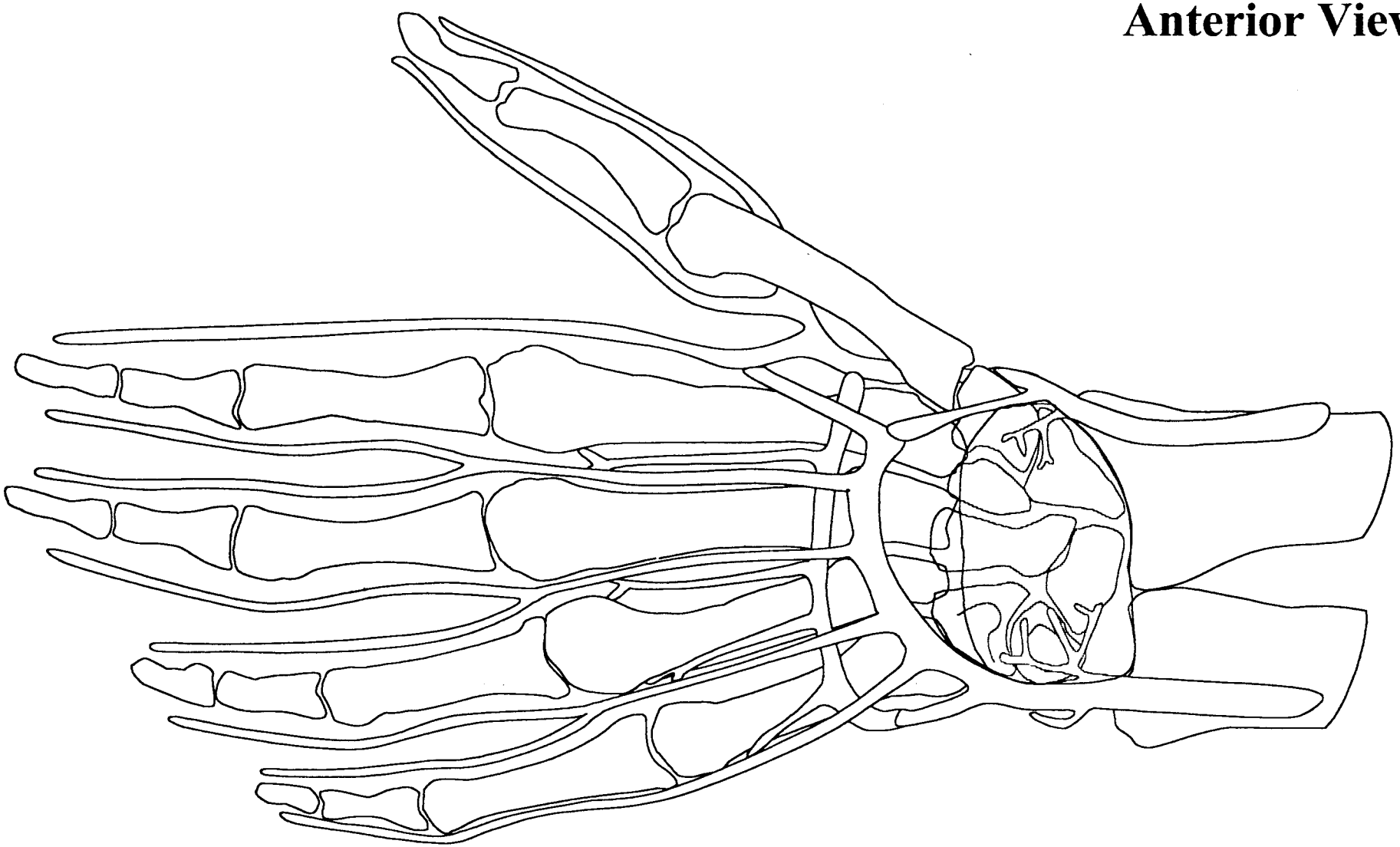
Arterial Supply of the Palmar Surface of the Hand

Anterior View

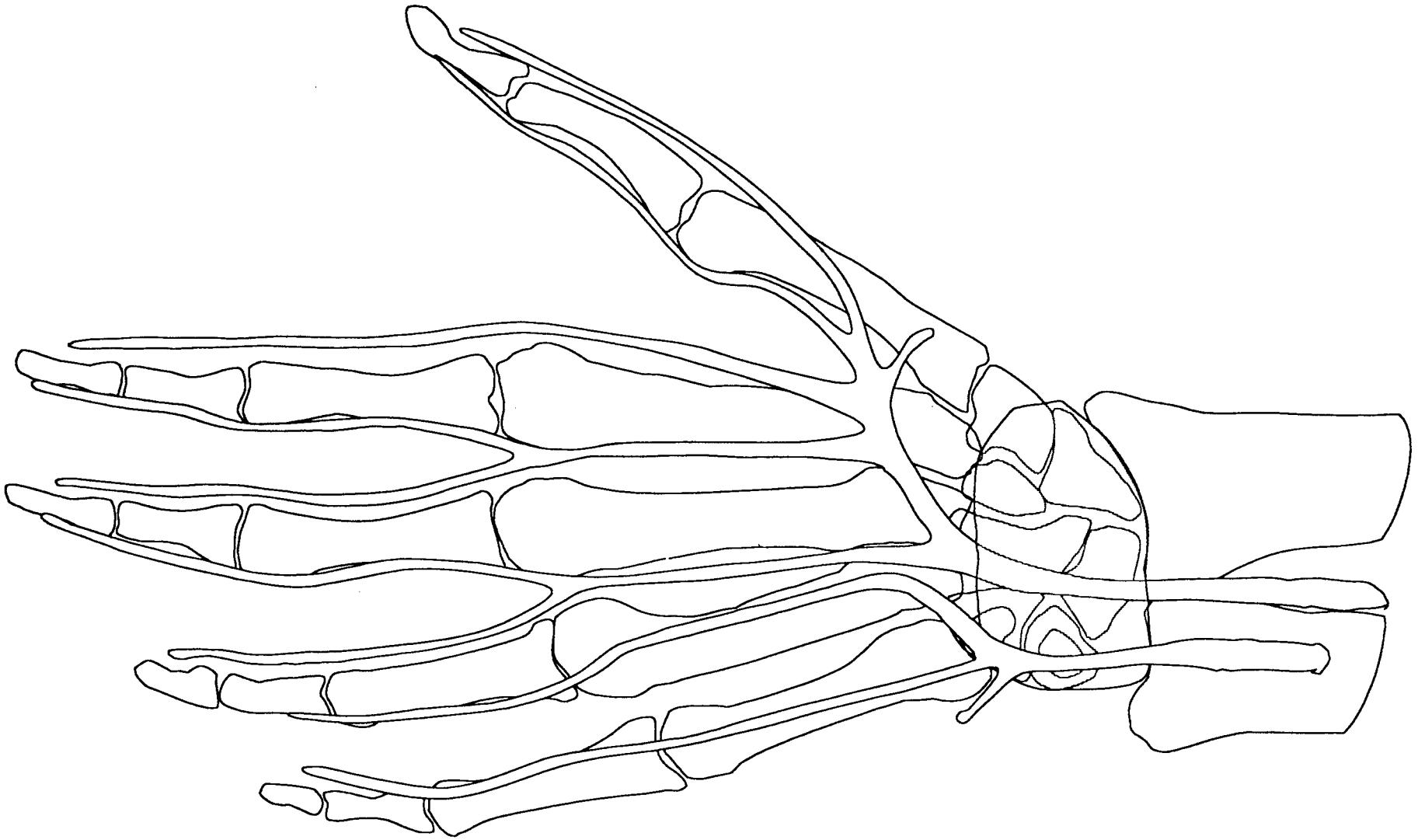


Arterial Supply of the Palmar Surface of the Hand

Anterior View

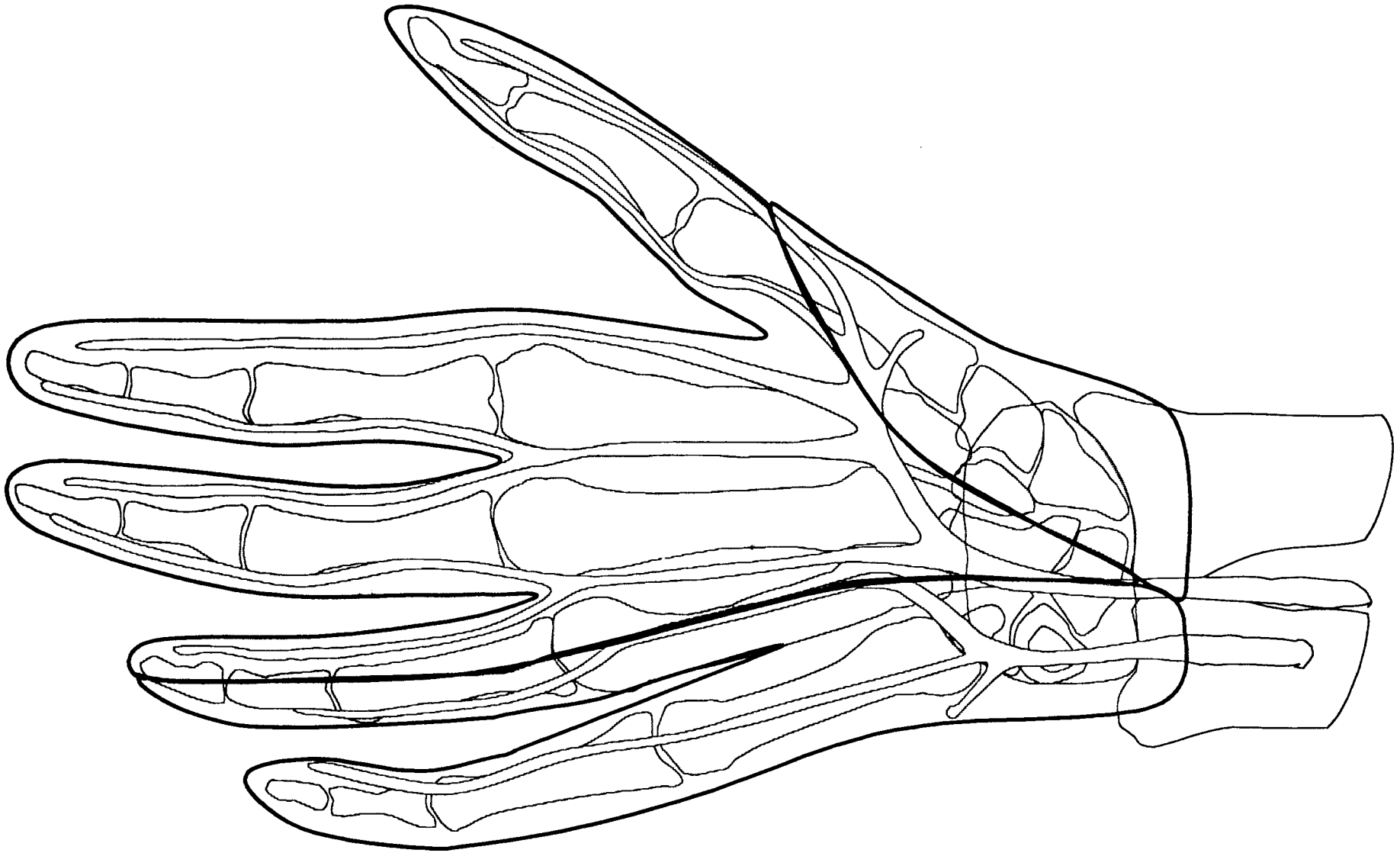


Palmar Surface of the Hand



Anterior View

Palmar Surface of the Hand



Anterior View

Laboratory Assignment
Upper Limb Joints

Sternoclavicular Joint
- Sternoclavicular Ligament
- Articular Disk
- Interclavicular Disk
- Costoclavicular Ligament

Acromioclavicular Joint
Coracoacromial Ligament
Coracoclavicular Ligament
- Trapezoid
- Conoid

Coracohumeral Ligament
Glenohumeral Joint
- Glenoid Labrum

Transverse Humeral Ligament

Elbow Joint
- Radial Collateral Ligament
- Annular Ligament
- Ulnar Collateral Ligament
  - Anterior band
  - Posterior band
  - Oblique band

MP Joints
PIP Joints
DIP Joints
- Palmar Ligaments
- Collateral Ligaments
- Deep and superficial transverse metacarpal ligaments

Overview of the Upper Limb Joints

- Sternoclavicular Joint
- Acromioclavicular Joint
- Shoulder Joint
- Elbow Joint
- Wrist, hand and fingers

Sternoclavicular Joint

- Double synovial plane (gliding) joint
- Includes the sternal end of the clavicle, manubrium sterni, and the cartilage of the first rib.
- Components include:
  - Fibrous Capsule
  - Sternoclavicular Ligament (Anterior and Posterior)
  - Articular Disk
  - Interclavicular Ligament
  - Costoclavicular Ligament

Acromioclavicular Joint

- Synovial plane joint formed between acromion of scapula and lateral end of the clavicle
- Accessory ligaments include the following:
  - Coracoacromial
  - Coracoclavicular
    - Lateral-Trapezoid
    - Medial-Conoid
  - Coracohumeral

Coracoacromial Arch

- Formed by the acromion, coracoid process and the coracoacromial ligament
- Functions to prevent upward displacement of the head of the humerus
- Subacromial bursa separates the inferior aspect of the arch from the underlying supraspinatus tendon

Glenohumeral Joint (Shoulder Joint)

- Synovial ball and socket joint formed by the head of the humerus and the glenoid cavity of the scapula.
- Socket deepened by the glenoid labrum
- Capable of movement in every direction due to the laxity of the capsule
- Movements include
  - Flexion and extension
  - Abduction and adduction
  - Circumduction and rotation

Fibrous Capsule of the Shoulder Joint

- Strength results mainly from the rotator cuff muscles
- Laxity of the fibrous capsule allows for the free movement of the shoulder joint
- Attaches proximal to the glenoid cavity and to the anatomical neck of the humerus

Ligaments of the Glenohumeral Joint

- Coracoacromial
- Glenohumeral
  - Weak bands of fibrous connective tissue that strengthen the anterior surface of the capsule
  - Superior, middle and inferior
- Transverse Humeral Ligament
  - Between the greater and lesser tubercles
  - Holds down the long head of the biceps tendon
- Coracohumeral Ligament
  - Strengthens the superior part of the capsule

Elbow Joint

- Hinge Joint
- Formed by the humerus, radius and ulna
- Comprised of three separate articulations
  - 1. Ulna and Humerus
  - 2. Head of the Radius and the Humerus
  - 3. Proximal Radio-Ulnar articulation

Joint Capsule of the Elbow

- Fibrous capsule surround the elbow joint
- Attached to the lateral and medial ends of the capitulum and trochlea
- Proximal to the coronoid and olecranon fossa

Ligaments of the Elbow Joint

- Radial collateral ligament
  - Fanlike, blends with the anular
  - Helps form the proximal radio-ulnar joint which permits pronation and supination
- Anular ligament of the radius
  - Encircles and holds head of radius in the radial notch
  - Forms the proximal radioulnar joints
- Ulnar collateral ligament
  - Consists of three bands, anterior (band), posterior(fanlike), and oblique

Distal Radio-Ulnar Articulation

- Rounded head of Ulna articulates with the ulnar notch on the medial side of the distal end of the radius
- Articular disk binds ends of the ulna and the radius together

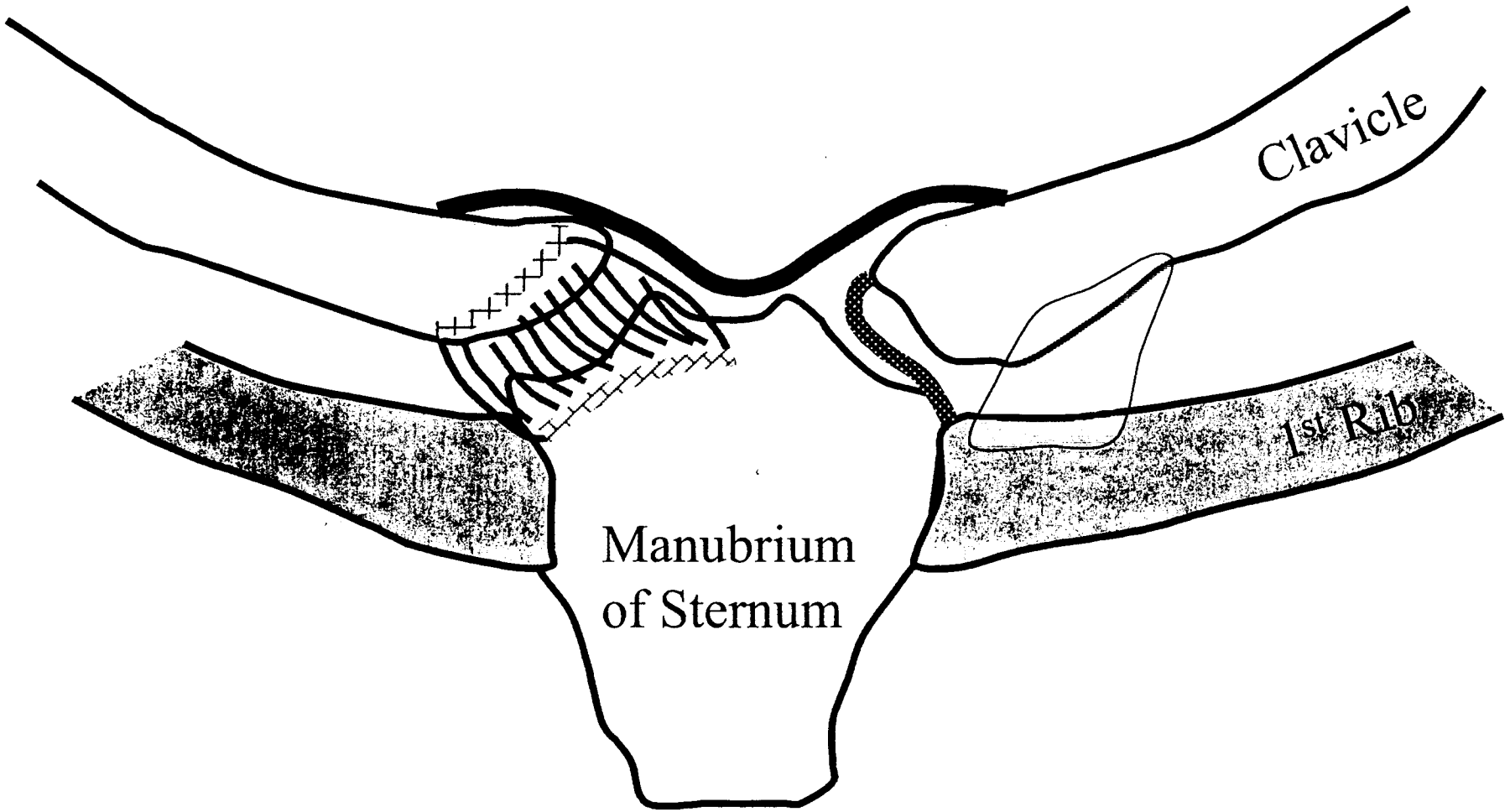
Articulation of the Wrist Joint

- Condyloid type of synovial joint
- Distal end of the radius and the articular disc articulate with the proximal row of carpal bones except for the pisiform
- Ulna does not articulate with the carpal bones
- Movements include flexion, extension, abduction, adduction, and circumduction

Joints of the Hand and Fingers

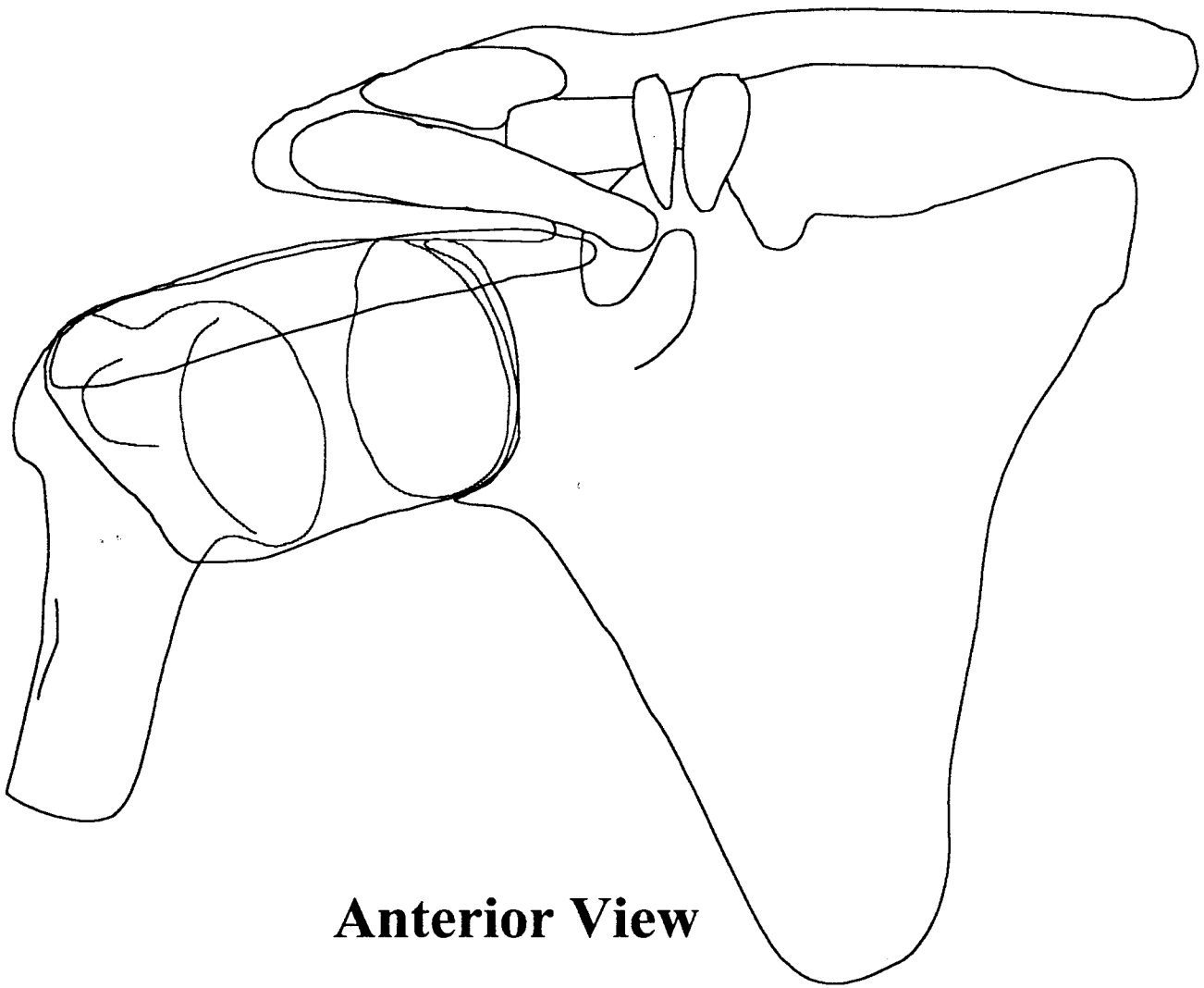
- Consist of metacarpophalangeal joints, proximal interphalangeal joints and distal interphalangeal joints
- Covered by joint capsule
- Joint capsule strengthened by the palmar, collateral and deep transverse metacarpal ligaments

Sternoclavicular Joint



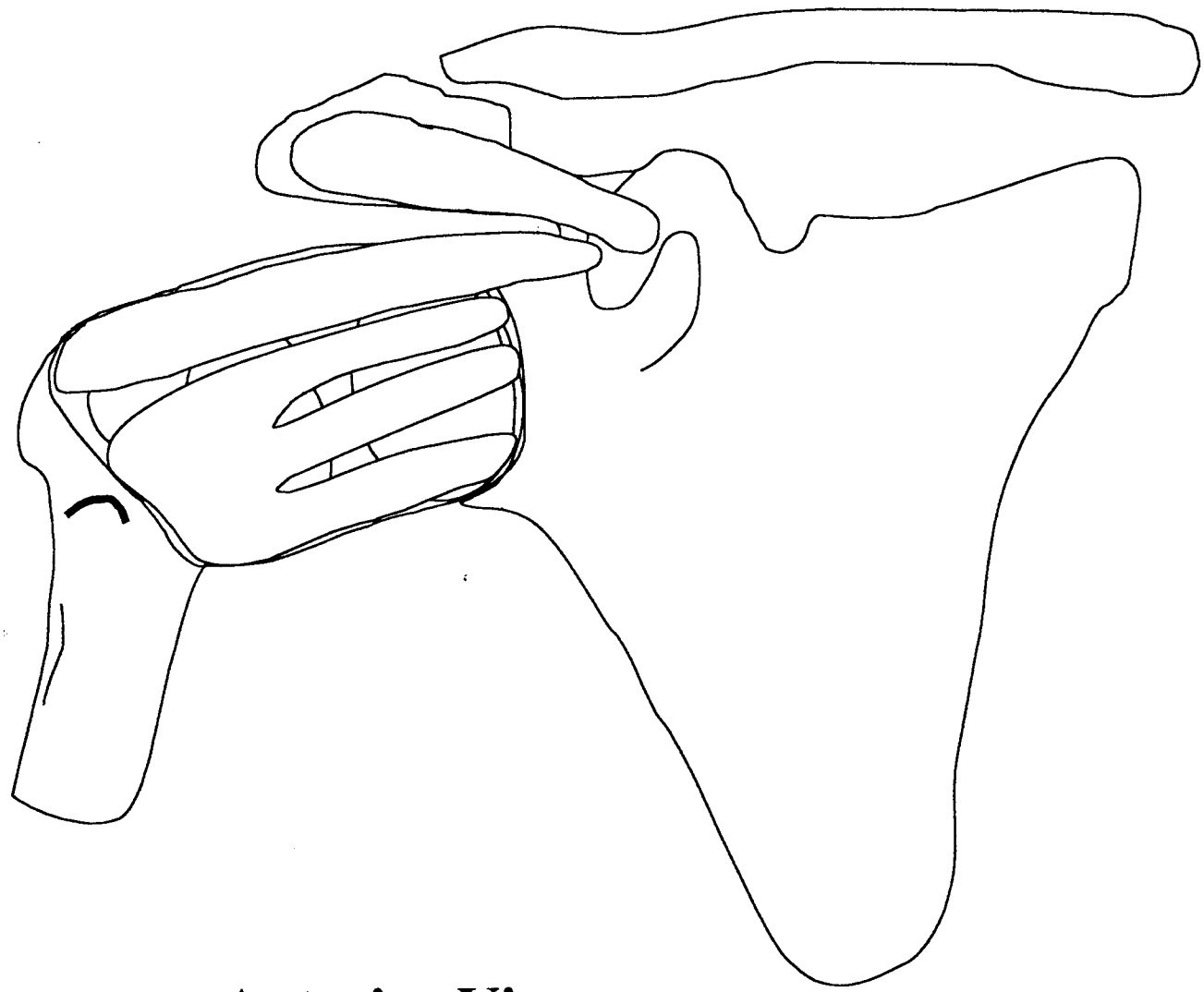
Anterior View

Acromioclavicular Joint



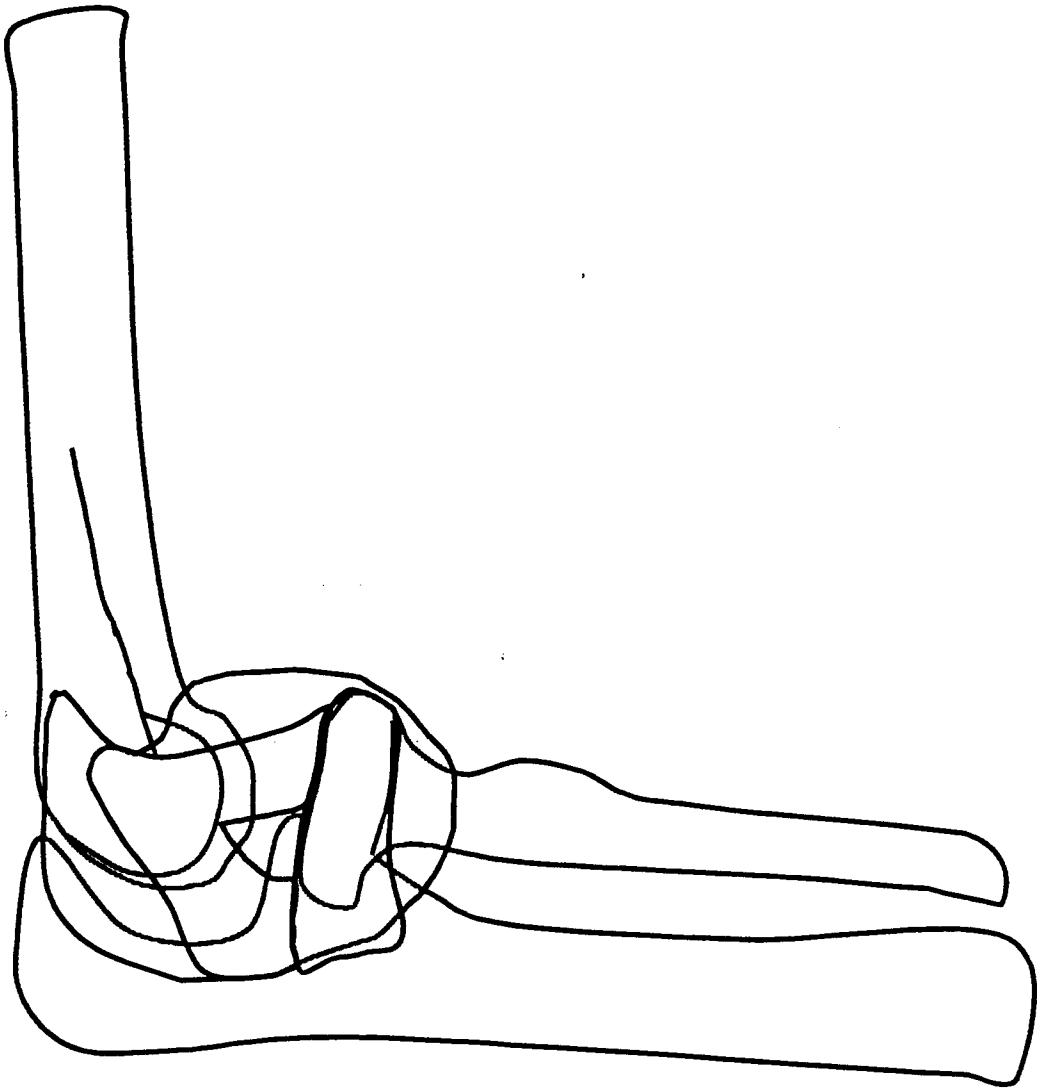
Anterior View

Glenohumeral Joint



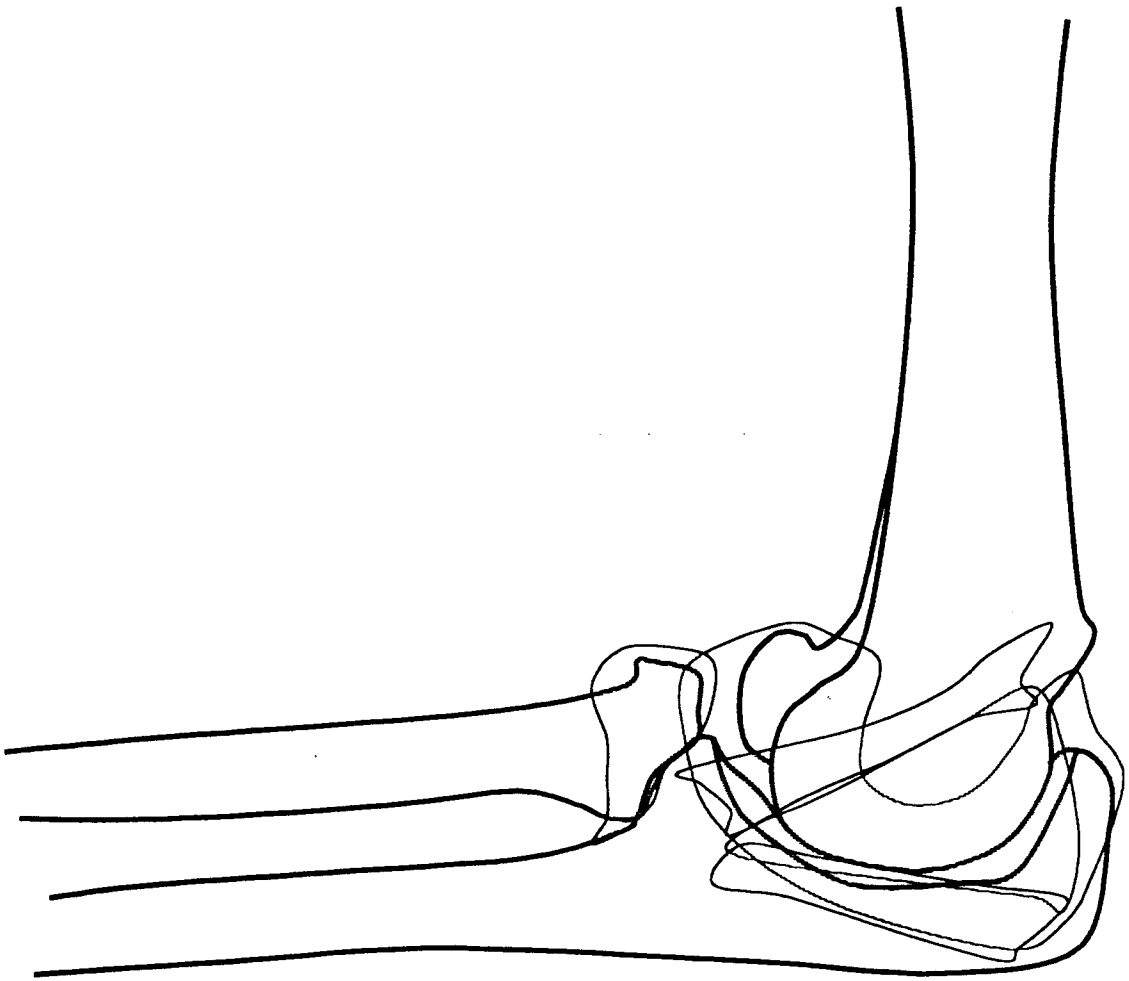
Anterior View

Elbow Joint



Lateral View

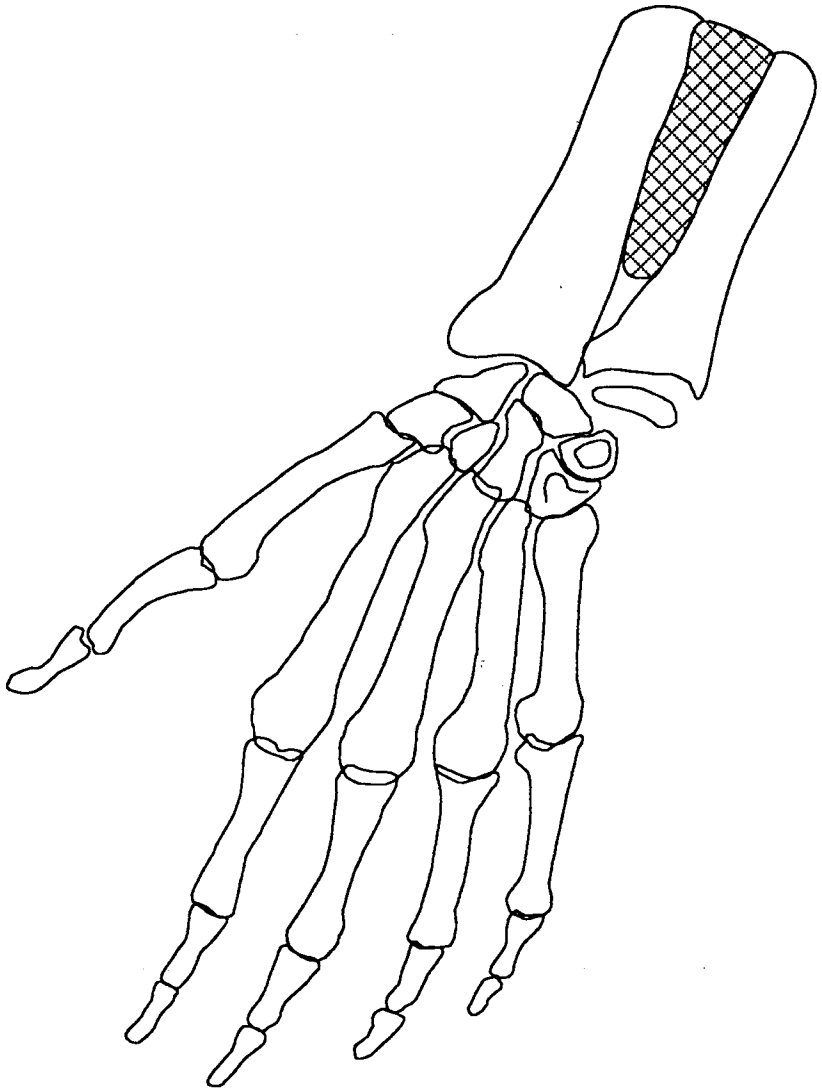
Elbow Joint



Medial View

Overview of Wrist and Hand

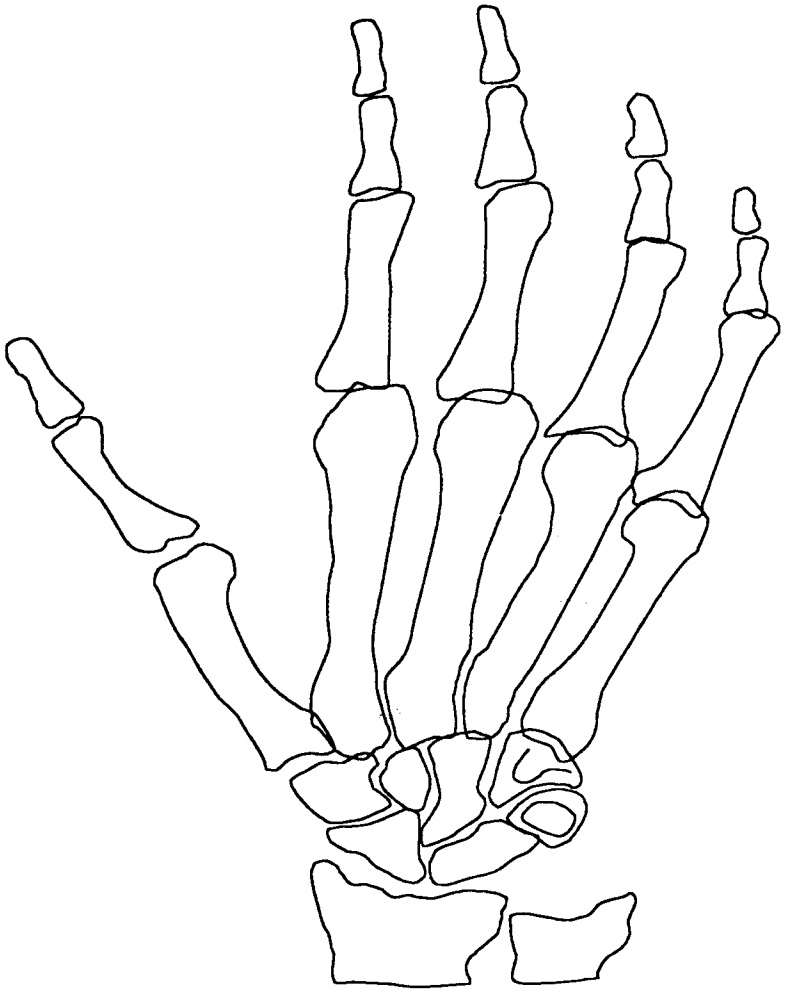
Lateral



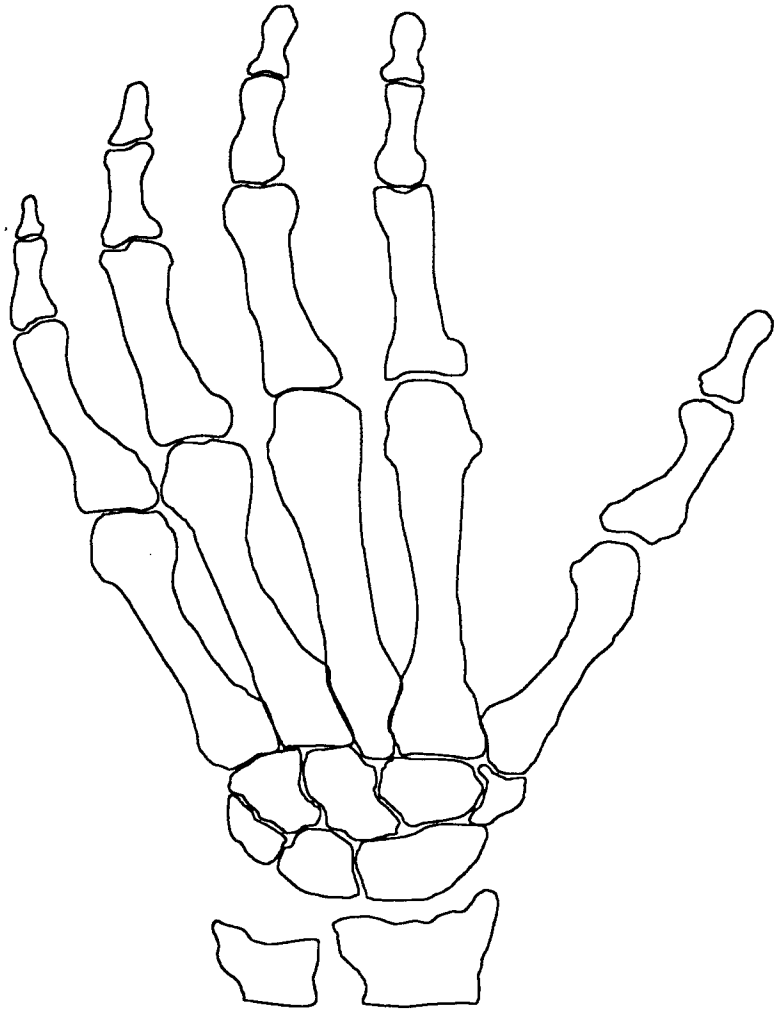
Medial

Palmar View

Bones of Wrist and Hand

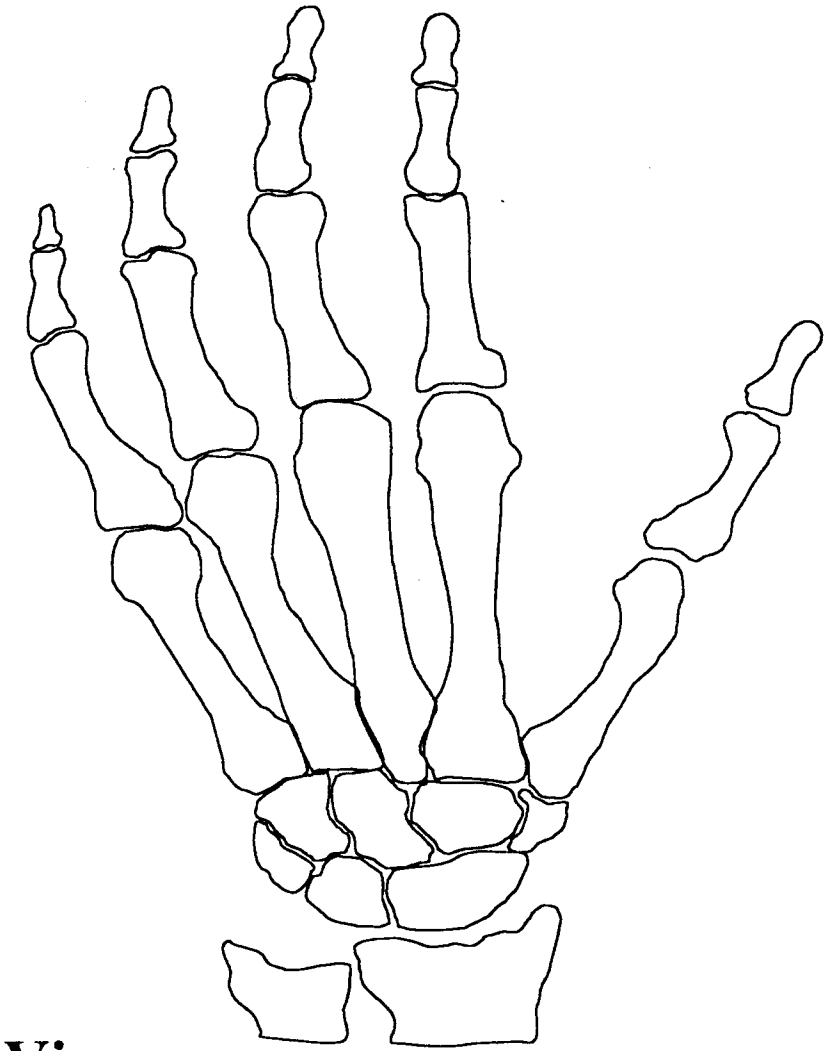


Palmar View



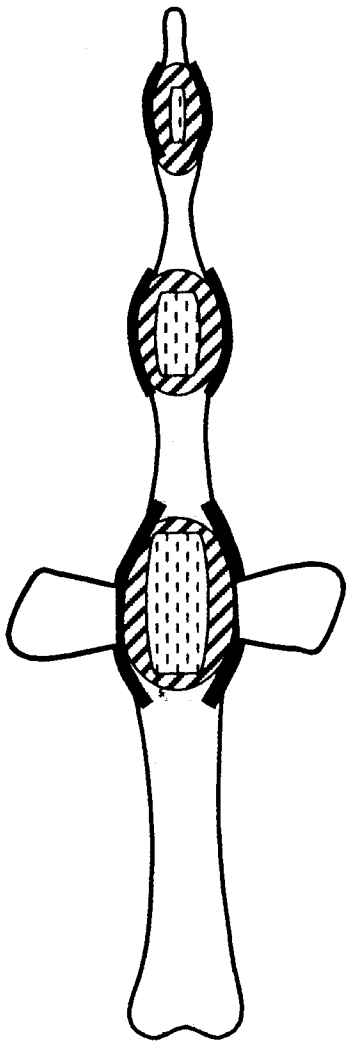
Dorsal View

Joints of Wrist, Hand and Fingers

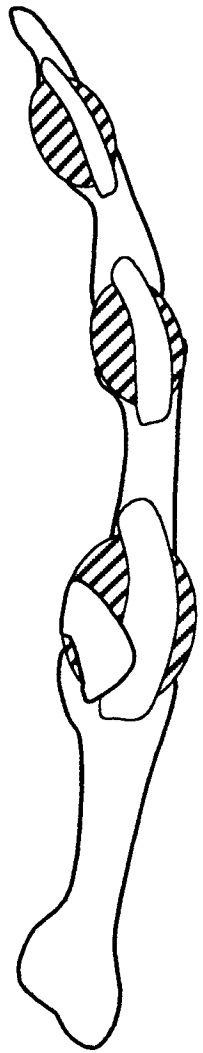


Dorsal View

Joints and Ligaments of the Digits

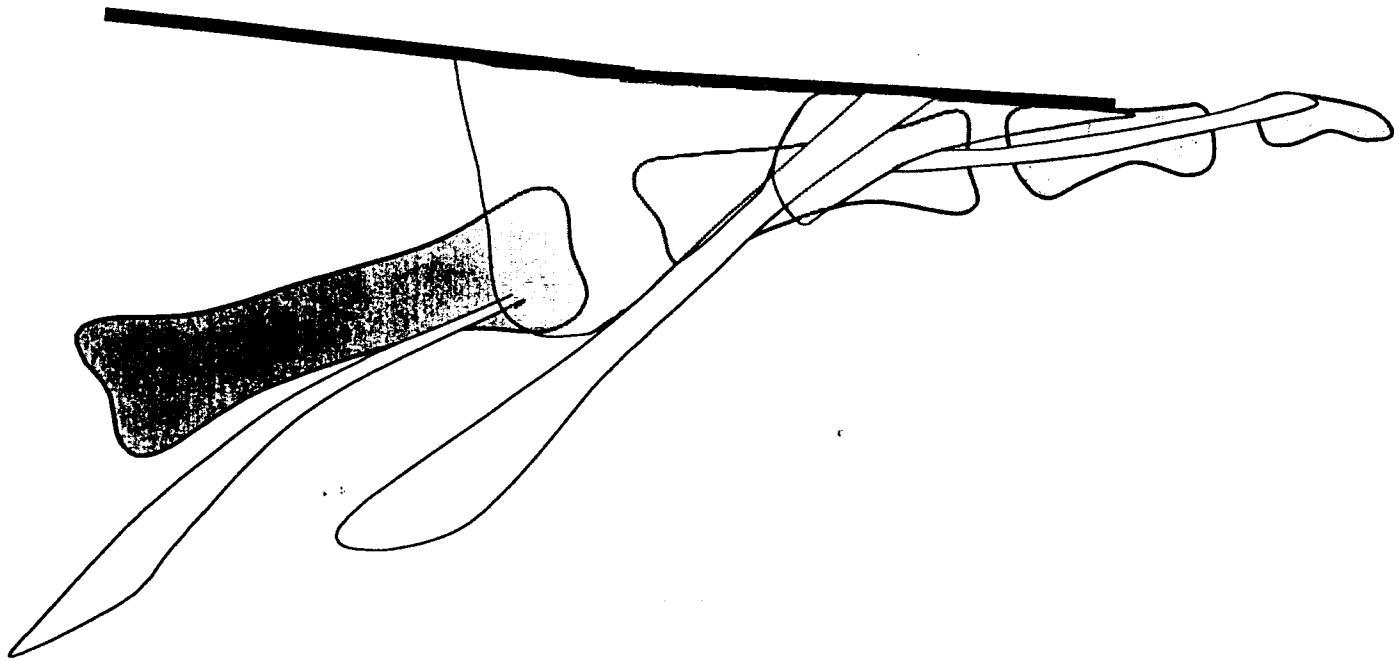


Palmar View



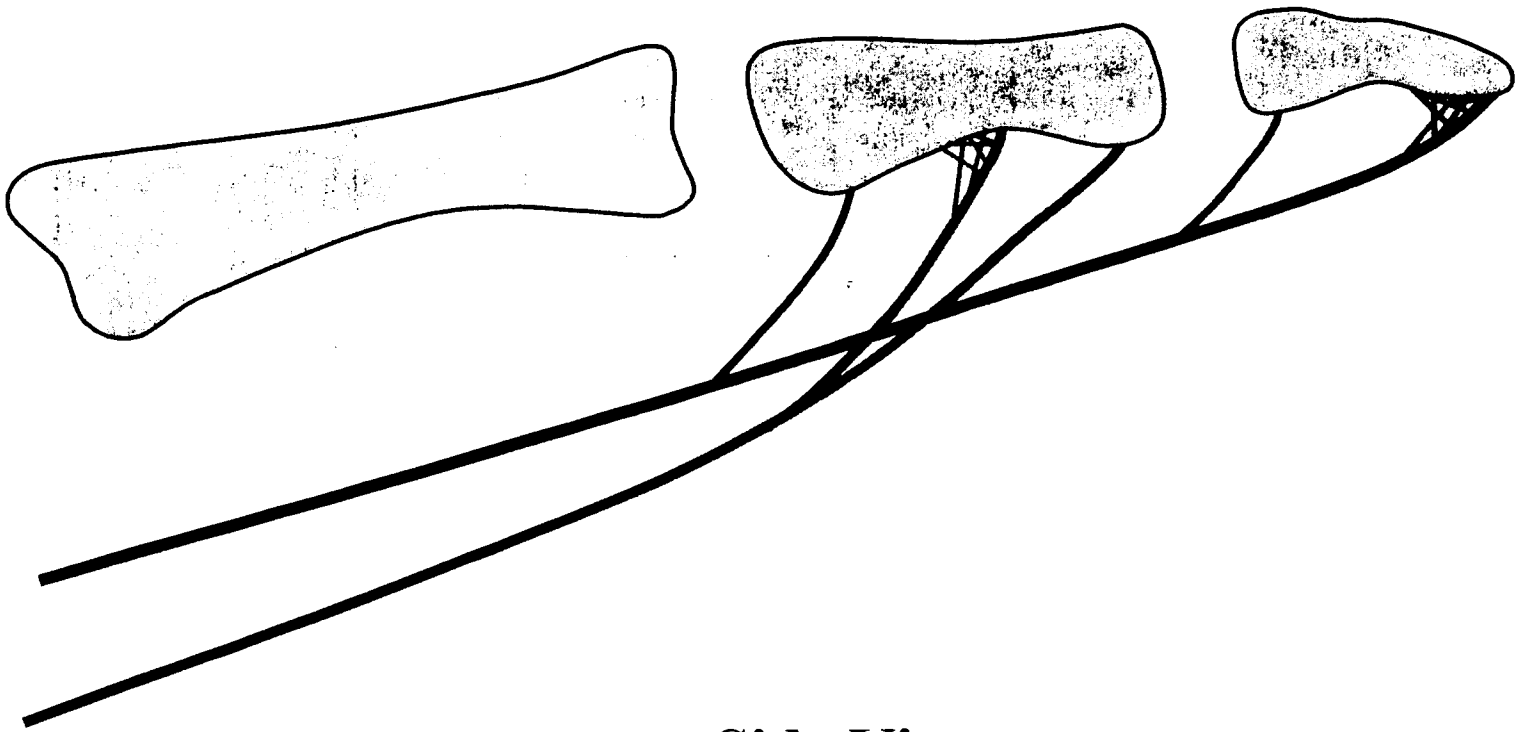
Side View

Extensor and Flexor Apparatus



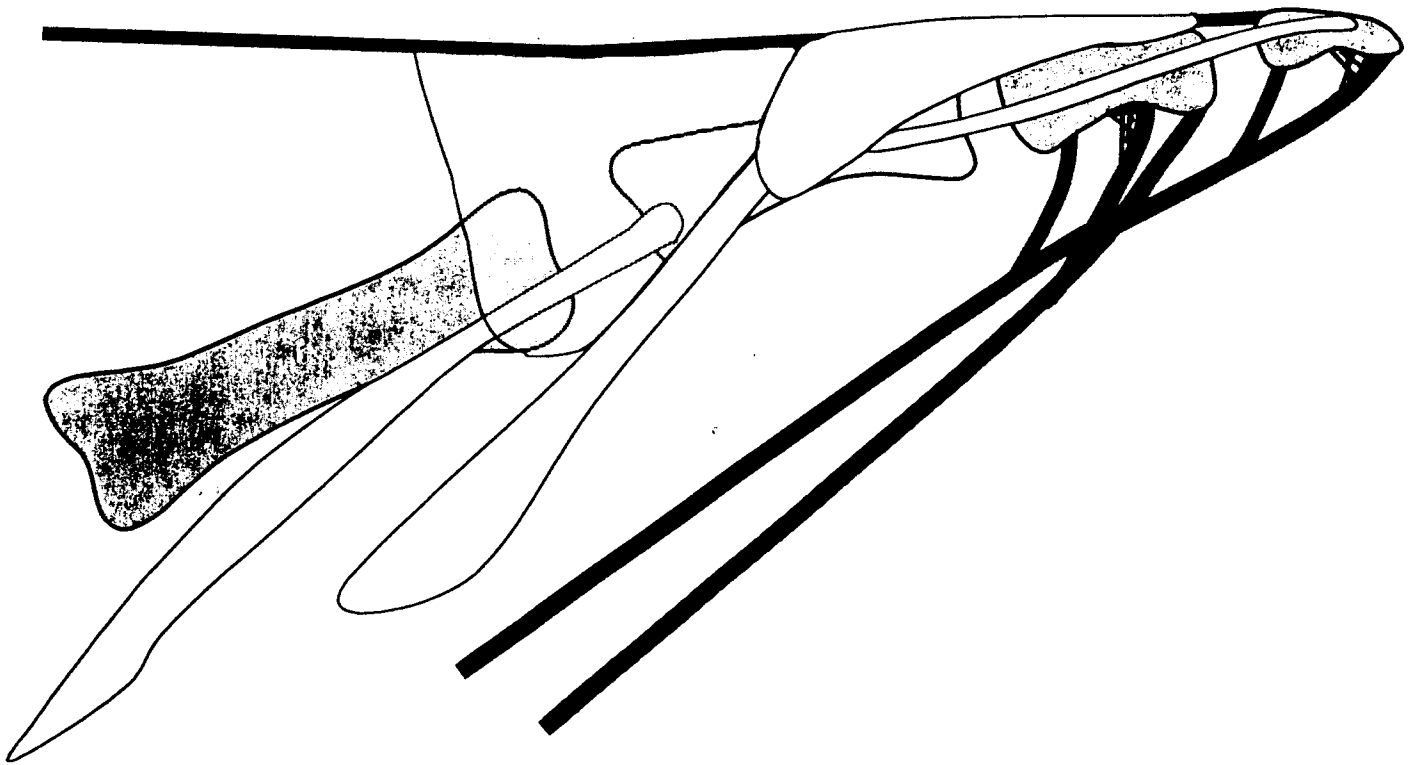
Side View

Flexor Setup



Side View

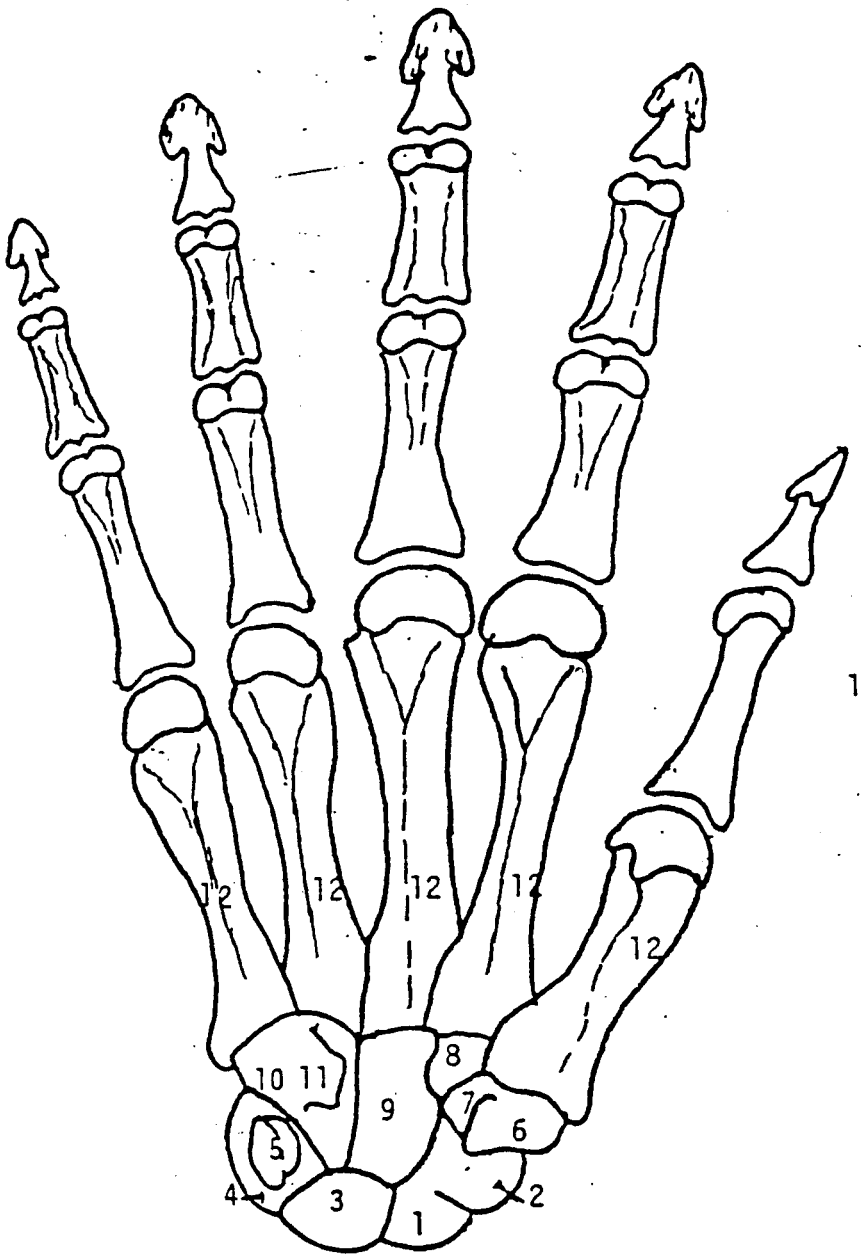
Combined Extensor and Flexor Setup



Side View

THE SKELETON OF THE HAND

anterior or palmar view



bones of carpus

1. scaphoid (navicular)
2. tubercle of scaphoid
3. lunate
4. triquetrum
5. pisiform
6. trapezium
7. groove of trapezium
8. trapezoid
9. capitate (os magnum)
10. hamate
11. hook of hamate
12. metacarpals

    base and head

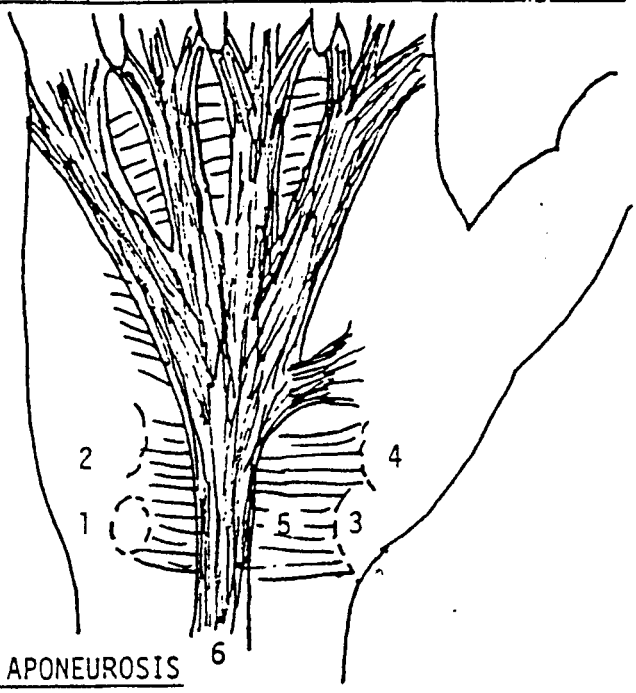
    proximal phalanx

    middle phalanx

    distal phalanx

    (plural = phalanges)

The Palmar Aponeurosis and Flexor Retinaculum



PALMAR APONEUROSIS

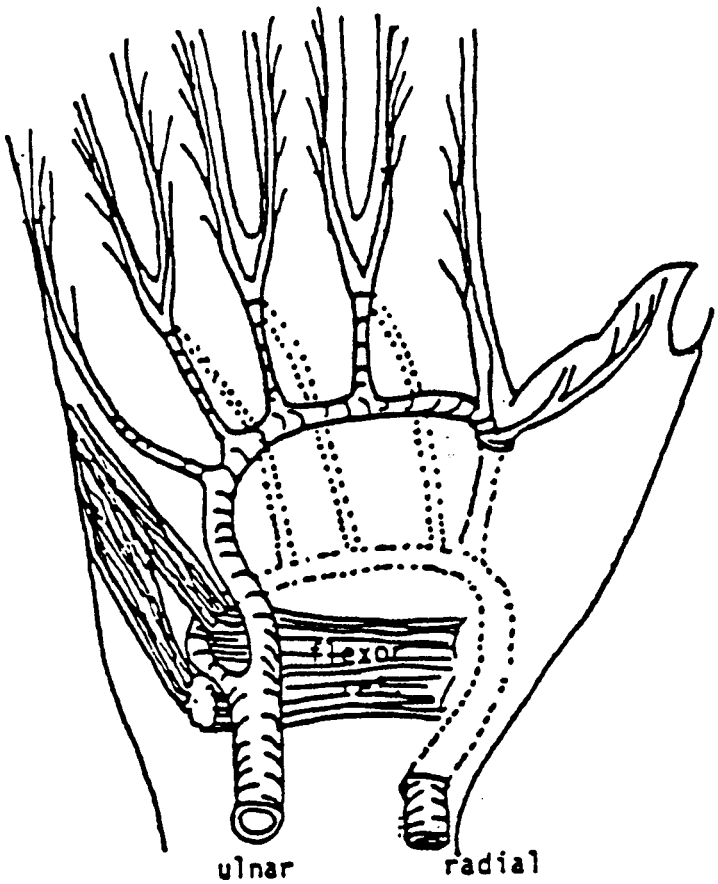
Note on diagram and yourself

1. position of pisiform
2. position of hook of hamate
3. tubercle of scaphoid
4. ridge of trapezius
5. flexor retinaculum (ventral carpal ligament)
6. tendon of palmaris longus

Dense connective tissue triangle attached to flexor retinanculum proximally. Laterally it blends into fascia of thenar and hypothenar muscles. Distally it splits into four slips to the figers which fuse to the capsule of the metacarpo-phalangeal joints and the flexor sheaths of the digits. It is cross reinforced by transverse running bands and sends slips deep into the palm between the flexor tendons.

FUNCTION

It binds the skin of the palm firmly in place and protects the deep structures. Abnormal scarring of this fascia is called Duouytren's Contracture.



THE NERVES OF THE PALM OF HAND

1. Ulnar Nerve
   a. Superficial branch: to skin of 1½ digits
   b. Deep branch: to all muscles not supplied by median

2. Median Nerve
   a. Superficial branch: skin of 3½ digits and lateral 2 lumbricals
   b. Recurrent branch: to 3 muscles of thenar eminence.

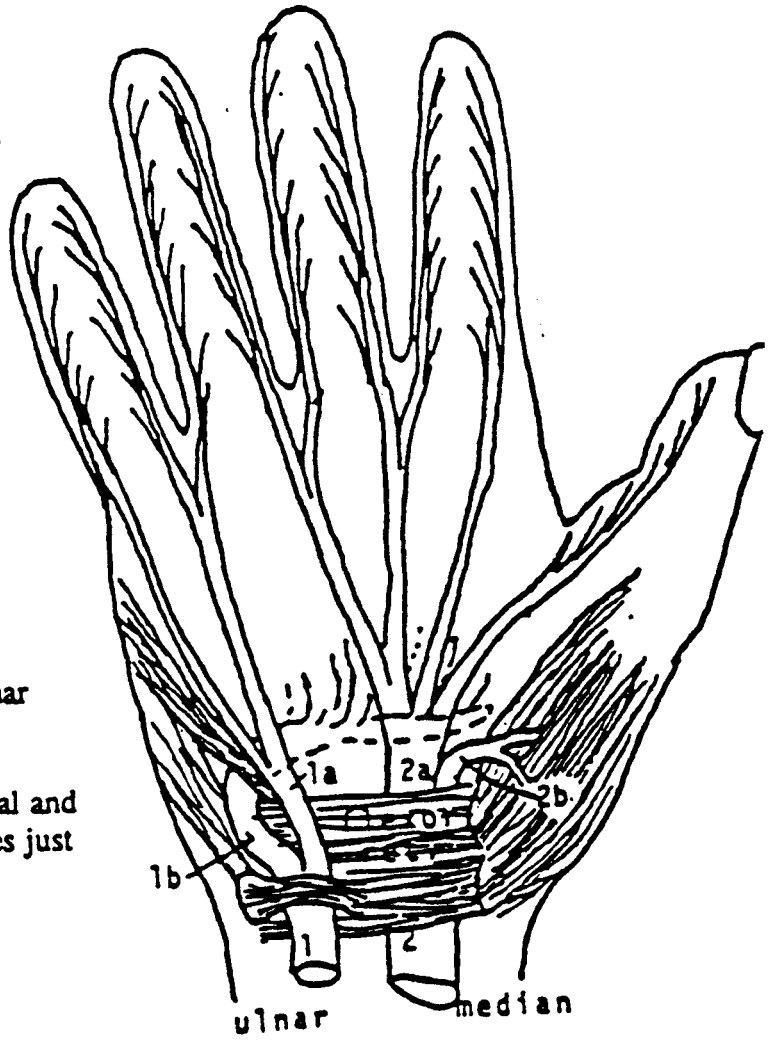
N.B. Dorsum of hand supplied by radial and dorsal branch of ulna which arises just proximal to the wrist joint.

THE SUPERFICIAL PALMAR ARCH

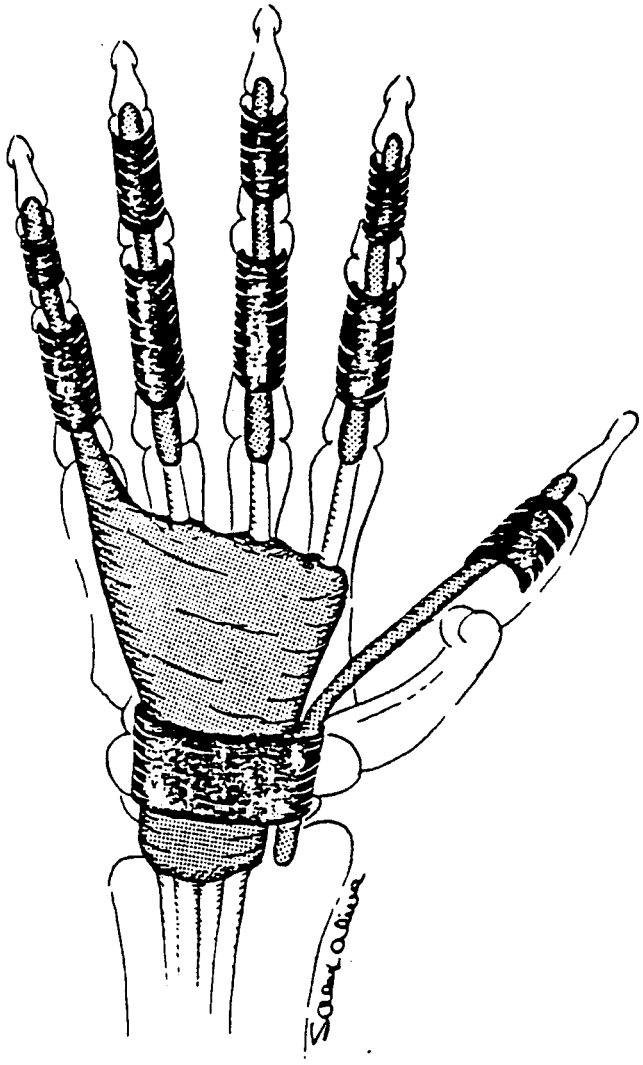
The ulnar artery enters the palm and gives a deep branch to the deep arch. The superficial branch crosses the palm in line with the out stretched thumb to form the superficial palm arch. It is completed by the princeps pollicis or radial indicis of the radial. The arch gives off common digitals to the webs between the fingers which give use to the proper digitals to the fingers rise.

THE DEEP PALMAR ARCH

The radial artery pierces the muscles between the thumb and index and crosses the base of the metacarpals (1" proximal to superficial arch) and gives off re-enforcing branches to those of superficial arch.



Flexor Sheaths



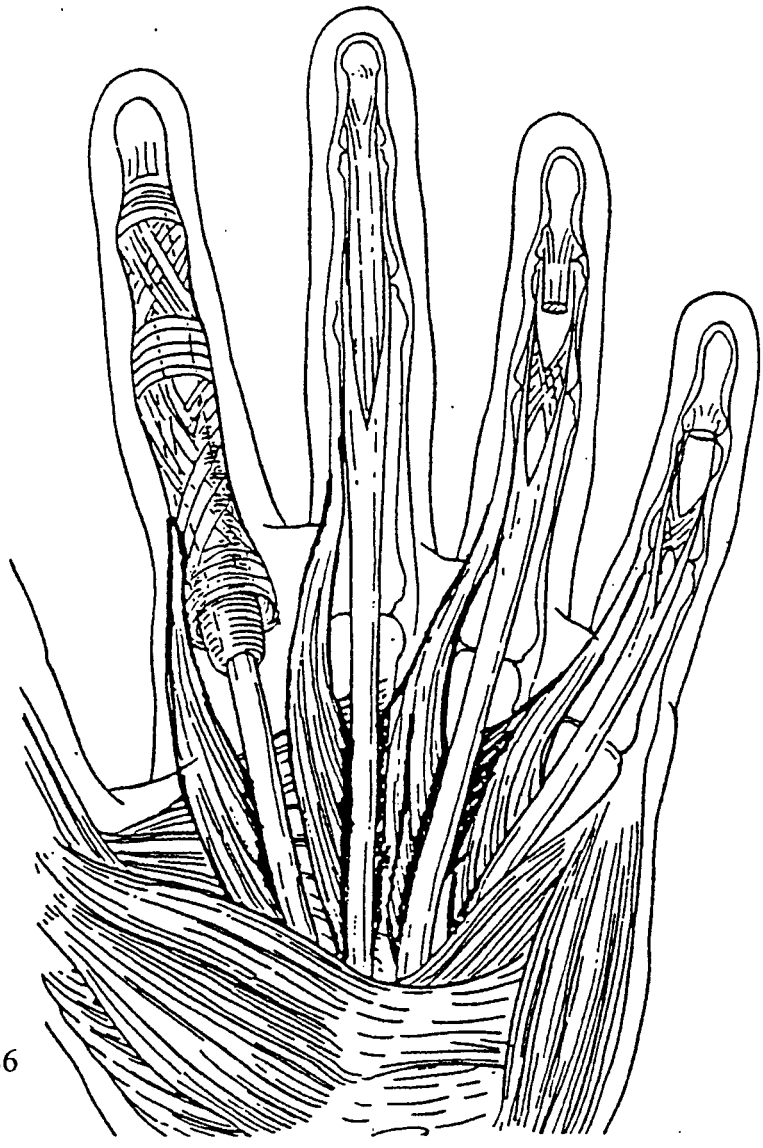
1. flexor retinaculum
   holds long tendons in carpal tunnel

2. digital flexor sheaths
   are like the retinaculum: they bind th
   flexor tendons against the phalanges

3. common synovial sheath
   a bursae surrounding the long flexor te
   allowing them to slide under the retina

4. digital synovial sheaths
   allows the two long flexor tendons to s
   under the digital flexor sheaths. The
   to digit V is continous with the common
   sheath

5. synovial sheath of flexor pollicis
   is a single separate sheath that someti
   communicates to the common one



Flexor Tendons and Lumbricals

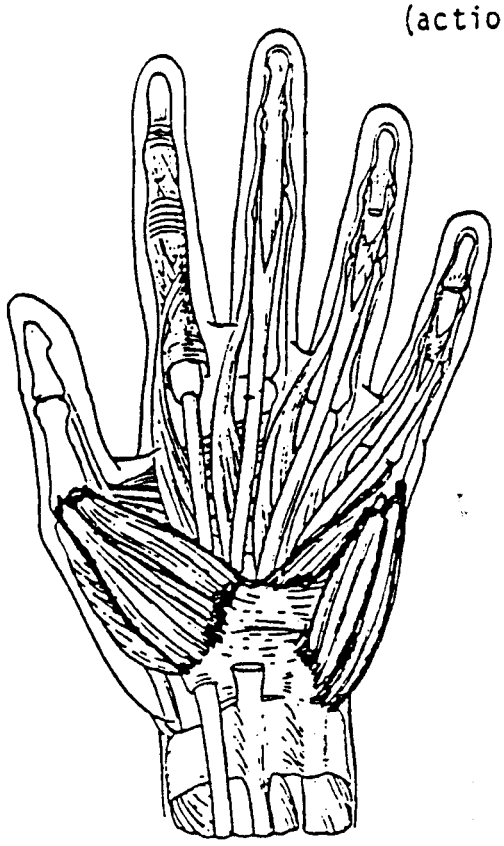
flexor digitorum superficialis
  shown only on digit V

flexor digitorum profundus

LUMBRICAL MUSCLES

  attachments: profundus tendon
    -extensor hood on thumb side
  actions
    flexs M/P - extend I/P
  nerve supply
    lateral 2 - median
    medial 2 - ulna

THE THENAR AND HYPOTHENAR MUSCLES
(action implied by names)



1. FLEXOR POLLICIS BREVIS

attachments: rectinaculum to base of proximal phalanx

2. ABDUCTOR POLLICIS BREVIS

attachments: retinaculum to base of proximal phalanx

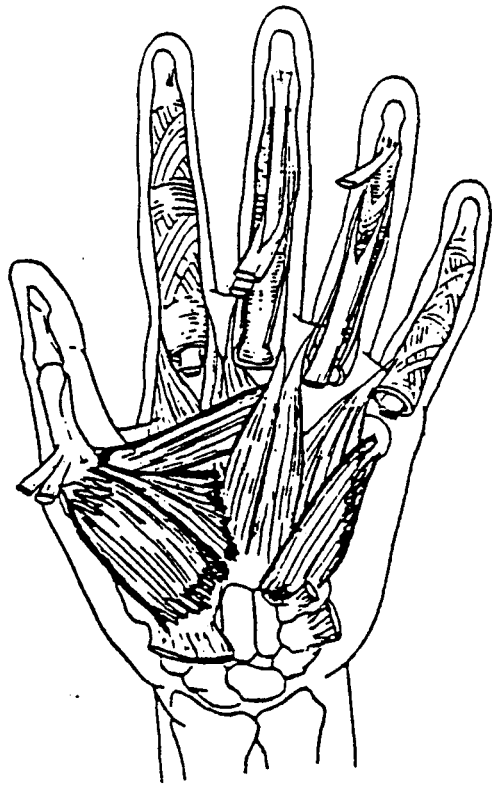
3. FLEXOR DIGITI V

attachments: hamate and rectinaculum to base of proximal phalanx

4. ABDUCUTOR DIGITI V

attachments: pisiform and retinaculum to base of proximal phalanx

The arrangement of muscles is the same on each digit. An abductor on the outside, a flexor towards the midline of the hand and an opponens deep to both.



5. OPPONENS DIGITI V

attachments: rectinaculum to side of fifth metacarpal

6. OPPONENS POLLICIS

attachments: rectinaculum to side of first metacarpal

(This is a very important thumb muscle)

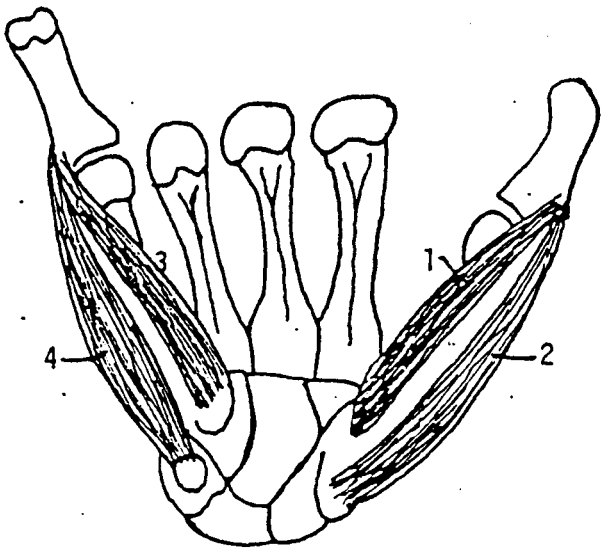
7. ADDUCTOR POLLICIS

attachments: metacarpal III and capitate to base of proximal phalanx

(radial artery passes between heads)

Nerve Supply: Three thenar muscles = median
Three hypothenar muscles <u>and adductor pollicis</u> = ulnar

THE THENAR AND HYPOTHENAR MUSCLES
(action implied by names)



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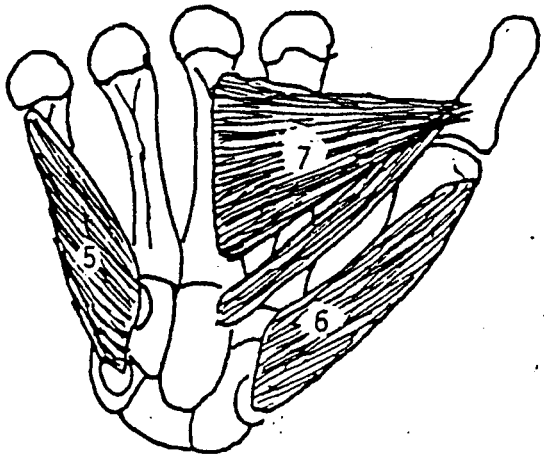

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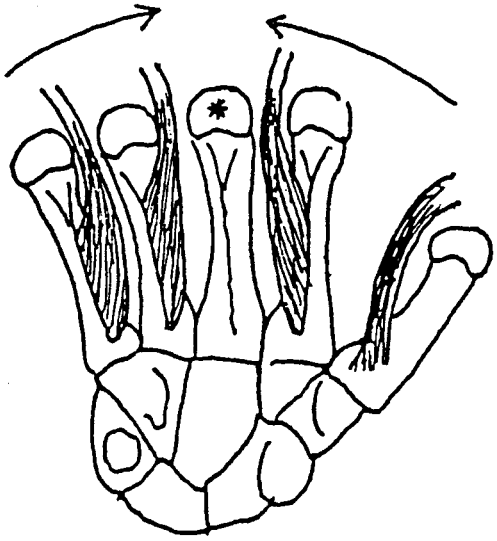
THE INTEROSSEI MUSCLES

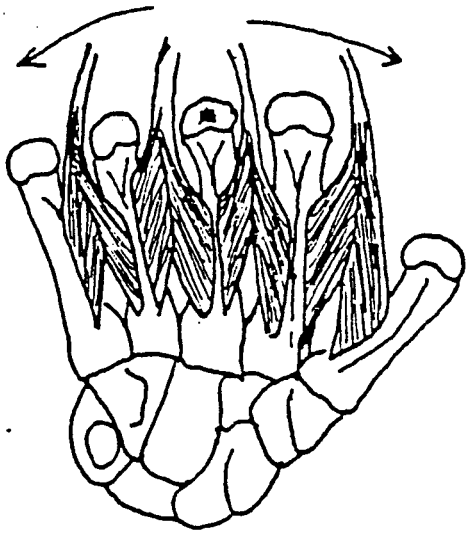


PALMAR INTEROSSEI (VOLAR INTEROSSEI)

attachments: their own metacarpals into the extensor hood

action: adduct the fingers towards midline

Some texts list three palmar interossei instea of four. In this case the interosseous of the thumb is considered as being a deep head of the flexor brevis.



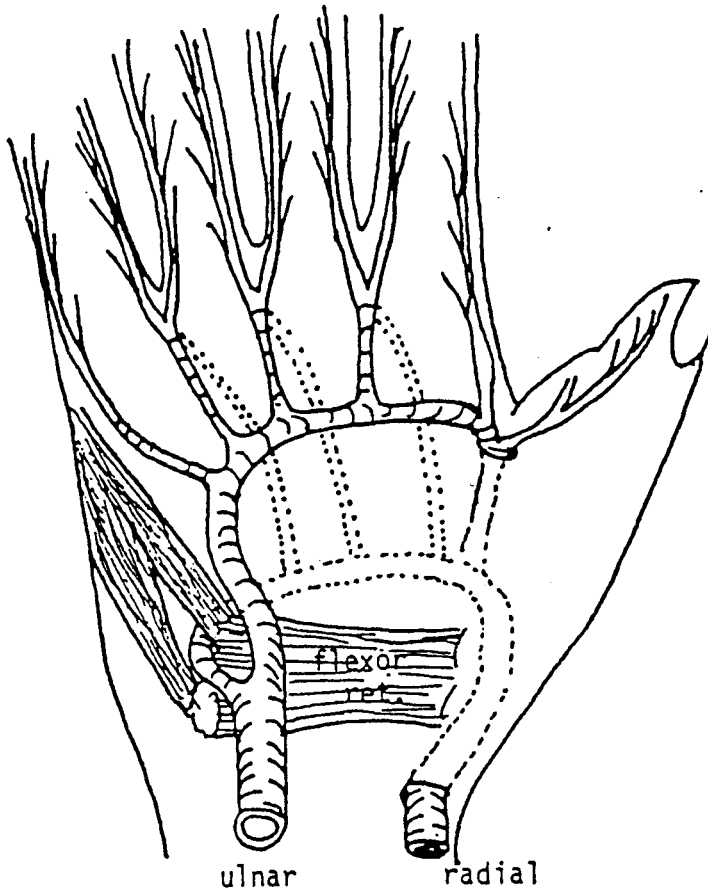
DORSAL INTEROSSEI

attachments: adjacent metacarpals into the extensor hood

actions: abduction of the digits away from midline

Nerve Supply of all interossei = ulnar

N.B. When the interossei act together they cancel each others adduction and and abduction and flex the metacarpal phalangeal joints and extend the the interphalangeal joints. Loss of the ulnar nerve causes a clawing of fingers due to a loss of these very important muscles.



THE NERVES OF THE PALM OF HAND

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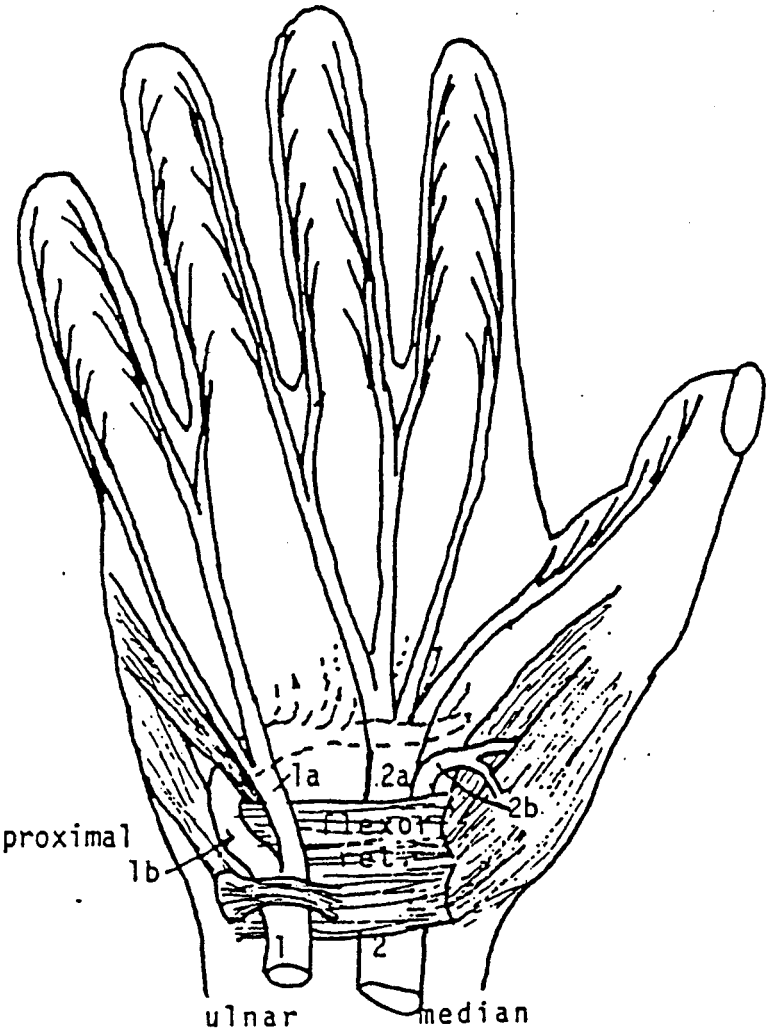
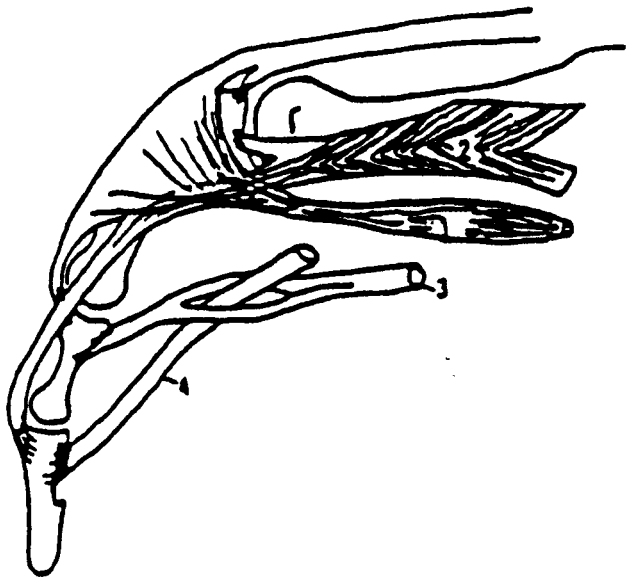


DETAILS OF EXTENSOR EXPANSION



extensor digitorum communis tendon

proximal attachment: capsule of

M/P joint middle band: base of 2nd

phalanx lateral bands: base of distal phalanx

1. lumbrical muscle
2. interosseus muscle
3. flexor superficialis tendon
4. flexor profundus tendon

The extensor expansion or hood is fused to the capsule of the metacarpal phalangeal joints. Because of this, pull on the extensor tendons only extends this joint. The lumbricals and interossei muscles because they attach into the hood distal to the M/P joint pull on the distal part of the expansion and extend the interphalangeal joints. The palmar and dorsal interossei acting together check each others adduction and abduction. The contribution and precise action of the lumbricals is controversial.

REVIEW QUESTIONS

1. What is a surface marking for the superficial palmar arterial arch? Of what artery is it a terminal branch? What is a surface marking for the deep arch? Of what artery is it a branch?

2. Trace the course of both the median and ulnar nerve in the hand.

3. What are the 4 **different** joints flexed by the flexor digitorum profundus?

4. What would be the sensory and motor loss of cutting the median nerve at the wrist? What single movement of the thumb would be lost? What remaining intact muscles would the patient us to perform the other 4 movements?

5. What movement would a patient not be able to perform if the ulnar nerve were cut at the wrist? Do you **understand** why?

6. With a deep puncture wound of the fifth digit on its palmar surface, how does infection spread to the thumb?

THE HAND

Nomenclature:

- consider that the hand has no lateral or medial side
- palmar or volar = front
- dorsal = back
- hand has a radial side and an ulnar side

- The fingers are named:
- lst digit = thumb
- 2nd digit = index
- 3rd digit = middle (long)
- 4th digit = ring
- 5th digit = little (small)

I. Muscles of the Palmar Surface:
   A. Each digit (except the thumb) has three flexible joints
      1. distal joints flexed by flexor digitorum profundi (there are 4 of them)
      2. middle (proximal interphalangeal joints (Abb: PIP) flexed primarily by flexor digitorum superficialis (there are 4 of them)
      3. metacarpal-phalangeal joint (Abb: MP joint) flexed primarily by small intrinsic (arise within the hand) flexors of the hand (there are 3 sets)

Clinical Correlation (CC): If you have a lesion of the palm, you can tell which muscles have been damaged by testing their actions:

1. Profundi are mass flexors of the distal phalanx – they act as a unit (very few people have independent flexion of distal phalanx – and then it is usually only the index finger).
2. Superficialis muscle acts independently at middle joint.

I. Innervation:
   A. On the volar side, the muscles are innervated either by the median nerve or by the ulnar nerve.
      1. lst rule of anatomy – skin overlying the muscles, is innervated by the nerve that innervates the underlying muscles.
      2. Ulnar nerve innervates 2 profundi (those of the ring and little finger) and the flexor carpi ulnaris (which functions to bend the wrist over to the ulnar side.
      3. All of the long flexors that come from the forearm to the hand are innervated by the median nerve, or a branch of the median nerve- these include:

a. 2 profundi to middle and index finger
b. 4 superficialis muscles
c. flexor pollicis longus (innervated by anterior interosseous n. , a branch of the median nerve)
d. flexor carpi radialis (wrist flexor on radial side)
e. palmaris longus (15 to 18% do not have this muscle and some people have it only on one side)
f. pronator teres
g. pronator quadratus (innervated by the anterior interosseous [C8], a branch of median nerve)

N.B.: f and g above pronate the hand at the wrist – pronation is a median nerve function.

Clinical Correlation: The palmaris longus muscle is important clinically because it's tendon is used by surgeons to replace other tendons in surgery of the hand.

III. Down in the hand itself, there are many structures packed in a small amount of space.

A. 9 tendons
1. 4 superficialis
2. 4 profundi
3. flexor pollicis longus

B. Median Nerve:
1. can be found beneath the palmaris longus
2. absolutely the most important nerve of the hand
a. it moves the thumb
b. most importantly it supplies sensation
1. without the median nerve, the hand would be "blind."
2. would be able to rotate or pronate the thumb – sometimes can be compensated for by cross-innervation from the ulnar nerve.

Clinical Correlation: There is a serious problem in patients with leprosy. They experience anesthesia of fingertips, even if very little is left in terms of motor function, you can maintain a certain degree of hand function, if the median nerve is spared.

C. Carpel Canal (Carpal tunnel)
1. 8 carpal bones form a concavity for tendons to pass through
2. transverse carpal ligament (flexor retinaculum) across the top – sheath of fibrous tissue

Clinical Correlation: Swelling due to arthritis, inflammation, or injury can lead to compression within carpal tunnel. If median nerve is compressed,within tunnel, pain and numbness results. Often it is necessary to do a surgical release to relieve compression. If the condition is neglected, permanent numbness and loss of motor function to the point of compression.

IV. Intrinsic Muscles of the Hand:

A. defined as muscles that arise and end in the hand.
1. they are short
2. they are important – provide fine mobility of fingers, allow manipulation
3. there are 20 intrinsic muscles of the hand.
- 5 are innervated by the median nerve or branches
-15 are innervated by the ulnar nerve " "

a. Intrinsic Muscles Innervated by the Median Nerve
(1) abductor pollicis brevis – left thumb off the palm
(2) opponens pollicis – draws the thumb toward the palm as it is being rotated
(3) flexor pollicis brevis has two heads
- superficial head – innervated by median nerve
- deep head – innervated by deep branch of ulnar nerve (C8 & T1)
a. flexes the proximal phalanx of thumb, and continues to act, flexes the metacarpal bone and rotates it medially. In the latter movement it cooperates with opponens pollicis muscle.

N.B. These three muscles (abductor pollicis brevis, opponens policis and flexor pollicis brevis) are the key muscles involved in the rotation of the thumb across the palm. The movement takes place at both the metacarpophalangeal and carpometacarpophalangeal joints.

(4 & 5 lumbricals)
a. radial side act as flexor of MP joint and extend IP joint
b. All other intrinsic muscles of the hand are innervated by the ulnar nerve, These include:
1. flexor pollicis brevis – deep head flexes the paroximal phalanx of thumb, flexes metacarpal bone, rotates it medially.
2. adductor pollicis – very strong – brings thumb against palm, used when adducted thumb is also flexed as in gripping.

Clinical Correlation: (adductor pollicis can adduct the thumb, but can not pronate the thumb. A patient with a lesion of the median nerve will be able to draw the thumb across

the palm (adduction), but will not be able to position the plane of the thumbnail parallel to the palm of the hand (pronation).

3. abductor digiti minimi abducts little finger away from 4th, thus it takes part in habitual spreading the digits when they are extended.
4. flexor digiti minimi brevis, flexes the little finger at the metacarophalangeal joint.
5. opponens digiti minimi draws 5th metacarpal bone forward and rotates it laterally at metacarpophalangeal joint.
6. lumbricals of the 4th and 5th digits (Note lumbrical muscles link one tendon (flexor) to another (extensor).

N.B. When the middle, ring or little finger is flexed fully at the MP joint and the proximal interphalangeal joint (PIP), its distal phalanx can neither be flexed or extended by voluntary effort so long as the other fingers are kept extended The inability to extend the distal phalanx is due to the way extensor digitorum are inserted. The terminal phalanx can be extended only when the middle phalanx is also extended.

7. interossei (7) – 2 groups
   a. volar (palmar): The first palmar interosseous flexes and adducts the proximal phalanx of the thumb.
   b. dorsal: abduct the fingers (spreading the fingers apart) relative to a central axis through the middle finger. The interossei in conjunction with the lumbricals, flex the proximal phalanges; as a consequence of their insertion into dorsal digital expansions, they are able in certain conditions, - extend the middle and distal phalanges.
8. palmaris brevis – not important – has no function other than to wrinkle up palmar skin.

N.B. When one loses the function of a muscle, there may not be a way of controlling the unopposed force – this can be the result in a variety of deformities.

V. DORSAL ASPECT OF THE HAND

A Everything on the dorsal aspect is innervated by the radial nerve (or a branch... posterior interosseous or deep radial nerve (both are the same)

1. abductor pollicis longus radial wrist deviator as well as an abductor of thumb. Acting with abductor pollicis brevis, abducts thumb with extensor pollicis., It extends the thumb at carpometacarpal joint.

2. extensor pollicis brevis extends the proximal phalanx of the thumb in continued action, helps to extend metacarpal bone.

N.B.: In the lower part of the forearm, the abductor pollicis longus and extensor pollicis brevis become superficial by emerging between extensor carpi radialis brevis and

extensor digitorum. Muscle also forms boundary of anatomical snuff box with abductor pollicis longus.

3. extensor pollicis longus forms ulnar boundary of "snuff box" Extends the distal phalanx of the thumb, and acting in association with extensor pollicis brevis and abductor pollicis longus, it extends the proximal phalanx and the metacarpal. In continued action, owing to the obliquity of the course of its tendon, extensor pollicis longus, adducts the extended thumb and rotates thumb laterally.

4. four communis (extensor digitorum) tendons
5. extensor indicis proprius independent extensor of index finger
6. extensor digiti minimi-independent extensor of little finger

Clinical Correlation: A patient with a lesion of the extensor indicis proprius will not be able to extend the index finger, while keeping the others flexed. Similarly, the extensor digiti minimi can be tested in this manner.

A. Wrist Movements:
   1. flexor carpi radialis longus (median nerves C6 and C7)
   2. flexor carpi ulnaris (ulnar nerves C7 and C8)

N.B. Wrist Movement: With flexor carpi radialis and flexor digitorum superficialis.. The flexor carpi ulnaris flexes the wrist; with extensor carpi ulnaris it adducts the hand. Both flexor and extensor carpi ulnaris act as synergists to prevent abduction of the hand when the thumb is extended at the carpometacarpal joint.
Flexor carpi ulnaris also flexes the pisiform bone during abduction and flexion of the little finger.
When the wrist is flexed against resistance, notice that two tendons are prominent; flexor carpi radialis (laterally) and the palmaris longus in the mid line. Flexor carpi ulnaris (medially) can also be identified proximal to the pisiform bone.

B. Across the dorsum of the hand – radial to ulnar (review)
   1. abductor pollicis longus: To base of lst metacarpal, abducts thumb and extends it at the carpometacarpal joint; innervated by the posterior interosseous nerve (C7, C8) a branch of radial nerve

   2. extensor pollicis brevis: To base of proximal phalanx of thumb. Extends thumb at MP and carpometacarpal joint. Nerve supply, posterior interosseous (C7, C8).

   3. extensor pollicis longus: to base of distal phalanx of thumb. Extends thumb at IP, MP, CMP joints. Nerve supply posterior interosseous C7, C8, a branch of radial nerve.

4. extensor carpi radialis longus: To base of index (2nd) metacarpal slightly to the radial side. Extends and abducts hand – tends to radially deviate the wrist (but only slightly when extending). (radial nerve C6 and C7)

5. extensor carpi radialis brevis: To base of 3rd metacarpal: extends and abducts the hand. When extending wrist, it brings wrist up in a central position. Nerve supply deep branch of radial (posterior interosseous) . Deep branch of radial – a branch of radial nerve .

6. extensor digitorum (communis) (4) To extensor expansions of the index, middle, ring, and little fingers (muscle divides into four tendons, which pass with extensor indicis proprius through a separate tunnel under extensor retinaculum. Tendons diverge to 4 fingers. The tendon to the index is accompanied by extensor indicis.]
Nerve supply is the posterior interosseous nerve (C7 and C8). Extends the index, middle, ring and little fingers at their MP and IP joints and extends the hand.

7. extensor indicis proprius: To ulnar side of communis tendon (extensor expansion) of index finger. Extends index finger at MP and IP joints. Nerve supply, posterior interosseous (C7, C8)

8. extensor digiti minimi: To extension expansion (communis tendon) of little finger. Extends little force at MP and IP joints (nerve supply - posterior interosseous of radial nerve, C7, C8)

9. extensor carpi ulnaris: To base of 5th metacarpal. Extends and adducts the hand. Nerve supply posterior interosseous nerve (C7 and C8).

10. supinator located proximally in forearm

Clinical Correlation: The wrist is the key joint of the hand and its position will affect the functions of the muscles of the hand. For instance, extending the wrist can assist weak flexors of the fingers. This is used in reconstructing a badly damaged hand. When the wrist is extended, you independently extend the 3rd and 4th digits, because you can use your instrinsic muscles to help. The instrinsic muscles are the actual extensors of the two distal joints. Through a complicated arrangement, they are able to transfer their amount of action to extend the distal two joints. By extending the wrist, one allows the instrinsic muscles to come into play and help to independently extend the fingers.

Extensor carpi radialis longus and brevis act synergically with the flexors of the fingers, for example, when the fist is clenched. Working with the extensor carpi ulnaris, they extend the wrist; working with flexor carpi radialis, they abduct the hand.

VI. The Extensor Hood (see Hollinshead, pp 294-296)

A. 1. Common extensors go out onto the proximal phalanx

2. At the proximal phalanx, there is an extensor hood

a. goes down and around MP joints

b. tethers common extensor to act as an extensor of the proximal phalanx

c. tendon blends into a fibrous sheath that runs out to the distal phalanx contributed by:

1. tendon from interossei
2. tendon from lumbrical (on radial side only)
3. there is a ligament between these two tendons called the intrametacrpal ligament

-this whole structure terminates on the dorsal aspect of the distal phalanx

d. secondary insertion at the base of the middle phalanx – aids in complete extension when the wrist is extended

e. the axis of flexion is below the line of pull of the interossei and lumbricals tendons – consequently, - they act to extend the distal two joints.

f. Ligament underneath hood that attaches to flexor tendon sheath – ligament of landsmeer (hard to see except in fresh specimen) – located just below the axis of flexion – function to resist hyperextension.

Clinical Correlation: Minor injuries to this hood arrangement can cause havoc with finger in terms of flexion and extension. Two examples:

1. Patient bangs dorsal aspect of the PIP joint. Swelling results – "tough" patient keeps working it – phalangeal head batters hood, eventually pushes up through hood – finger goes into a flexed deformity at the middle joint.

   Dynamic tendon band of hood (common extension tendon + tendons from the lumbricals and interossei) is now below the axis of the joint (has dropped to the side) middle joint is hyperflexed, distal joint is hyperextended – very difficult to fix (if possible at all) – called the Boutinere Deformity.

2. Dynamic tendon band of hood rides up (usually associated with arthritis) – base of proximal phalanx moves down toward palm – get hyperextension at middle joint, hyperflexion of the distal joint – called swan neck deformity (telescoping of the finger) – not hard to repair as boutinere deformity.

VII. Flexor tendon sheath

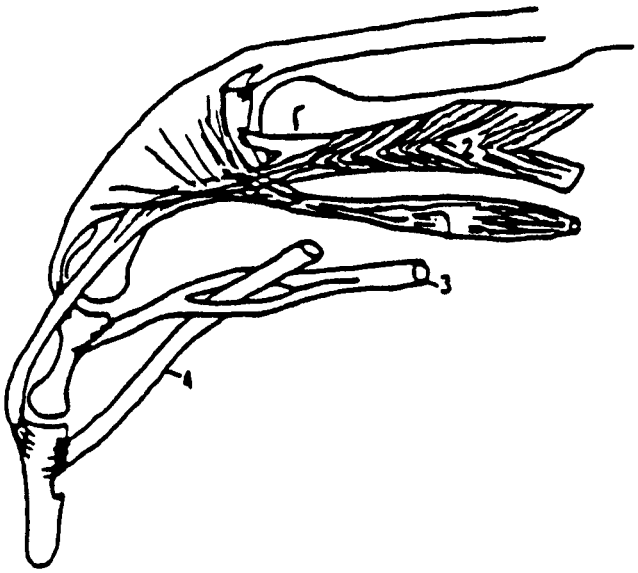
A. A tunnel of fibrous tissue on the volar aspect of the hand

B. 1. superficialis splits in two
   2. profundus runs between the two halves of the superficialis tendon
   3. the superficialis inserts on the sides of the volar aspect of the middle phalanx

C. profundus inserts on the distal phalanx

Clinical Correlation: This is a tight space. Any injury (infection, cut, etc) can lead to significant scarring which will freeze the tendons in the canal. This used to be called "no man land" because doctors were reluctant to operate in this area during the time of acute injury for fear that there would be such scarring. With the advent of better instruments and techniques, doctors now can perform surgery in this area, but not without risk. The sheath runs from the middle of the proximal phalanx to the distal palmar crease (last crease in the hand). The tendons are very tightly applied to one another in this tunnel which holds these against the phalanges for efficiency of flexion.

DETAILS OF EXTENSOR EXPANSION



extensor digitorum communis tendon
proximal attachment: capsule of
M/P joint middle band: base of 2nd
phalanx lateral bands: base of distal phalanx

1. lumbrical muscle
2. interosseus muscle
3. flexor superficialis tendon
4. flexor profundus tendon

The extensor expansion or hood is fused to the capsule of the metacarpal phalangeal joints. Because of this, pull on the extensor tendons only extends this joint. The lumbricals and interossei muscles because they attach into the hood distal to the M/P joint pull on the distal part of the expansion and extend the interphalangeal joints. The palmar and dorsal interossei acting together check each others adduction and abduction. The contribution and precise action of the lumbricals is controversial.

REVIEW QUESTIONS

1. What is a surface marking for the superficial palmar arterial arch? Of what artery is it a terminal branch? What is a surface marking for the deep arch? Of what artery is it a branch?

2. Trace the course of both the median and ulnar nerve in the hand.

3. What are the 4 **different** joints flexed by the flexor digitorum profundus?

4. What would be the sensory and motor loss of cutting the median nerve at the wrist? What single movement of the thumb would be lost? What remaining intact muscles would the patient us to perform the other 4 movements?

5. What movement would a patient not be able to perform if the ulnar nerve were cut at the wrist? Do you **understand** why?

6. With a deep puncture wound of the fifth digit on its palmar surface, how does infection spread to the thumb?

REVIEW QUESTIONS

1. What parts of the clavicle and scapula can be palpated in the living subject?

2. What muscles act in forceable adduction of the arm? What muscles act in passive adduction of the arm (watch it)?

3. Where do you think the brachial plexus is must vulnerable?

4. If the upper trunk of the brachial plexus were damaged, what muscles would be affected? Which one lease?

5. If the lower root of the brachial plexus were damaged, which major "long distance' nerve would be most affected? Which one least?

6. What nerve accompanies the thoraces-dorsal artery? Through what space does the posterior circumflex artery pass? What nerve accompanies it?

7. What functional loss will occur after damage to mhe axillary nerve? Do you think this nerve is vulnerable to injury?

8. How can blood bypass the first two stages of the axillary artery?

9. What is the purpose of a bursa? Which one in the shoulder is commonly inflamed? Why?

10. Which of the rotator cuff muscles is most susceptible to damage? How does the patient compensate for its loss?

11. What structures give support and protectionto the shoulder joint?

12. Review all the muscles which aid in the movement of the shoulder.

13. What parts of the ulna can be easily palpated? Of the radius?

14. What is the relationship of the styloid process of the radius with that of the ulna? How does this limit wrist movements?

15. Where can you palpate the radial artery?

16. What would be the effects of a dislocated lunate bone?

17. What is the relationship of the median nerve to the biceps tendon?

18. Between what two muscles does theulnar nerve traverse the forearm?

19. Against what muscles does the median nerve traverse the forearm?

20. In injection of the cubital vein, what structures might be accidentallly damaged? What structure usually prevents this from happening?

#1

CASE HISTORY

A 16-year old male football athlete was engaged in a "blocking drill," where he was asked to "drive" his shoulder repeatedly into a thin pad attached to a metal frame. He experienced considerable pain on one impact and heard a "cracking" noise at the same time. He was taken to the locker room, and, on removal of his shirt and pads, it was noted that his right upper limb seemed to be "hanging" low, and there was a conspicuous bump on the top of his shoulder. Attempt to abduct the shoulder, whether carried out by the patient or by his examiners, caused extreme pain. On examination the shoulder was extremely tender (painful) near the bump and less so on the nearby areas of skin.

A. What is the nature of the injury, and what anatomic structures are involved?

B. What accounts for the protuberant "bump" on the crown of the shoulder?

C. What sort of treatment is recommended for injuries of this sort?

#2

CASE HISTORY

A 19-year old motorcycle enthusiast was riding on a slick pavement street after a light rain. Attempting to negotiate a turn at high speed, the motor cycle spun out and the rider was thrown, landing on the pavement on his outstretched hands. He had gloves on, and suffered no abrasions. He checked himself over and seemed to be in one piece, and retrieved his motorcycle and went on his way. Later that evening while watching TV, his left wrist began to throb, and the pain increased steadily. He could move all his fingers, and decided to "tough it out" and see how things were in the morning, realizing he had no insurance. He took aspirin and some Percodan (a strong opiate pain killer) left over from some dental work he had undergone some months before, and controlled the pain. This went on for several days and the pain then seemed to improve and he forgot about the injury in the ensuing weeks.

About 3 months later, however, he began to experience renewed pain in the wrist, and it began to be more difficult to carry out a full range of motion. He was also having some intermittent fevers. By this time he had acquired a job offering health insurance, and went to the doctor. Examination of the wrist revealed pain to passive motion in several directions and point tenderness over the anatomic "snuff box." There was also some redness over the wrist, and blood test showed signs of inflammation (an elevated white cell count).

A. What was the differential diagnosis for the original injury?

B. How did the patient endure the early symptoms and seemingly recover?

C. What was the particular injury suffered by this patient?

D. What accounts for the late-onset symptoms?

#3

CASE HISTORY

A 77-year-old female was walking outside her home during winter and slipped on a hidden patch of ice. She used outstretched arms to break the fall and heard a cracking sound. After the fall, she observed that the dorsal surface of her left wrist seemed to protrude posteriorly in an unnatural fashion. She went to the doctor's office, and she noted further that her right and left upper limbs were no longer the same length. An x-ray of the wrist was taken, and it showed damage to both radius and ulna.

A. What part of the radius is fractured in this sort of injury?

B. How does the injured limb come to be shorter than the normal limb?

C. Why is such an injury more serious in a young child than in older adults?

#4

CASE HISTORY

A 25-year old man was a belted passenger in an auto crossing an intersection when the car was hit on the rider's side by a speeding car running through a red light. The impact occurred on the young male passenger's right arm. He was transported to Hershey Medical Center. In the emergency room, it was noted that his head and neck were uninjured, apart from superficial abrasions and a "whiplash." His right upper limb, however, had a spreading haematoma on the lateral surface of the arm, and an x-ray confirmed a clean midshaft fracture of the humerus. It was noted on the x-ray that the proximal fragment of the humerus was tightly applied to the wall of the axilla, and that the upper end of the distal humeral fragment seemed to have slipped superior and lateral to the proximal humeral fragment. Over the course of the next several hours, the patient experienced a progressive weakness in the extension of his wrist. He could flex his elbow, though weakly in comparison to normal. He could supinate and pronate his forearm. He could still curl his fingers into a partial fist although he could not close his fist tightly. Sensation was intact on the anterior surfaces of the arm and hand, but inconsistent on the dorsal surface of the forearm and hand.

A. Why is the proximal humeral fragment adducted?

B. Why did the distal fragment slide superior and lateral to the proximal fragment?

C. What accounts for the weakness of the elbow flexion?

D. Why are supination and pronation intact?

E. Why was he unable to extend his wrist, and why was wrist flexion limited?

F. Why was finger flexion limited?

#5

CASE HISTORY

A 47-year-old right-handed anatomy professor decided he would take his 14-year-old son, a new member of the tennis team, and provide him with some high-level competition on the tennis courts. The professor had not played tennis for some time, but felt he could rely on his always-strong serve to impress his son. The two volleyed for a long period and then played two vigorous sets of tennis. The son diplomatically allowed his father to win in the first set, and darkness fell and the match was discontinued. The next morning the father found it very painful to attempt to grasp something with his right hand, his elbow was swollen, and he was forced to withdraw from the planned completion of the tennis match with his son. After taking some antiinflammatory medication, the pain abated, and he was able to hold things in his hand. He tried to do some work in his shop later in the afternoon, but found that the use of a screwdriver produced excruciating pain in the elbow region once again.

A. What is "tennis elbow?"

B. Which particular stroke in tennis is likely to produce it?

C. What anatomical facts explain why the attempt to use the screwdriver exacerbated the pain?

#6

CASE HISTORY

A 27-year old farmer inadvertently had his left hand and wrist run over by a tractor and the blade attached to its front end. He suffered serious superficial lacerations on both the anterior and posterior sides, and it was clear that certain deeper blood vessels and tendons had been lacerated as well. His surgeon at the Penn State College of Medicine realized that a prolonged period of repair of these tendons and vessels and the cleaning and closure of more superficial lacerations would be required. The anesthesiologist recommended that a single injection of anesthetic agent might be used to make these repairs with no discomfort to the patient.

A. What is the nature of the injury, and what anatomic structures are involved?

B. What is the anatomic landmark guide for the placement of anesthetic agent?

#7

CASE HISTORY

A 24-year-old female office worker named Isabel became pregnant, and as her pregnancy progressed she noticed that her fingers seemed stiffer and it was difficult for her to type on her word processor. She found that she could only type for 5 to 10 minutes at a time, and her wrist would begin to ache and further typing would be impossible. Subsequently she began to notice that her index and ring fingers seemed numb and on closer examination that her thumb was also partially numb as well. She was somewhat surprised that her doctor prescribed diuretics or "water pills," and she was advised that wearing a splint on her wrist while sleeping would be useful.

A. Why should pregnancy have an effect on this woman's ability to type?

B. Why are the fingers on the lateral side of her hand affected most?

C. What is the rationale for prescribing the diuretics and the use of the splint?

#8

CASE HISTORY

A large female newborn infant (nine and one-half pounds) was delivered vaginally with some difficulty. In particular, after the baby's head had emerged from the birth canal, the shoulders seemed to be "stuck." The obstetrician gently turned the baby's head so that it was facing to the left and then pulled downward on the head and neck in an effort to get the upward-facing anterior or right shoulder of the baby to emerge next. After a few moments this was accomplished, and thereafter the left shoulder emerged relatively easily, as did the trunk and the remainder of the body. The baby cried immediately, was active and vigorous and was pronounced in good health. Later that day, however, it was noticed that the baby seemed not to move her right upper limb very well, while she freely moved her left upper limb and both lower limbs. Moreover, the right upper limb seemed to be held close alongside the body, with the elbow extended and the forearm pronated.

A. What accounts for the combination of the upper limb abnormalities observed in this baby?

B. What mechanism likely produced the injuries seen here?

C. What is the likely outcome in cases such as these?

VERTEBRAL COLUMN

A. Pertinent features of individual vertebrae.

1. The typical vertebra composed of body and vertebral arch.

   a. Body - serves as a primary weight-bearing and shock absorbing component, and each adjacent body is separated by an intervertebral disc.

   b. Vertebral arch - consists of paired pedicles and laminae, a spinous process, arising from the union of the two laminae, paired transverse processes, and paired superior and inferior articular processes that generally arise from the pedicle and the laminae.

      (1) Spinous process and Transverse process ace as levers to which muscles and ligaments are attached to aid in moving and stabilizing the vertebral column.
      (2) Inferior articular processes of one vertebra are joined by a synovial joint (zygapophyseal joint) to the superior articular processes of the next lowest vertebra. The facing direction of their cartilage-covered articular facets largely determines the type of motion permissible between vertebrae in different spinal regions. While most of the weight-bearing functions are borne by the bodies, the articular processes do offer some support particularly in the lower lumbar and lumbosacral region where the overlapping of the inferior articular processes over the next lower set of superior articular processes help to resist the tendency of one vertebra to slide forward on the next lower one.

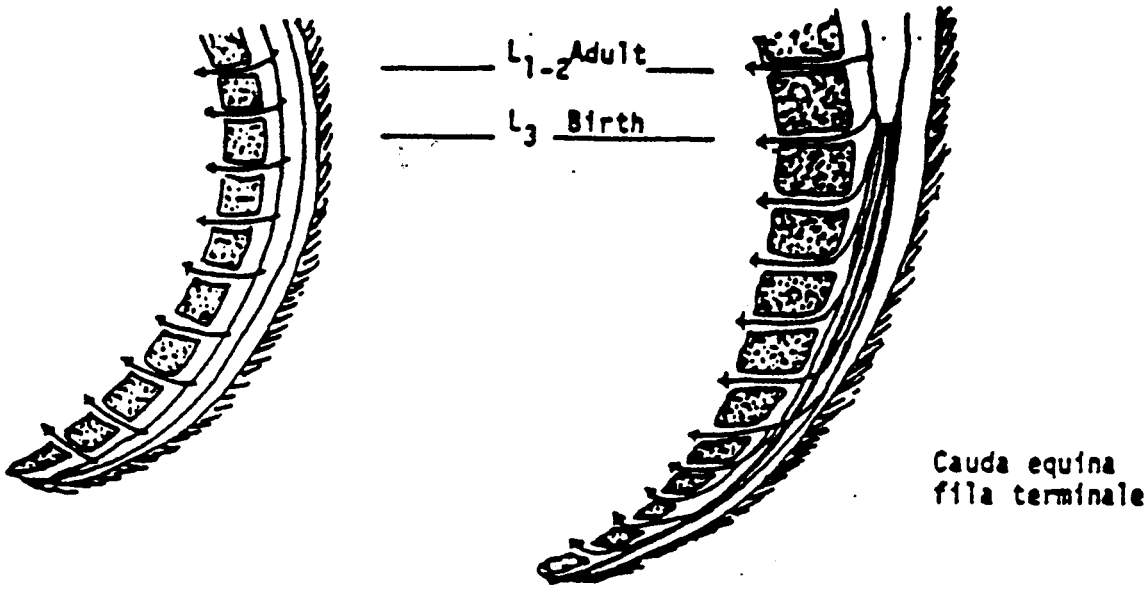
   c. Vertebral body and arch enclose the vertebral foramen. The longitudinal formed by successive vertebral foramina is the vertebral canal which houses the spinal cord, roots of the spinal nerves and related meningeal structures.

   d. Boundaries of the intervertebral foramen

      (1) Superior - pedicle of the vertebra above. The lower margin of the pedicle, which forms the superior boundary of an intervertebral foramen.
      (2) Inferior - pedicle of the vertebra below.
      (3) Posterior- inferior articular process of the vertebra above and the superior articular process of the vertebra below as they form the zygapophyseal joint.

"Recession" of the neural tube.

There is an important shift in the relationship of the neural tube to the developing vertebral column; originally, the neural tube is enclosed by the developing vertebral column from cranial to caudal poles, but because the vertebral column lengthens faster, there is a relative "recession" of the neural tube with time.



6. Congenital malformations.
   a. Failure of neural arches to fuse - spina bifida, meningocele (1/1,000 births)
   b. Development of only one-half of vertebral body - scoliosis
   c. Pilonidal sinus/cyst

E. Differentiation of Dermatome and Myotome.

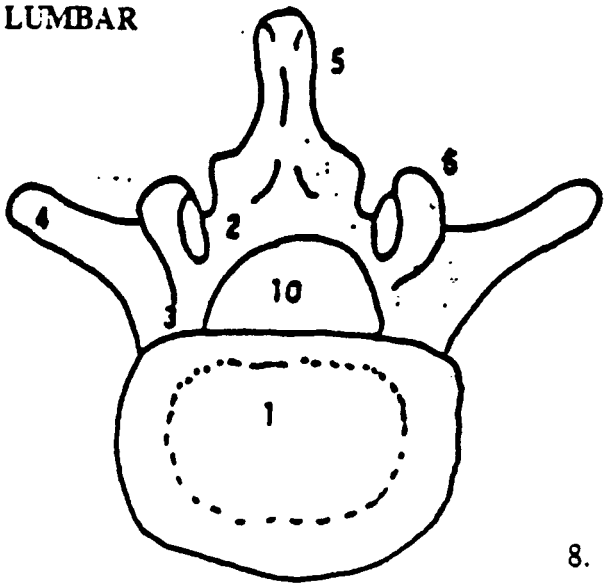
1. Dermatome arises from dorsal lateral corner of somite and spreads beneath the ectoderm to form dermis.

2. Myotome is the central block of the somite which forms muscle of trunk.

VERTEBRAL OSTEOLOGY

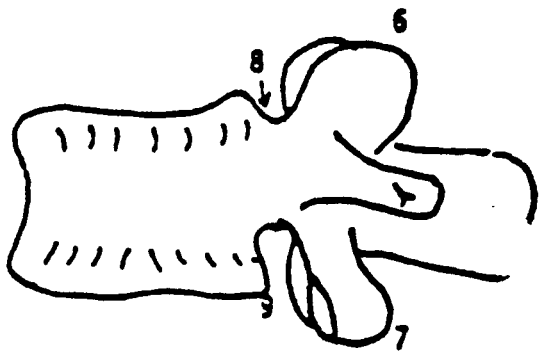
The vertebral column is made up of 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 2-3 coccygeal vertebrae.

LUMBAR

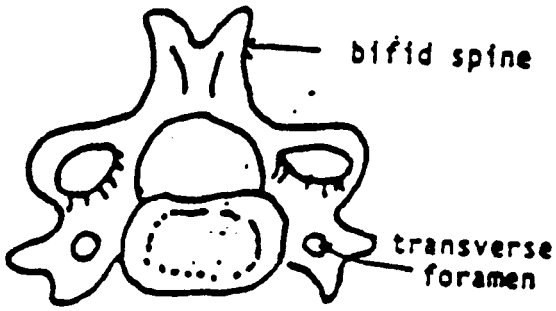


Parts of a typical vertebrae

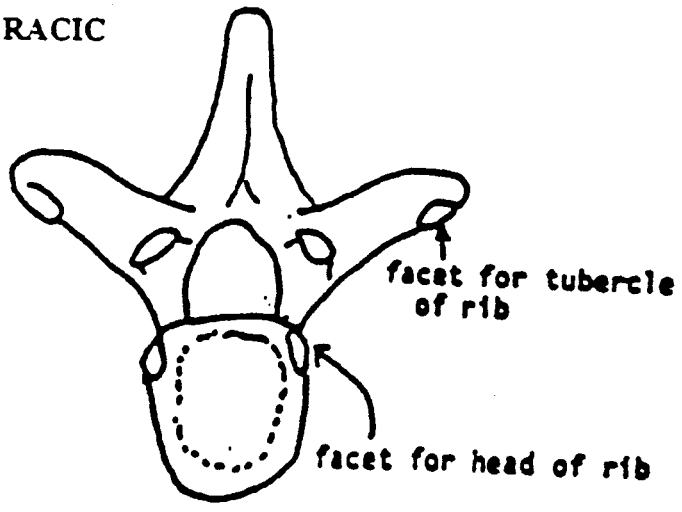
1. body
2. lamina
3. pedicle
4. transverse process
5. spine
6. superior articular process
7. inferior articular process
8. superior notch
9. inferior notch
10. vertebral canal



CERVICAL

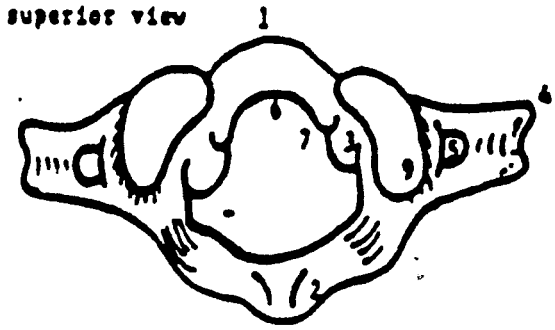


THORACIC



The first 2 cervical vertebrae are greatly modified as will be seen later. The sacrum consists of 5 units which begin to fuse about age 20. The discs between them, however, may persist late into life.

CERVICAL OSTEOLOGY

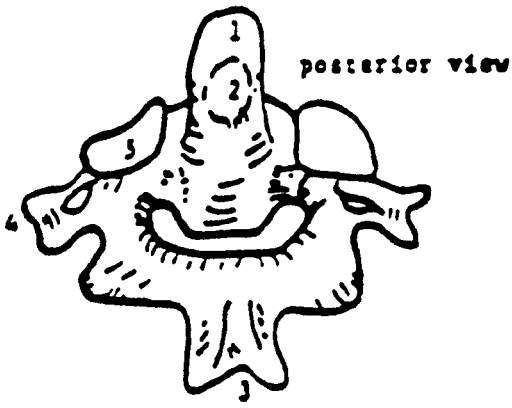


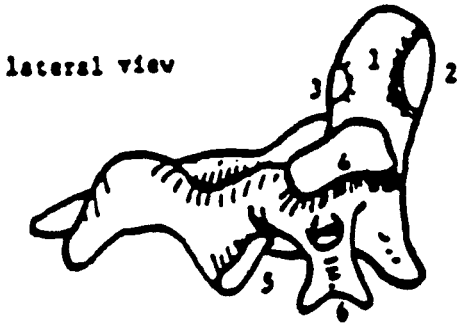
Atlas

1 - anterior arch
2. - posterior arch
3. - lateral mass
4. - transverse process (well developed)
5. - foramen transversarium (intervertebral foramen)
6. - facet for dens (articular process)
7. - tubercles for transverse part of cruciate
8. - groove on posterior arch for vertebral artery
9. - oval facets for occipital condyles

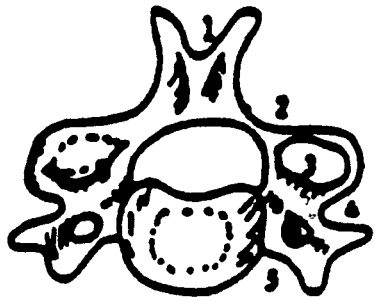
Axis

1. - dens or odontoid process (body of C_1)
2. - facet for transverse ligament
3. - spine
4. - transverse process with foramen
5. - superior articular facets for atlas





1. - dens
2. - anterior facet for anterior arch
3. - posterior facet for transverse liagment
4. - superior articular facet
5. - interior articular facet
6. - transverse process with foramen



Typical Cervical Vertebra (superior view)

1. - bifid spine
2. - lamina
3. - superior articular process
4. - pedicle
5. - transverse process
   anterior tubercle (ant. tub. of C_6 is large and is called the carotid tubercle)
6. - foramen transversarium*

*This is the one special feature common to all cervical vertebrae. A bifid spine is absent on the 1st and 7th vertebra and oaften also on the 6th.

Anterior - poster surface of the bodies of adjacent vertebrae and their intervertebral disc.

(a) In thoracic and lumbar regions, the upper one-half of the anterior boundary is formed by the body of the higher vertebra, while the lower one-half is formed by the disc and a small part of the body of the lower vertebra.

2. Cervical vertebrae - The anterior cervical curvature is due to the wedge shaped intervertebral disc.

- The lateral border of the upper surface of the bodies of the last 5 cervical show prominent lips, which fit against lateral convexities of the lower surface of the vertebral body above. These form the "Joints of Luschka" or "lateral interbody joints".

3. Thoracic vertebrae - The posterior thoracic curvature is caused by the wedge-shaped bodies. The laminae and downwardly directed spinous processes overlap as adjacent vertebrae.

4. Lumbar vertebrae - The forward curvature is caused partly by the wedge-shaped bodies and partly by the wedge-shaped disc.

(a) Pedicles arise from the upper part of the body.
(b) The laminae are not as long in the vertical direction as the bodies (plus the discs) so there exists a space between the laminae of adjacent vertebrae.
(c) Spinous processes project largely posteriorly, therefore do not overlap.

5. Sacrum

(a) The sacral spinal nerves are formed within the sacral canal. There are separate pairs of dorsal and ventral sacral foramina between each sacral segment, these transmit, respectively, the dorsal and ventral rami of the sacral spinal nerves.
(b) The ventral canal opens into the dorsal aspect of the sacrum through a sacral hiatus, which may vary in size.
(c) The upper two segments have large laterally directed surfaces for articulation with the iliac bones.

6. Coccyx - has no vertebral canal

B. Mechanics of the Spine

1. Center of gravity of the body as a whole - in the considerations of total body posture or locomotion, it is convenient to consider that the total mass of the body can be treated as if it were concentrated in one point, called the center of gravity. This is located just in front of the second sacral segment.

2. A line passing through the center of gravity to the center of earth would be the line of gravity. In the upright position, the gravitational force tends to exert translatory and rotatory accelerations on the multiple weight supporting bony links between the head and the ground. Equilibrium would only be obtained if the line of gravity passed through the individual center of gravity of each link, through each axis of motion of the joints between the links, and then into the area of support of the foot against the ground. In the upright position, the line of gravity only approaches these equilibrium conditions and therefore, the rotatory components of gravity must be neutralized by

ligamentous and muscular forces if equilibrium (the normal upright posture) is to be achieved.

The line of gravity arises from the supporting surface between the ball and the heel of the foot; then passes in front of the ankle and knee joints and slightly behind the hip joint; then through the lumbosacral junction and behind the lumbar vertebral bodies to intersect the spine again at the thoracolumbar junction; then in front of the thoracic vertebral bodies and through the cervico-thoracic junction; then behind the cervical vertebral bodies to the occipitocervical junction.

So owing to the compensatory nature of the secondary forward spine curvatures, the spine as a whole approaches the line of gravity as much as the anteroposterior deflection of the curves will permit. As a result, the weight of the trunk is distributed relatively equally in front and behind the line of gravity so little, if any, muscular activity is necessary to maintain the upright position of the spine.

C. Ligaments of the Vertebral Column

1. Anterior longitudinal ligament
2. Posterior longitudinal ligament
3. Ligamentum flava
4. Supraspinous ligament
5. Interspinous ligament
6. Intertransverse ligament
7. Intertransverse ligament
8. Ligamentum nuchae

D. Intervertebral discs

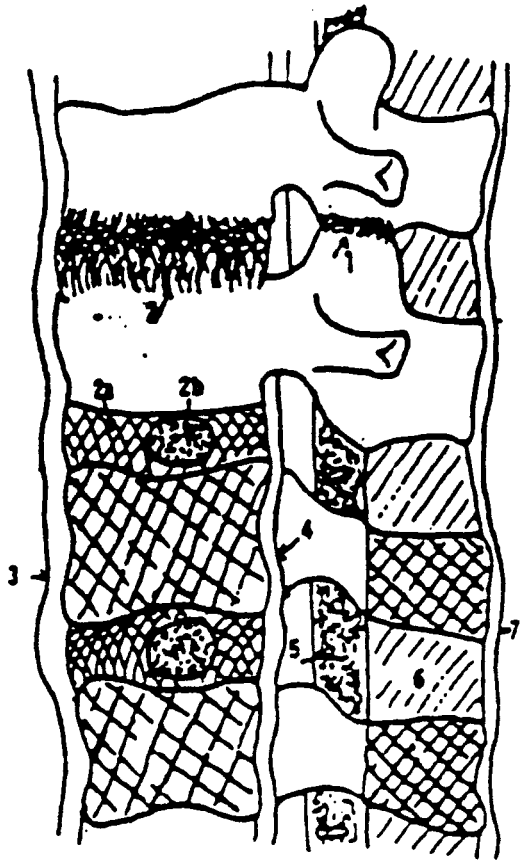
a. Joins together the bodies of adjacent vertebrae. Makes up 1/4 of the total length of the vertebral column. Because water is "squeezed" out during weight-bearing, the male loses about 3/4 inch and the female 1/2 inch in stature during the course of a weight-bearing day. It is reinforced around most of its circumference by the anterior and posterior longitudinal ligaments. It serves as a somewhat distensible envelope for the plastic nucleus pulposus.

b. Anulus fibrosus - the fibrocartilaginous peripheral part of the disc. It is made up of layers of obliquely running vertical fibers, with alternate layers running in opposite directions. Posteriorly, it is narrower, more loosely organized, attached less well into hyaline cartilage plates and reinforced by the thinner posterior longitudinal ligament. It serves as a somewhat distensible envelope for the plastic nucleus pulposus.

c. Nucleus pulposus - a semigelatinous mass surrounded by the anulus fibrosus and somewhat eccentrically placed closer to the posterior surface of the disc.

(1) Hydraulic mechanism of the nucleus pulposus - the disc is a self-contained fluid-elastic system that absorbs shock, permits transient compression and allows fluid displacement within its elastic container. It thus permits movement and distortion of the total functional disc unit. Since the nuclear fluid is held in a closed, but somewhat distortable container (anulus), any externally applied force exerted upon any unit area is transmitted undiminished to every unit area of the interior of the container (Pascal). Therefore, in movements of the spine, this system will distribute the weight over the entire surface of the vertebral body to prevent undue load from being concentrated on the edge toward which the column is bent.

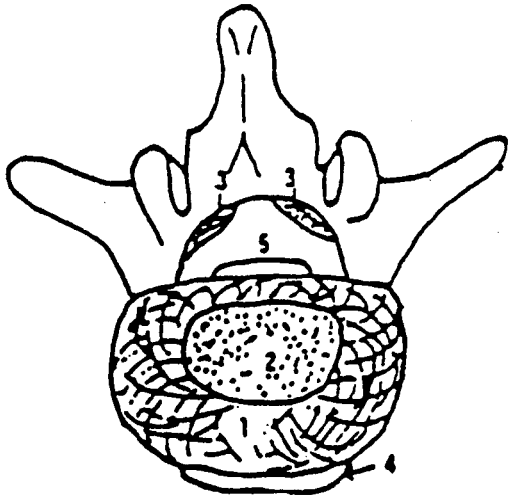
DETAILS OF INTERVERTEBRAL JOINTS



1. articular processes-sliding synovial joints
2. intervertebral disc-symphysis
    a. anulus fibrosus
    b. nucleus pulposus

Ligaments

3. anterior longitudinal (anterior on bodies)
4. posterior longitudinal (posterior on bodies)
5. ligamentum flavum (lamina to lamina (is elastic not collagenous)
6. interspinous ligament (spine to spine)
7. supraspinous



Position of Ligaments in Superior View

1. area of anulus fibrous (note it is thinnest posteriorly)
2. area of nucleus pulposus
3. ligamentum flavum (paired from lamina to lamina)
4. anterior longitudinal (anterior to body)
5. posterior longitudinal (posterior to body but anterior to spinal cord)

Herniation of the nucleus pulposus - "a slipped disc". This is usually posterior and lateral where the anulus is thinnest and the posterior longitudinal ligament is absent. This, unfortunately is in the region of the intervertebral foramen and the exiting spinal nerve.

VERTEBRAL COLUMN: INTERVERTEBRAL JOINTS

Between the vertebrae exists a series of intervertebral joints - all essentially the same.

Between the articular processes are simple sliding synovial joints surrounded by a fibrous capsule.

Between the bodies are the intervertebral discs of fibrous cartilage - classical symphysis joints. The discs also act as shock absorbers.

Between any 2 given vertebrae only a small amount of movement takes place. By summation of the movement between all the vertebrae, the full range of movements of the vertebral column is made possible.

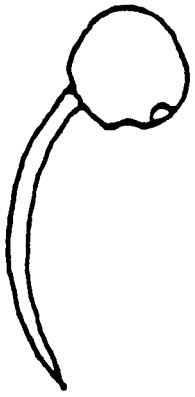
The cervical and lumbar regions are the most mobile. Because of the bracing from the ribs and plane of the articular process, the movement of the thoracic vertebrae is more limited.

All joints are strengthened by several continuous running ligaments.

CURVATURES OF THE VERTEBRAL COLUMN

Normal

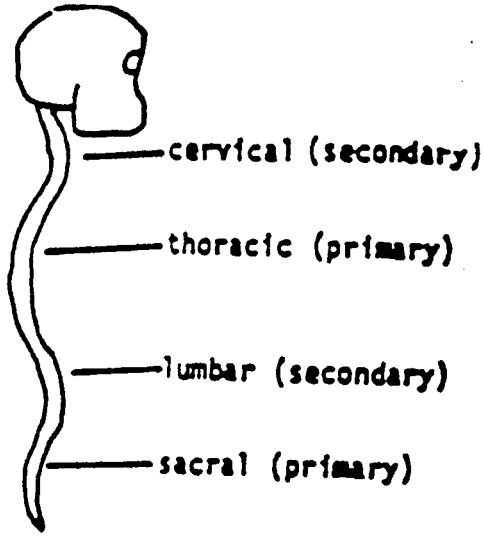
Primary Fetal Curvature



1. A secondary anterior cervical curvature develops when the child begins to hold its head up.

2. A secondary lumbar curvature develops (when the child learns to walk).

Secondary Curvatures



Abnormal

Scoliosis - any lateral curvature of the column

Kyphosis - omcreased thoracic curvature

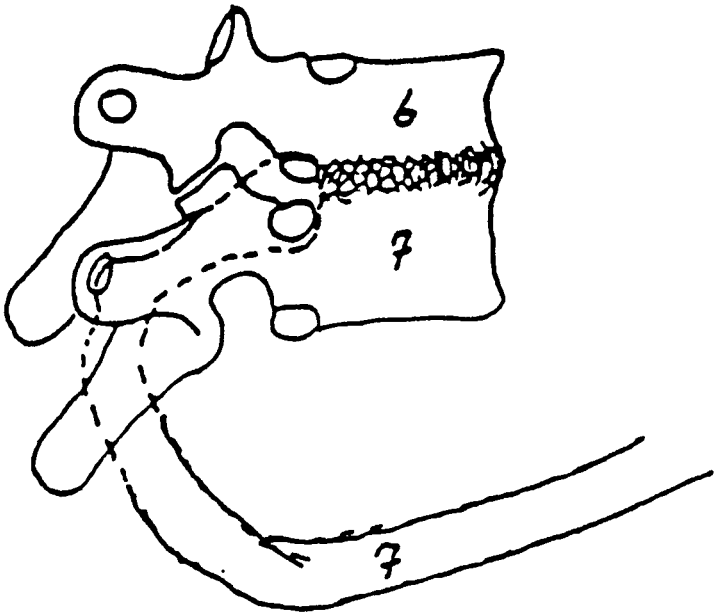
Lordosis - increased lumbar curvature (also increased cervical)

Spondylolisthesis - anterior slippage of one vertebra on another, usually L5 on the sacrum on L4 on L5.

COSTAL JOINTS

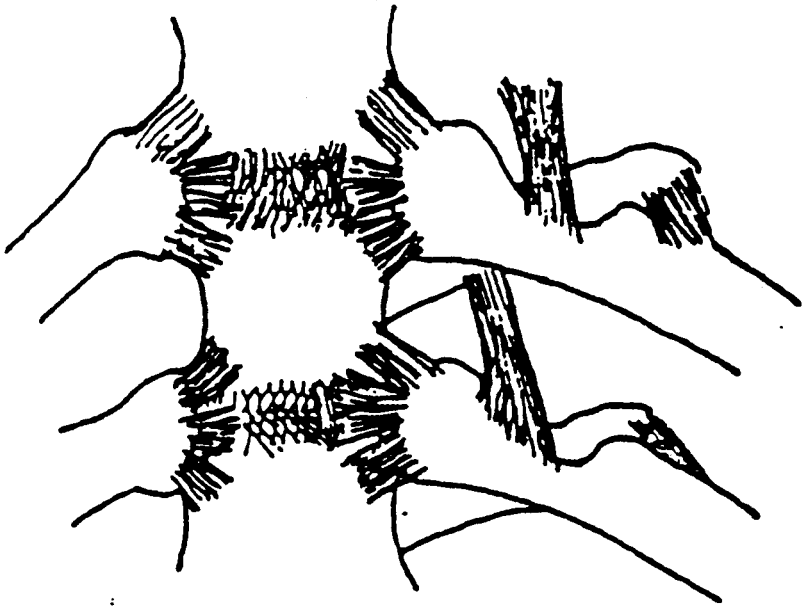
The first rib articulates with the sternum by a synchondrosis. All other anterior articulations are sliding synovial.

All posterior articulations are synovial. The head with the bodies of the vertebrae, the tubercle with the transverse process. The head and neck being held to the vertebrae by a series of ligaments.



Position of Rib on Vertebrae

Costo-vertebral ligament



Because of their shape, the upper and lower ribs move up and down like a "pump handle" on the vertebral column. The long middle ribs move like "bucket handles" on the thoracic wall.

ANATOMICALLY RELATED ABNORMALITIES OF VERTEBRAL COLUMN

1. Lumbosacral junction - A point of sharp change in direction between the movable presacral column operating on a long lever arm and the fixed sacrum. Normally, the upper surface of the sacrum shows a downward inclination at about 40 degrees so there is a tendency for the 5th lumbar vertebra to slide forward off to the sacral inclination (resisted by the articular processes). Therefore, this is an area of great stress upon both the bones and the disc.

2. Spondylolysis - A defect in the continuity of the laminae between the articular processes. Often involves the 5th lumbar vertebrae.

3. Spondylolisthesis - Where the defect of spondylolysis has resulted in a forward slip of the body of the vertebra above (usually 5th lumbar). This occurs because the supporting inferior articular processes and intervening part of the laminae of the 5th lumbar vertebra are not attached to the rest of the vertebra which is forced forward down the inclined plane of the sacrum.

4. Kyphosis - This abnormal dorsal convexity usually occurs in the thoracic region where the line of gravity passes in front of the vertebral bodies. Thus, if the vertebral body structure is weakened as by tuberculosis or disturbance of ossification, one gets a collapse of the body usually without involvement of the arch and a "kink" is formed in the vertebral column.

5. Lordosis - (abnormal ventral convexity) - e.g. the compensatorily increased lumbar lordosis during pregnancy, where the fetal mass anteriorly is counterbalanced by a backward displacement of the body above the lumbar region t keep the line of gravity over the support base.

6. Scoliosis (abnormal lateral curvature) - May be congenital as in a hemivertebra (only one side of the vertebral body develops). May be compensatory in response to the pelvic tilt caused by a short lower extremity. May be secondary to paralysis of the intrinsic muscles of one side of the back.

7. Fracture - Frequently from auto accidents or fall from a height. Most common type is an anterior compression fracture of a vertebral body resulting from forced hyperflexion. Lower thoracic and upper lumbar are the ones usually involved, because here there is a change in mobility between the relatively immobile thoracic column which acts as a long lever for the superimposed body weight upon the more mobile lumbar region.

CRANIOVERTEBRAL JOINTS

I. Atlanto-axial Joint

- The articulation of atlas and axis comprises 3 joints which have synovial membranes; one at the midline and 2 at the lateral position.

a. Lateral atlanto-axial joints (2 in number)
   - between inferior articular facet of lateral mass of atlas and superior articular facet of axis; covered with articular capsule (inside is the synovial membrane).
   - in front of these two vertebrae, and are connected by a continuation of anterior longitudinal ligament; they are fixed to each other.
   - behind, there is ligamentum flavum between the laminae of the C_1 and C_2 vertebrae.

b. Median atlanto-axial joint
   - is a pivot joint between the dens of the axis and the ring formed by anterior arch and transverse ligament of the atlas.

- Ligaments of craniovertebral joints
   a. transverse ligament
   b. superior longitudinal band
   c. inferior longitudinal band
      The above three structures are comprised of cruciform ligament of the atlas.
   d. alar ligament
      - superior to transverse ligament
      - attached to condyles of occipital bone
      - help to limit the rotation
   e. membrane tectoriâ: is within the vertebral canal; extends from the basilar part of the occipital bone to the body of axis; covers all the ligaments mentioned above; within the cranial cavity, it is continuous with cranial dura mater; below C_2 vertebra, it is continuous to form posterior longitudinal ligament.

II. Atlanto-occipital Joints

- Between the superior articular facet of atlas and condyle of the occipital bone.
- The condyle is convex and tilted laterally whereas the atlantal facet is concave and tilted medially.
- Two bones are united by (a) articular capsule which is fibrous and surrounds the condyle and atlas, (b) anterior and posterior atlanto-occipital membranes.
- Anterior atlanto-occipital membrane: continues with capsular ligament; in front, is strengthened by the continuation of anterior longitudinal ligament.
- Posterior atlanto-occipital membrane: extends from the posterior margin of foramen magnum to the atlas; the vertebral artery and the first cervical nerve are through the lateral side of this membrane.

III. The Movement of the Head

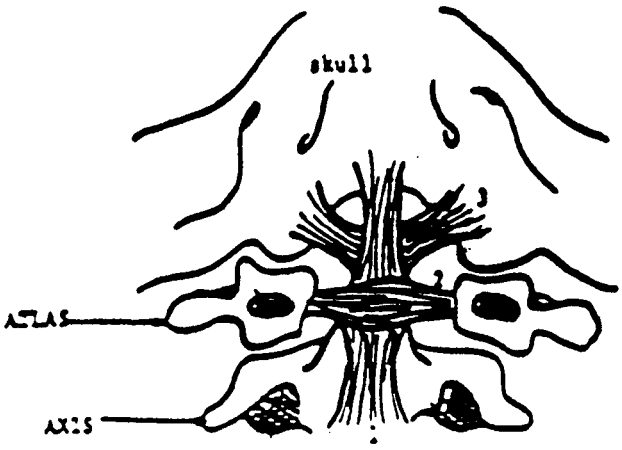
- Movement at the atlanto-axial joints:
  a. the rotation of the atlas (with the skull) upon the axis.
  b. the extend being limited by the alar ligaments.
  c. Muscles producing the movements include obliquus inferior, rectus major, and splenius capitis of one side acting with the opposite sternocleidomastoid.

- Movement at the atlanto-occipital joint:
  a. the movement includes (i) flexion and extension (nodding of the head, and (ii) a slight lateral titling motion to one or other side.
  b. muscles producing the movements
     (i) flexion - longus capitis and rectus capitis anterior
     (ii) extension - recti major and minor, obliquus superior, seminspinalis capitis, splenius capitis and upper part of trapezius.
     (iii) lateral flexion - rectus capitis lateralis, semispinalis capitis, splenius capitis, sternocleidomastoid, and trapezius (upper part).

THE ATLANTO-OCCIPITAL JOINTS: THE SPECIALIZED INTERVERTEBRAL JOINTS OF THE SKULL, ATLAS, AND AXIS

Coronal section from Posterior

(neural arch of atlas, axis, and posterior part of skull removed)



occipital bone

region of foramen magnum

(tectorial membrane removed)

cruciate ligament

1 vertical band attachments:

2 transverse band attachments:

3 alar or check ligaments attachments:

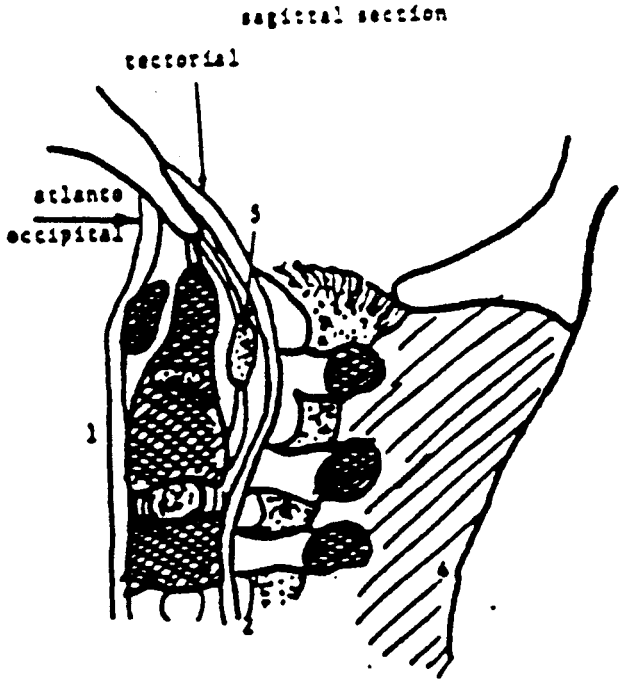
occipital bone of skull

region of foramen magnum

atlas (anterior and posterior arch)

axis

dens (note remains of disc of C_1 & C_2)



<u>Ligaments</u>

1. anterior longitudinal
   becomes anterior atlanto-occipital membrane
2. posterior longitudinal
   becomes tectorial membrane
3. ligamentum flavum
   in series with the posterior atlanto-occipital membrane
4. supraspinous
   becomes ligamentum nuchae
5. cruciate ligament: vertical and transverse (seen in cross section) bands (apical)

E. Joints of the Suboccipital Region

A. These joints are between the skull, the atlas, and the axis.

1. Atlanto-Occipital joint
   (a) Anterior Atlanto-Occipital Membrane
   (b) Posterior Atlanto-Occipital Membrane
   (c) Movement at the Atlanto-Occipital Joints
2. Atlanto-Axial Joint
   (a) Lateral Atlanto-Axial Joint
   (b) Median Atlanto-Axial Joint
3. Ligaments of the Atlanto-Occipital Joint
   (a) Transverse ligament of the atlas
   (b) Cruciform ligament
   (c) Alar ligament
   (d) Apical ligament
   (e) Tectorial membrane

F. **Muscles of the Back**:

The posterior muscles of the back are divided into extrinsic and intrinsic layers. The extrinsic muscles are divided into superficial groups, including the trapezius, latissimus dorsi and sternocleidomastoid, and a deeper group including the levator sacpulae, rhomboids, serrati posterior. These extrinsic muscles are primarily involved with movement of the head, upper limb, and ribs. The intrinsic muscles, (true) muscles of the back, are deep to the extrinsic muscles and are involved in movement of the vertebral column. There are two groups of intrinsic muscles, erector spinae , and transversospinali. The longissimus thoracis muscle belongs to the erector spinae group.

The deep transversospinalis group of back muscles include the: rotatores, semispinalis, and multifidus. These short oblique muscles of the back are primarily rotators of the spinal column. The splenius muscles are oblique muscles of the neck and are not considered deep muscles of the back.

Laboratory Assignment
Skull and Scalp

Scalp
- Skin
- Connective Tissue
- Aponeurosis
- Loose areolar connective tissue
- Pericranium

Meninges
- Dura Mater
- Arachnoid Mater
- Pia Mater

Dura Specializations
- Superior sagittal sinus
- Inferior sagittal sinus
- Confluence of sinuses
- Falx cerebri
- Tentorium cerebelli
- Falx cerebelli
- Diaphragma sellae

Facial Muscles
- Orbicularis oris
- Depressor anguli oris
- Mentalis
- Depressor labii inferioris
- Masseter
- Zygomaticus major and minor
- Buccinator
- Levator anguli oris
- Levator labii superioris
- Orbicularis oculi
- Frontalis
- Procerus
- Risorius

External Carotid Artery
- Facial artery
- Submental artery
- Superior and inferior labial arteries
- Angular artery
- Maxillary artery
- Superficial temporal artery
- Posterior auricular artery

Angular vein
Facial vein
Superficial Temporal vein
Maxillary vein
Retromandibular vein

Frontal bone
Parietal bone
Occipital bone
- Foramen magnum
- External occipital protuberance
- Nuchal lines

Temporal bones
- Zygomatic arch
- Mastoid process
- Styloid process

Sphenoid bones
- Sella turcica
- Pterygoid plates

Maxillary bones
- Incisive fossa
- Inferior orbital fissure
- Infraorbital foramen
- Zygomatic process

Zygomatic bones
- Zygomaticofacial foramen
- Zygomaticotemporal foramen

Mandible

Lambda
Bregma
Pterion
Nasion
Glabella

Coronal Suture
Sagittal Suture
Squamous Suture
Lamboid Suture

Palantine bones
Lacrimal bones
Nasal bones
Vomer
Inferior Nasal Concha
Ethmoid Bone
- Cribiform plate
- Crista galli

Anterior, Middle and Posterior Cranial Fossa
Incisive foramen
Vomer
Pterygoid plates
Foramen Ovale
Foramen Lacerum
Carotid Canal
Occipital Condyles
Stylomastoid Foramen
Foramen Spinosum
Optic Canal
Superior Orbital Fissure
Foramen Rotundum
Foramen Ovale
Frontal Crest
Anterior and Posterior Ethmoidal Foramina
Internal Acoustic Meatus
Jugular Foramen
Hypoglossal Canal
Clivus

Scalp

- Consists of skin and subcutaneous tissue that cover the calvaria
- Calvaria can be defined as the skull cap or skull vault without the facial bones.
  - Consists of the superior portions of the frontal, parietal and occipital bones
- Extends from the Superior Nuchal lines of the occipital bone to the supraorbital margins of the frontal bone
- Extends laterally over the temporal fasia to the zygomatic arches

Layers of the Scalp

Skin

Connective Tissue (tela subcutanea)

- Highly vascular

Aponeurosis (epicranial aponeurosis or galea aponeuorotica,

- Continuous with the occipitalis and frontalis muscles

Loose areolar (connective) tissue

- Contains the emmissary veins, layer upon which aponeurosis glide
- Freely movable with many potential spaces "Danger Space"

Pericranium.

- Adheres to the external periosteum of the calvaria

Emmissary Veins

- Emmissary veins are vavleless and connect the superficial veins of the scalp with the diploic veins of the skull bones and with the intracranial venous sinuses
- Emissary veins may spread infections from the scalp to the intracranial cavity. Normal blood flow is from inside to outside of the skull

Bleeding of the Scalp

- The scalp is extremely vascular and bleeds profusely when cut. Due to anastomoses, there is no single vessel to compress but bleeding may stop by direct pressure on or around the wound.
- The outermost connective tissue is highly vascular, and the loose connective tissue tends to hold cuts open, resulting in profuse bleeding of scalp. It is easily fixed with stitches

Meninges

Continuous with the meninges covering the spinal cord, three layers

- Dura Mater
  - Periosteal (outer) layer and meningeal (inner) layer
- Arachnoid Mater
  - Subarachnoid space
  - Fingerlike projections of the arachnoid, the arachnoid villi, push into the dural venous sinuses and absorb cerebrospinal fluid into the venous blood.
- Pia Mater
  - Highly vascular layer

Dura Specializations

- Separations of the two dural layers create the Dural Venous Sinuses which receive the blood from the veins draining the brain. Walls of the sinuses are line by endothelium.
  - Superior sagittal sinus
  - Inferior sagittal sinus
  - Confluence of sinuses
- Dural Reflections include the following
  - Falx cerebri
  - Tentorium cerebelli
  - Falx cerebelli
  - Diaphragma sellae

Facial Muscles

- Main action is for facial expression
- Innervated by the Facial Nerve (CVII)
- Enters the anterior surface of the face via the stylomastoid foramen and divides into five branches in the parotid gland

Actions of the Facial Muscles

- Orbicularis oris
  - Compresses and protrudes lips
- Depressor anguli oris
  - Depresses the angle of the mouth
- Mentalis
  - Raises the skin of the chin
- Depressor labii inferioris
  - Draws lips inferiorly and slightly laterally

Actions of Facial Muscles

- Masseter
  - Muscle of mastication
- Zygomaticus major and minor
  - Draws angle of mouth superolaterally
- Buccinator
  - Action is to keep the cheeks taut
- Levator anguli oris
  - Elevates the corner of the mouth

Actions of Facial Muscles

- Levator labii superioris
  - Raises and everts the upper lip
- Orbicularis oculi
  - Closes the eyelids
- Frontalis
  - Elevates eyebrows and skin of forehead

Actions of Facial Muscles

- Procerus
  - Draws medial part of the eyebrow inferiorly
- Risorius
  - Draws the corner of the mouth laterally

Arteries of the Face and Scalp

- Branches given off by the External Carotid
  - Facial
  - Submental
  - Superior and Inferior Labial
  - Angular
  - Maxillary
  - Superficial Temporal (Anterior and Posterior)
  - Posterior Auricular

Veins of the Face and Scalp

- Angular
- Facial
- Superficial Temporal (Anterior and Posterior)
- Maxillary
- Retromandibular

Frontal Bone

- Forms anterior portion of cranium roof of orbit and most of anterior cranial fossa
- Articulates posteriorly with paired parietal bones and with the sphenoid, nasal, lacrimal, maxillary and zygomatic bones
- Supraorbital Foramen allows passage for opthalmic division of trigeminal (CV V1)

Parietal Bones

- Large paired bones that form most of the superior and lateral aspects of the skull
- Temporal fossa is bounded by the superior temporal line and zygomatic arch
- Four largest sutures (immovable joints between adult cranial bones) occur where parietal bones articulate with other cranial bones

Occipital Bone

- Forms much of the posterior and inferior surfaces of the cranium
- Articulates with the parietal, temporal, and sphenoid bones and 1st cervical vertebra (atlas)
- Internally, the occipital bone forms the walls of the posterior cranial fossa that supports the cerebellum of the brain
- External occipital protuberance and the foramen magnum are located on the posterior inferior surface

Temporal Bones

Comes from Latin word temporum (time), gray hairs appear fir in the temple indicating the passing of time

Forms part of both the lateral walls of the cranial cavity and the zygomatic arch

Forms the only point of articulation with the mandible (temporomandibular joint)

Houses and protects the structures of the external, middle and inner ear

Mastoid process and Styloid process project off the inferior surface

Sphenoid Bones

Together with petrous temporal bone form the floor of the middle cranial fossa housing the temporal lobe of the brain

Body forms central axis, & contains two large paranasal sinuses separated by a septum.

Superior surface has the sella turcica, the seat of which is the hypophyseal fossa housing the pituitary

Lateral surfaces of body are united with the greater wings and the pterygoid plates.

Pterygoid process projects inferiorly from body

Maxillary Bones

Two halves fuse medially to form upper jaw and contains large maxillary sinuses

Incisive fossa - posterior to central incisors in the midline of hard palate and transmits the nasapalatine nerve supplying the palatine mucosa

Inferior orbital fissure between maxilla and greater wing of sphenoid - passage of zygomatic & maxillary nerve's (branche of CNV V2) and vessels to pass to the face

Infraorbital foramen - infraorbital division of (CNV V2)

Zygomatic process articulates with the zygomatic bone

Zygomatic Bones

- Forms part of the inferolateral margin of the orbit and the zygomatic arch
- Forms the rounded prominence of the cheek
- Contains two important foramen
  - Zygomaticofacial foramen (lateral surface)
  - Zygomaticotemporal foramen (temporal surface)

Mandible

- Lower jaw
- Consists of a horizontal body and vertical rami
- Mental foramen opens onto the anterior surface of the body
- Mental foramen is the exit for mental nerve (mandibular division of trigeminal CV V3)

Sutures of the Skull

- Coronal Suture
  - Between frontal and parietal bones
- Sagittal Suture
  - Between parietal bones
- Squamous Suture
  - Between parietal and temporal bones
- Lamboid Suture
  - Between parietal and occipital bones

Junctions of the Skull

- Lambda
  - Intersection of lamboid and sagittal sutures
- Bregma
  - Intersection of sagittal and coronal sutures
- Pterion
  - Junction of frontal, parietal, temporal and sphenoid bones
  - Overlies the middle meningeal arteries
- Nasion
  - Intersection of frontal and nasal bones
- Glabella
  - Smooth eminence superior to the nasion and between the superciliary arches

Small Bones of the Face

- Palantine Bones
  - Orbital process, perpendicular plate, and horizontal plate the complete the posterior part of the hard palate
- Lacrimal Bones
  - Medial wall of orbit
- Nasal Bones
  - Forms bridge of nose and superior border of the external nares
- Vomer
  - Forms inferior portion of the osseous nasal septum
- Inferior Nasal Concha
  - Project medially from lateral wall of the nasal cavity below middle concha of the ethmoid bone

Ethmoid Bone

- Named from Latin *ethmos* or sieve
- Forms part of the anteromedial floor of the anterior cranial fossa
- Part of the medial wall of the orbit, nasal septum, roof & lateral walls of the nasal cavity
- Made up of cribiform plate with crista galli, a median perpendicular plate and two lateral masses containing ethmoidal sinuses
- Extending medially from lateral masses are the curved superior and middle nasal concha. These bony outgrowths are lined with respiratory epithelium and help increase the surface area of the nasal cavity

Base of Skull

- Incisive Foramen
  - Allow passage of the nasopalantiine nerves
- Vomer
  - Thin, flat bone that makes a major contribution to the bony nasal septum
- Pterygoid
  - Medial and lateral pterygoid plates
- Foramen Ovale
  - Allows passage of the Mandibular nerve CNV V3

Base of Skull

- Foramen Lacerum
  - Enclosed by cartilage in life, nothing is transmitted but the internal carotid artery passes across
- Carotid Canal
  - Opening for Internal carotid artery
- Occipital Condyles
  - Articulation with C1
- Stylomastoid Foramen
  - Passage for the Facial Nerve CVII

Base of Skull

- Foramen Magnum
  - Passage for spinal cord, spinal accessory nerve CXI, vertebral arteries and anterior and posterior spinal arteries
- Styloid Process
  - Bony projection of the temporal bone
- Foramen Spinosum
  - Allows passage for the middle meningeal artery
- External Occipital Protuberance
  - Bony projection on the posterior aspect of the occipital bone

Cranial Fossa

Anterior Cranial Fossa
- Formed by the frontal bone anteriorly, the ethmoid bone in the middle and the body of the lesser wings of the sphenoid and anterior margin of the optic groove posteriorly

Middle Cranial Fossa
- Formed by the greater wings of the sphenoid and squamous parts of the temporal bones laterally and the petrous parts of the temporal bones posteriorly

Posterior Cranial Fossa
- Largest and deepest of the cranial fossa, oval-shaped, formed mainly by the occipital bone
- Bounded centrally by the dorsum sellae and anterolaterally by the petrou and mastoid portions of the temporal bones
- Dominated by the foramen magnum

Structures in the Anterior Cranial Foss

- Frontal Crest
- Anterior and Posterior Ethmoidal Foramina
- Crista Galli
  - Median ridge of bone, attachment for Falx cerebri which helps separat the hemispheres
- Cribiform Plate
  - Olfactory nerves CNI pass through foramina
- Orbital Plates
  - Orbital plates of the frontal bone form the roofs of the orbital cavities
- Lesser Wing of Sphenoid
  - Posterior boundary of anterior cranial fossa, ends as the anterior clinoi processes

Structures in the Middle Cranial Fossa

Optic Canal
- Passageway for the Optic nerves (CN II) and the opthalmic arteries

Superior Orbital Fissure
- Passage for the opthalmic veins, opthalmic division of the trigeminal (CN V V1), oculomotor nerve (CN III), trochlear nerve (CN IV), abducens nerve (CN VI), and sympathetic fibers

Foramen Rotundum
- Passage for maxillary division of the trigeminal (CN V V2)

Foramen Ovale
- Allows passage of the mandibular division of trigeminal (CN V V3)

Foramen Spinosum
- Passageway for the middle meningeal artery

Structures in the Middle Cranial Fossa

Foramen Lacerum
- Enclosed by cartilage in life, nothing is transmitted, but the internal carotid artery passes across

Sella Turcica
- Surrounded by the anterior and posterior clinoid processes
- Three parts: tuberculum sellae, hypophoseal fossa and the dorsum sellae

Petrous portion of Temporal Bone
- "Rock-like," houses the hearing apparatus
- Separates middle from posterior cranial fossa along with the dorsum sellae

tructures in the Posterior Cranial Foss

Internal Acoustic Meatus
- Opening for the facial nerve (CNVII), vestibulocochlear nerve (CNVIII and the labyrinthe artery

Jugular Foramen
- Passageway for glossopharyngeal nerve (CNIX), vagus (CNX), spinal accessory nerve (CNXI), internal jugular vein, and the inferior petrosal and sigmoid sinuses

Hypoglossal Canal
- Passageway for the hypoglossal nerve (CNXII)

Clivus
- Posterior continuation of the dorsum sellae

Foramen Magnum
- Passage for the spinal cord, spinal accessory nerve (CN XI), vertebral arteries and the anterior and posterior spinal nerves

Dural Sinuses

Confluence of Sinuses
- The junction between the Superior Sagittal, Straight, and Transverse Sinuses. It leads into the Transverse Sinus

Transverse Sinus
- It receives blood from the Superior and Inferior Sagittal, and Occipital

Sigmoid Sinus
- In posterior cranial fossa, continues as the internal jugular vein

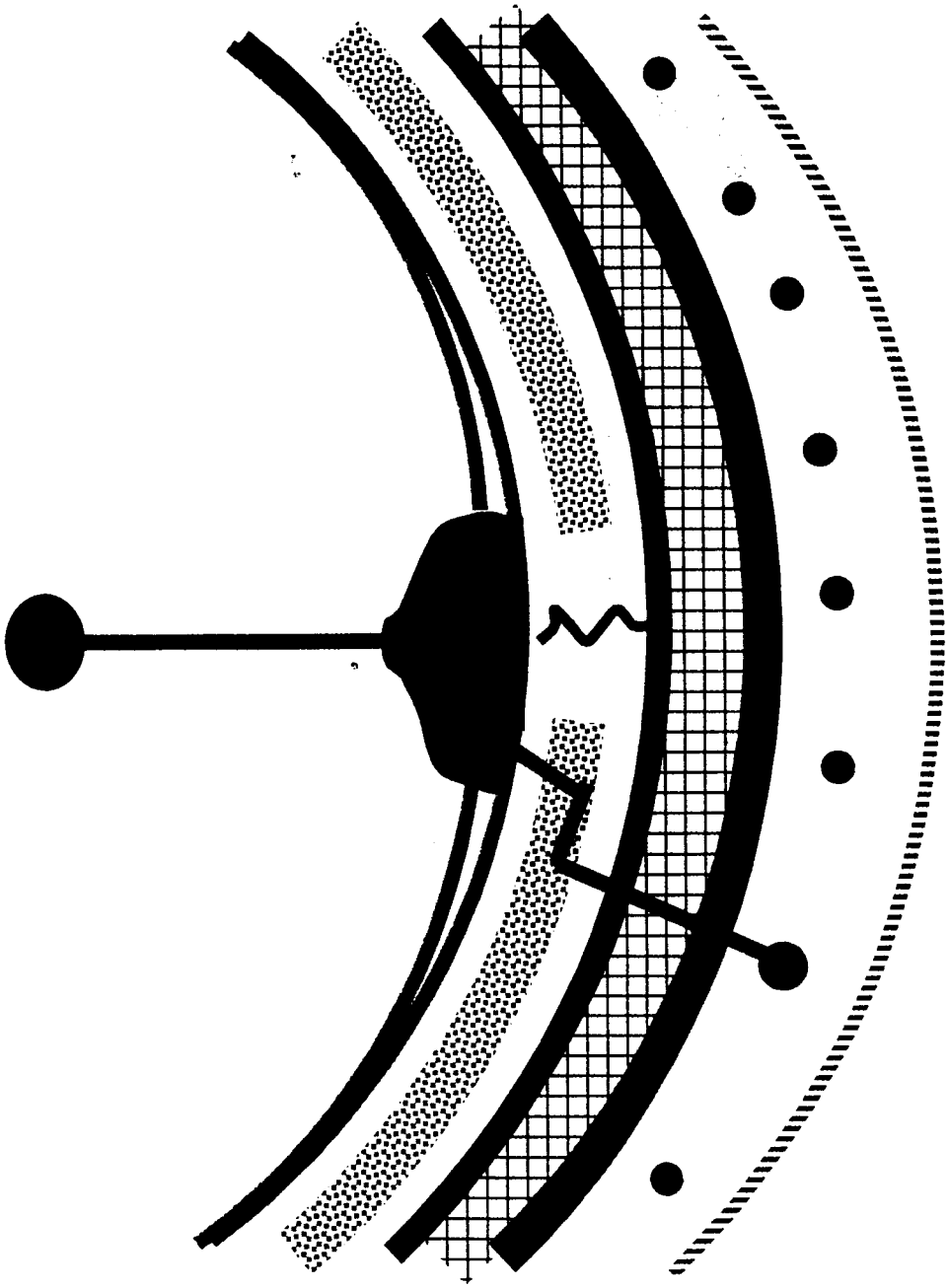
Dural Sinuses

Superior Petrosal Sinus
- Joins with the transverse sinus to form the Sigmoid sinus
- Runs in the attachment of the tentorium cerebelli to the superior margin of the petrous bone
- Attaches the cavernous sinus with the transverse sinus

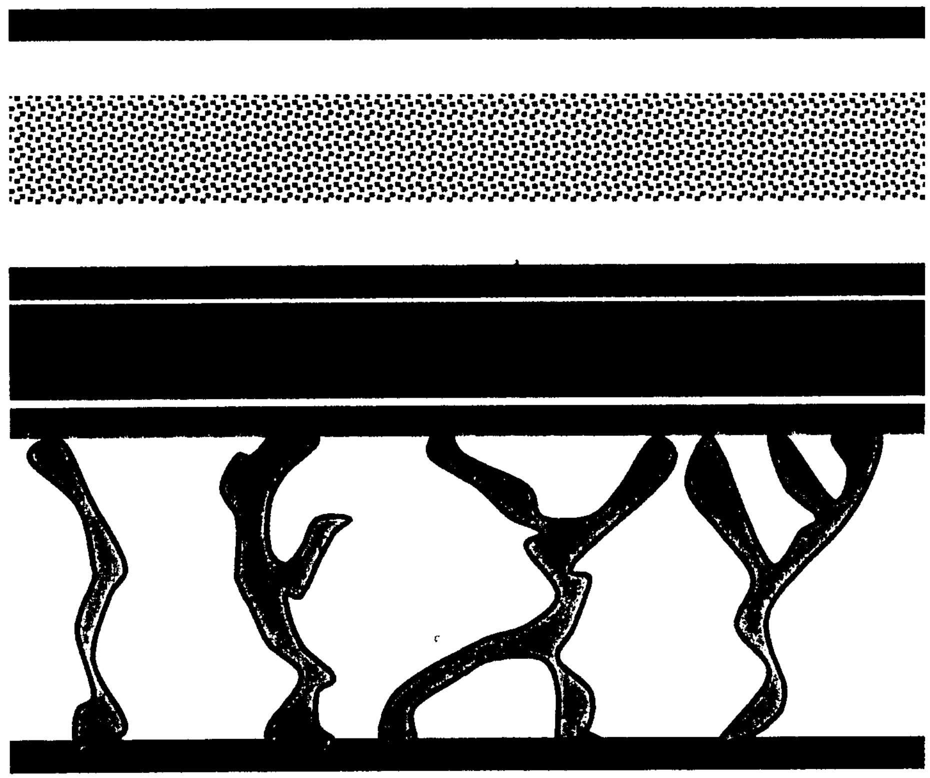
Cavernous Sinus
- Situated bilaterally on each side of the sella turcica

Cranial Nerve Openings

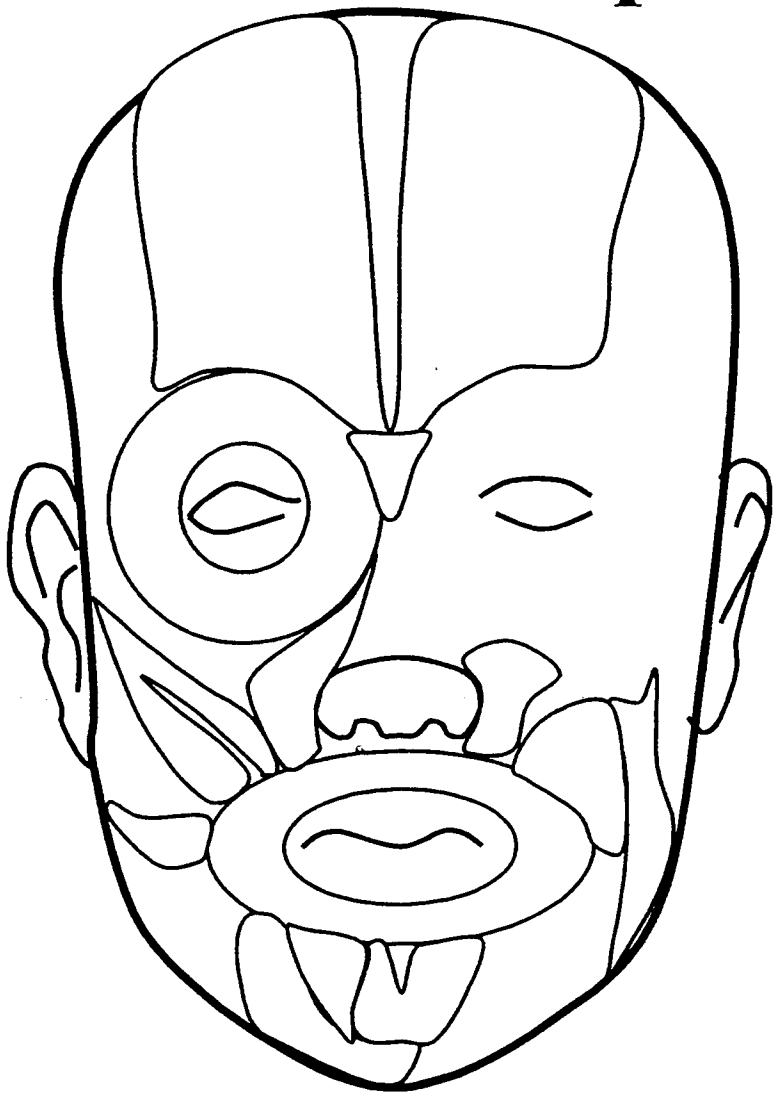
- **T**emporal
  - 5 cranial nerves: Facial (CNVII), Vestibulocochlear (CNVIII), Glossopharyngeal (CNIX), Vagus (CNX), Acessory (CNXI)
- **O**ccipital
  - 1 cranial nerves: Hypoglossal (CNXII)
- **E**thmoid
  - 1 cranial nerves: Olfactory (CNI)
- **S**phenoid
  - 5 cranial nerves: Optic (CNII), Oculomotor (CNIII), Trochlear (CNIV), Trigeminal (CNV), Abducens (CNVI)



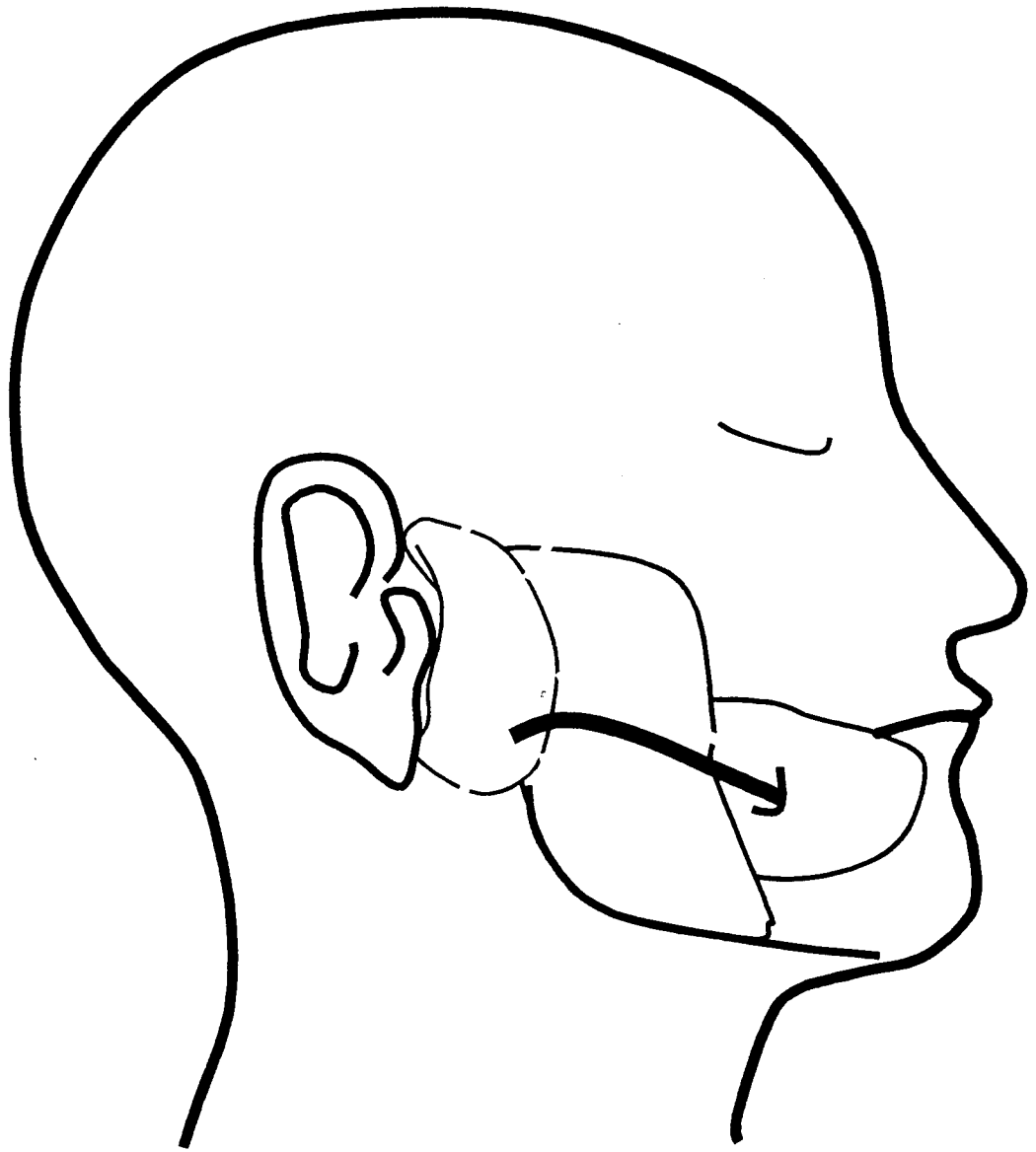
Meninges



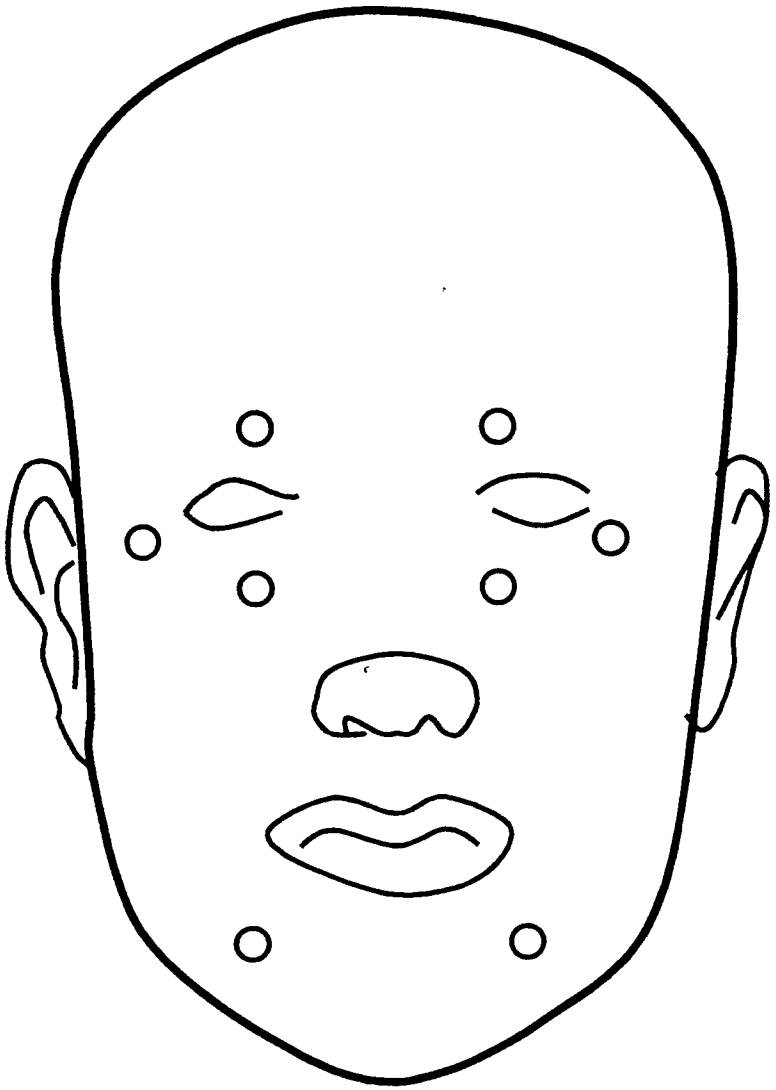
Muscles of Facial Expression



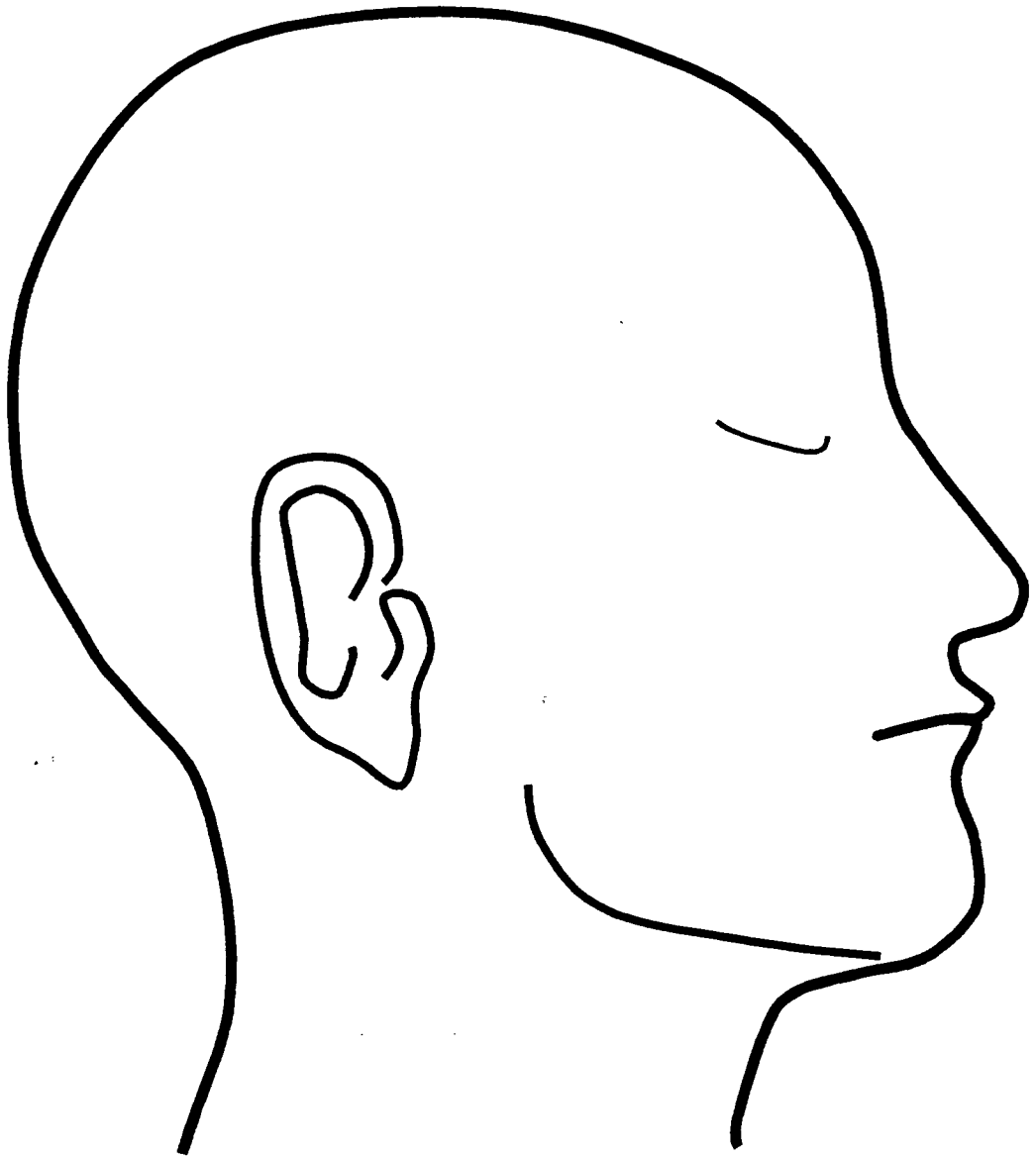
Lateral View of Face



Trigeminal Nerve Distribution

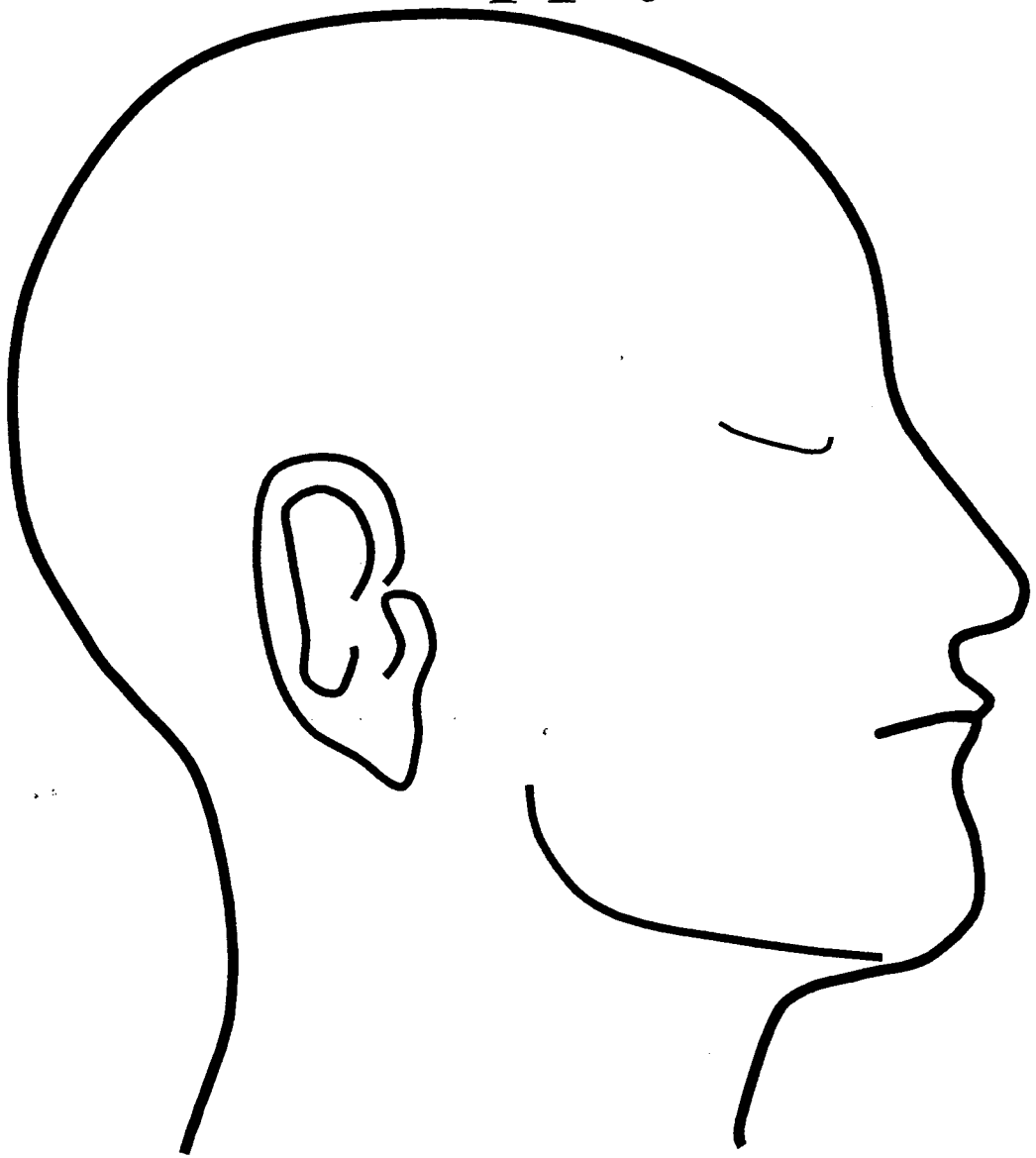


Arterial Supply of Face

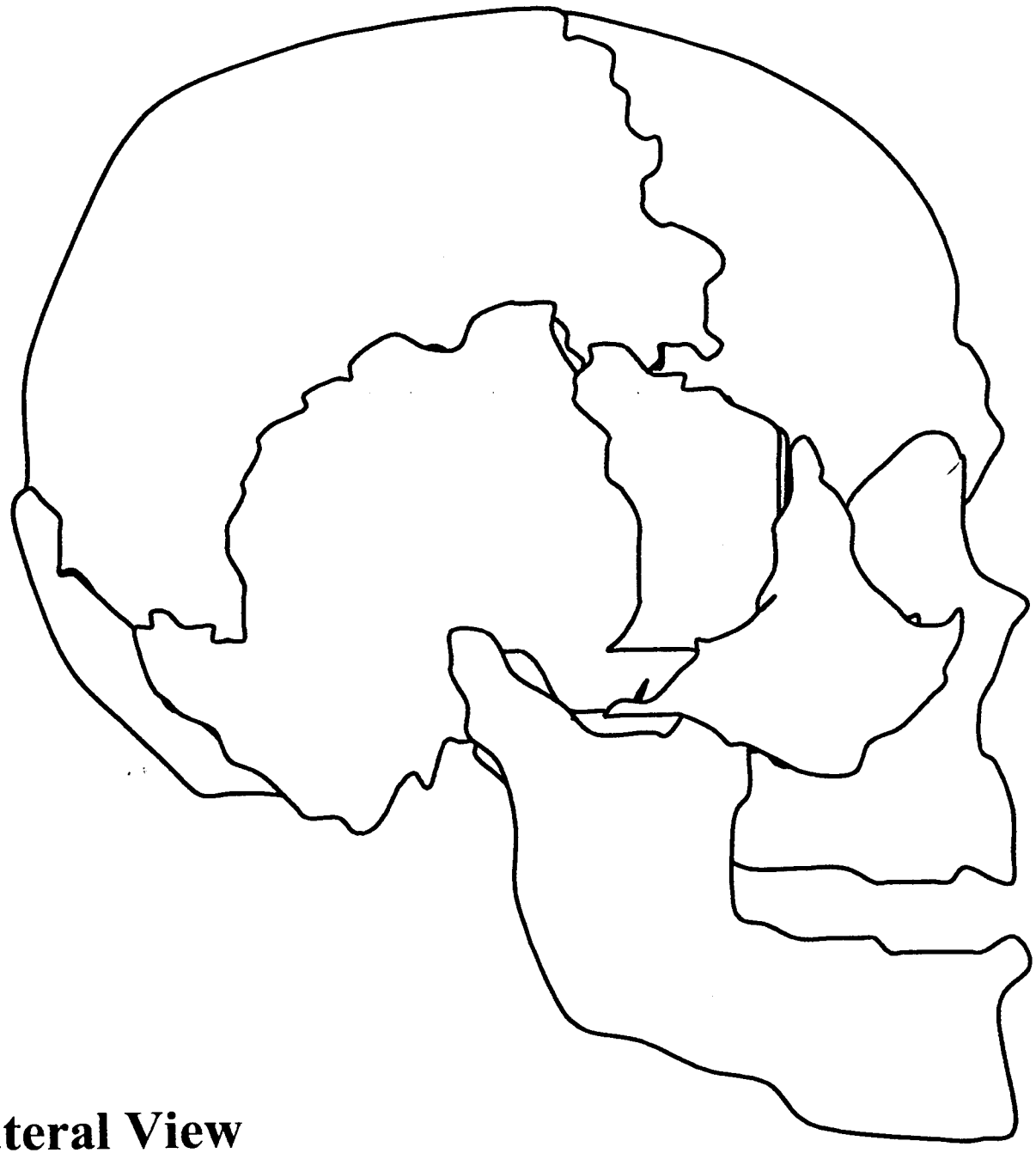


Lateral View

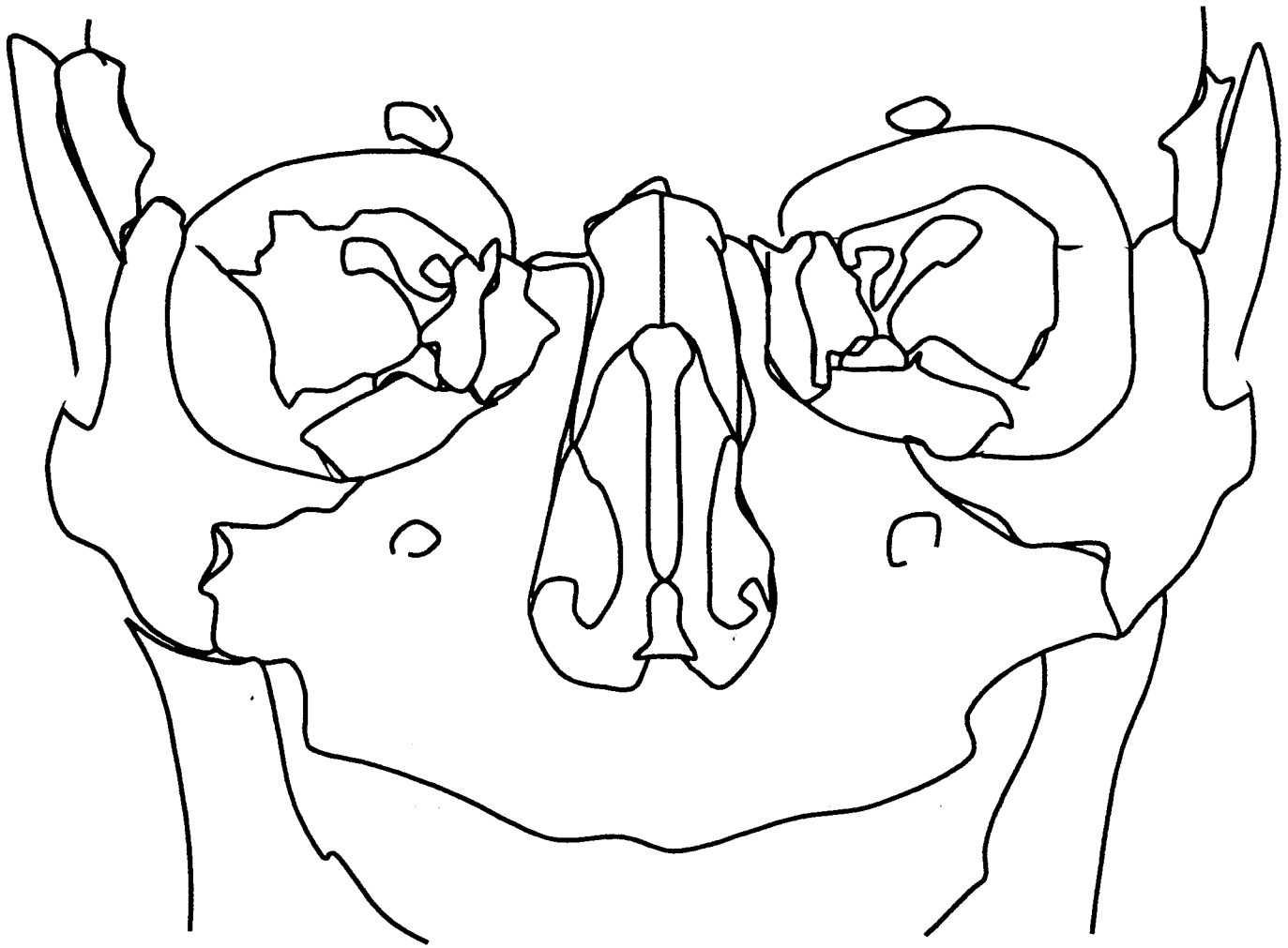
Venous Supply of Face



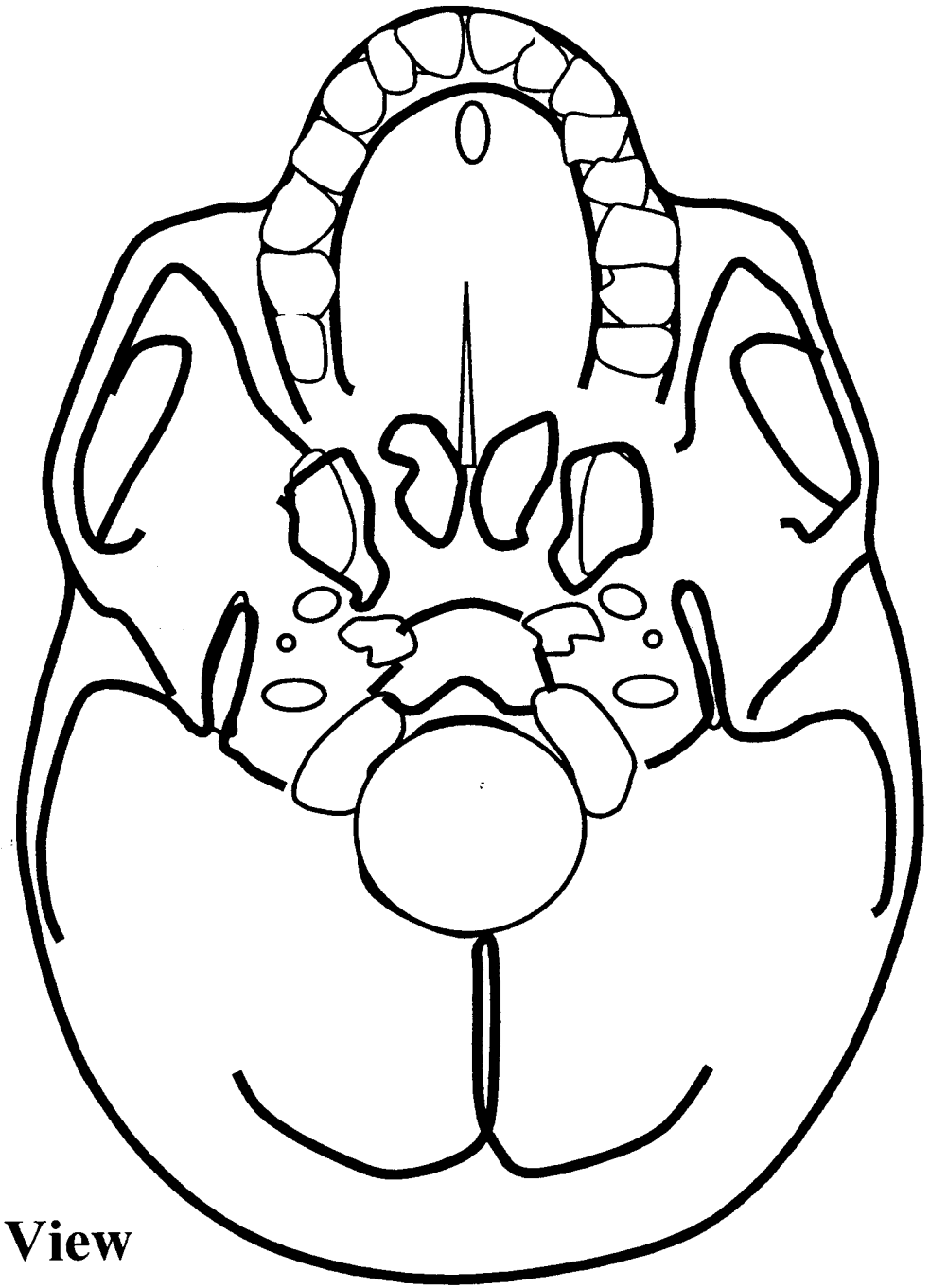
Lateral View



Skull: Lateral View

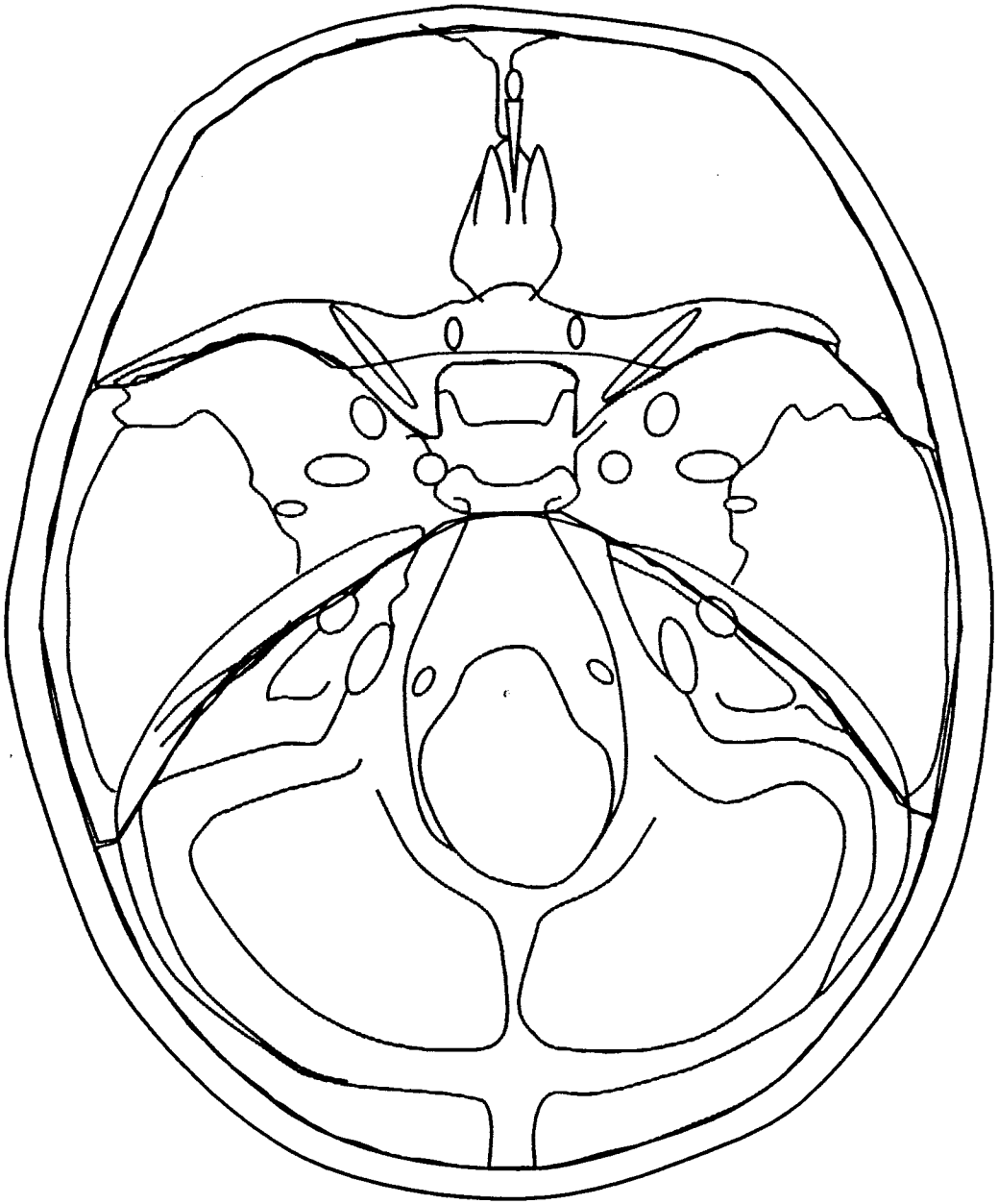


Skull: Anterior View



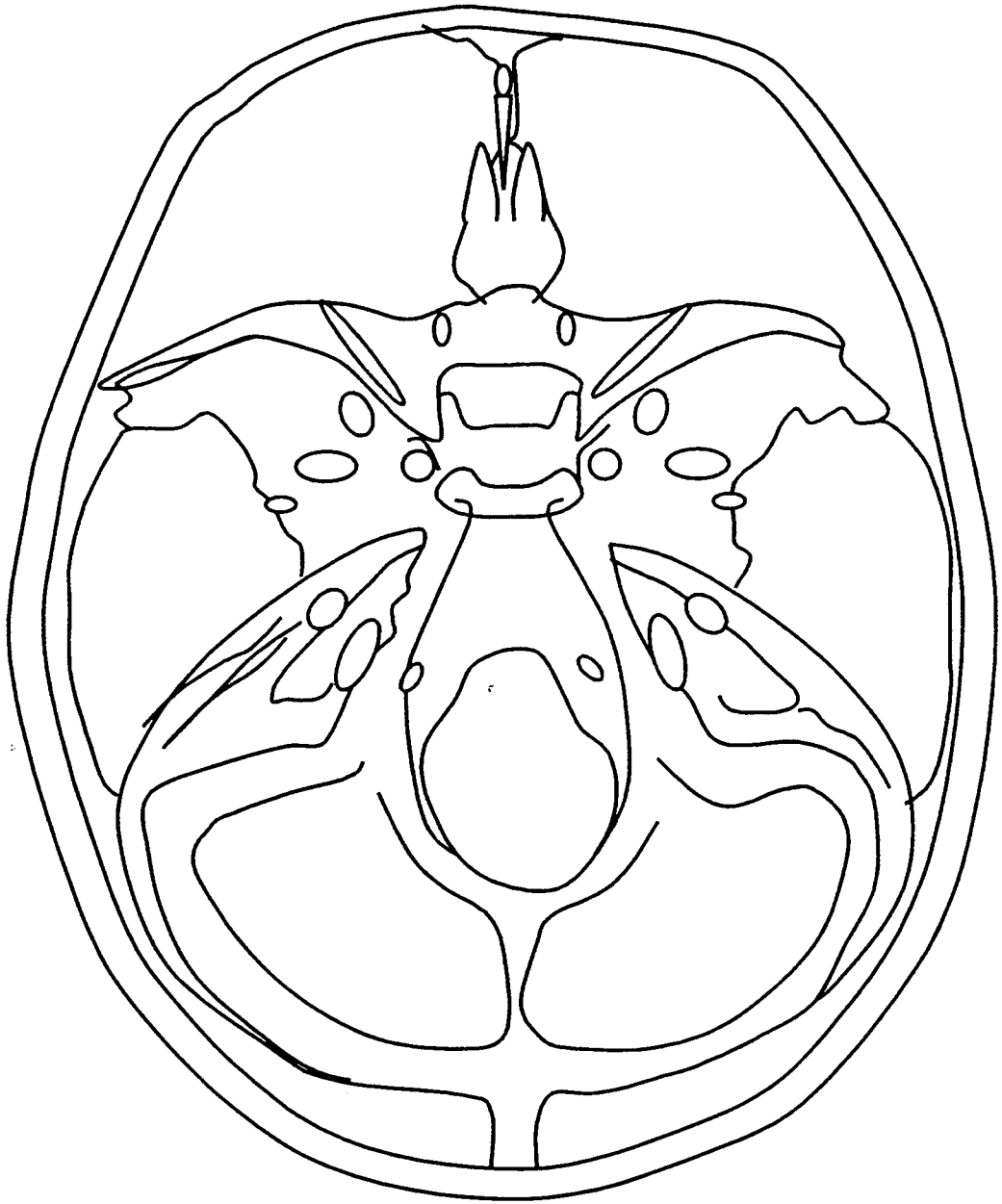
Skull: Inferior View

Cranial Fossa



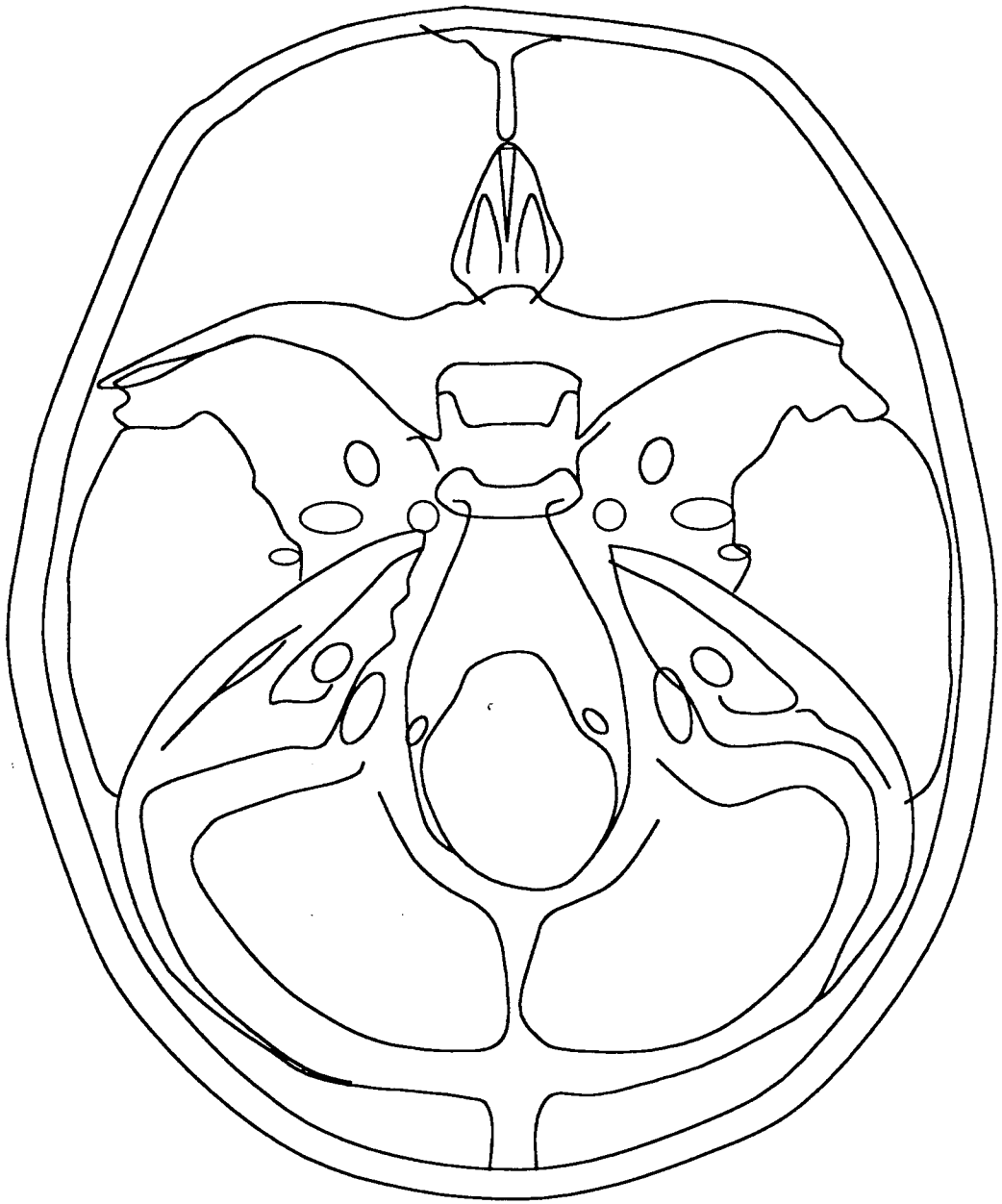
Superior View

Anterior Cranial Fossa Structures



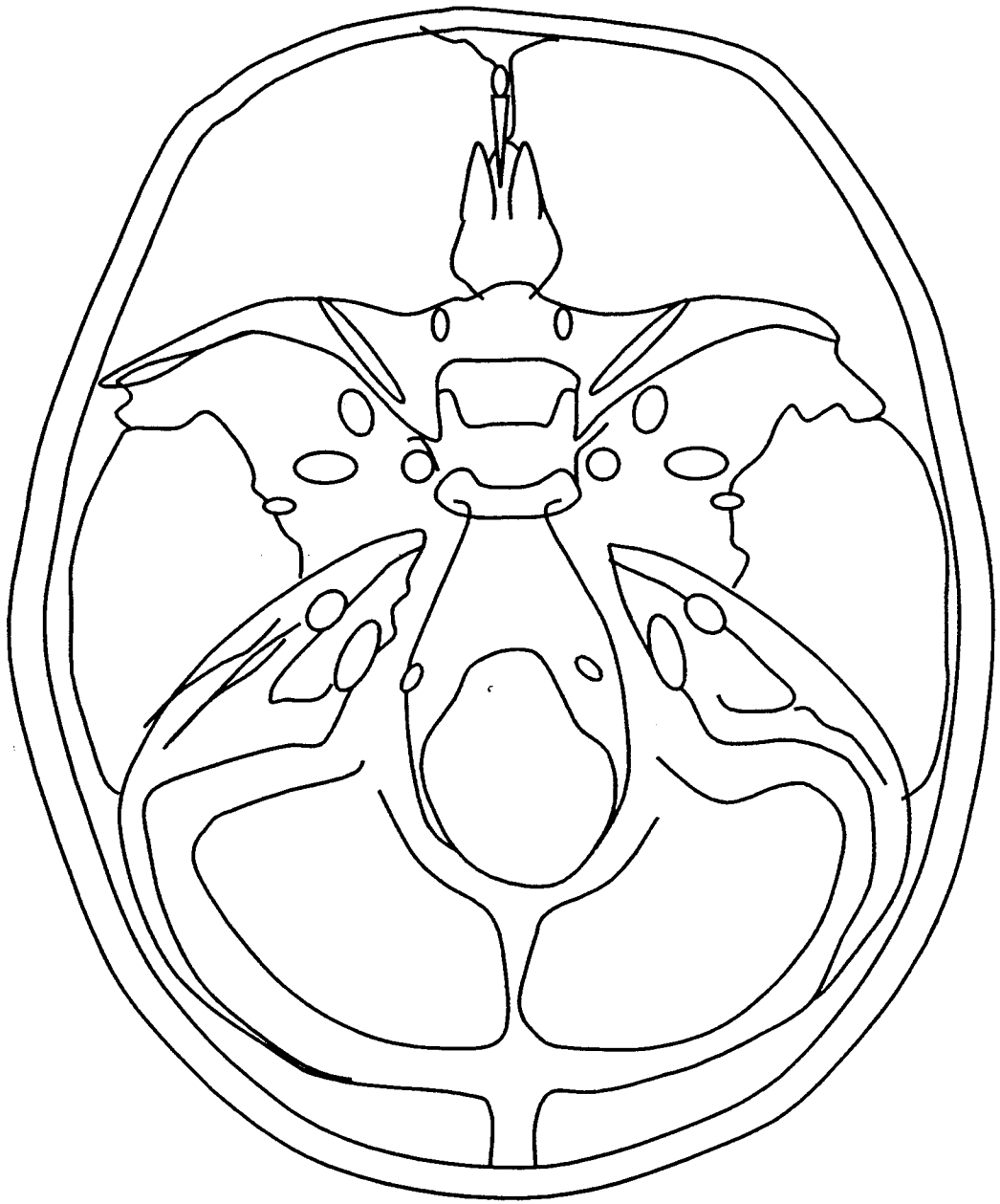
Superior View

Middle Cranial Fossa Structures



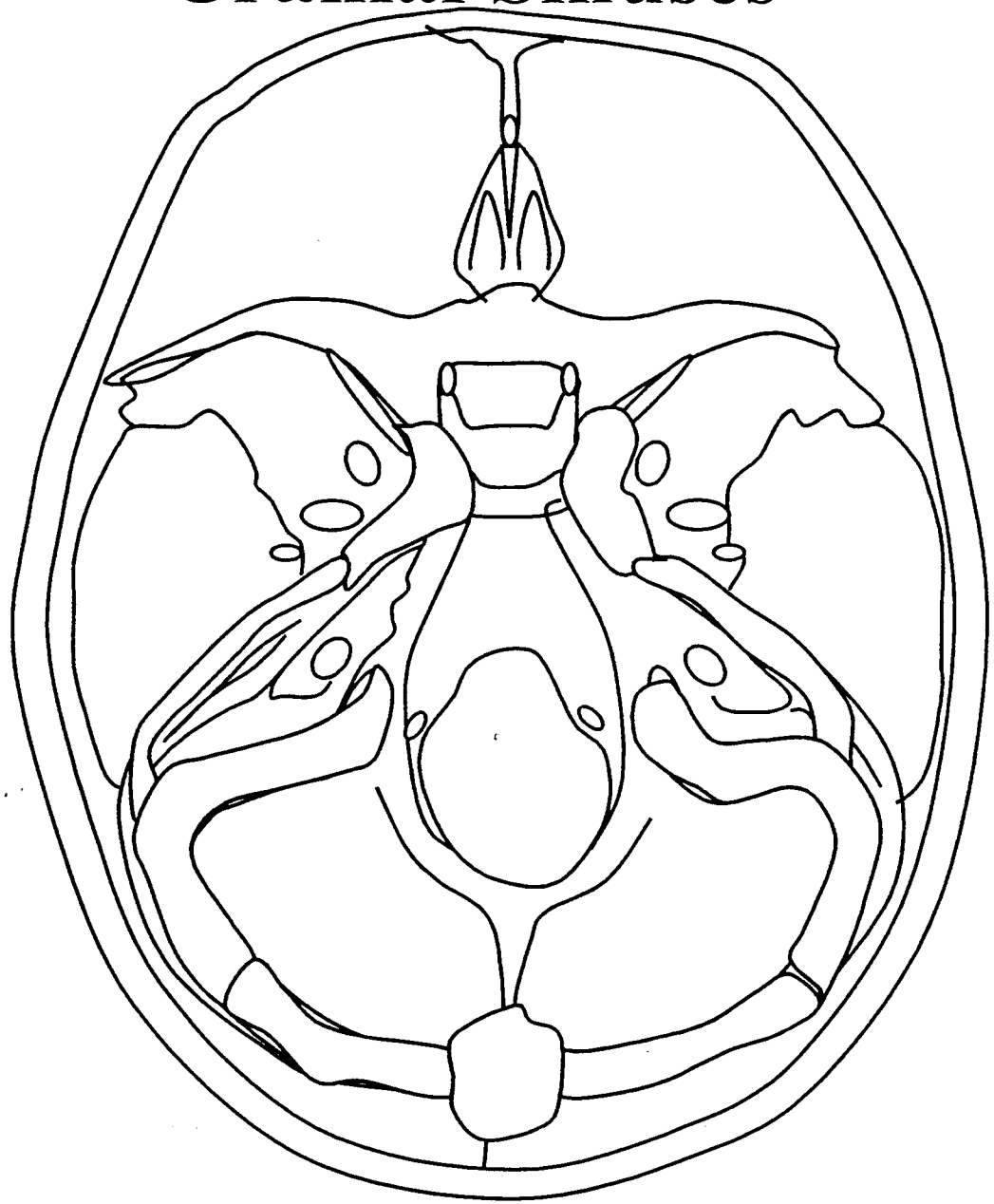
Superior View

Posterior Cranial Fossa Structures



Superior View

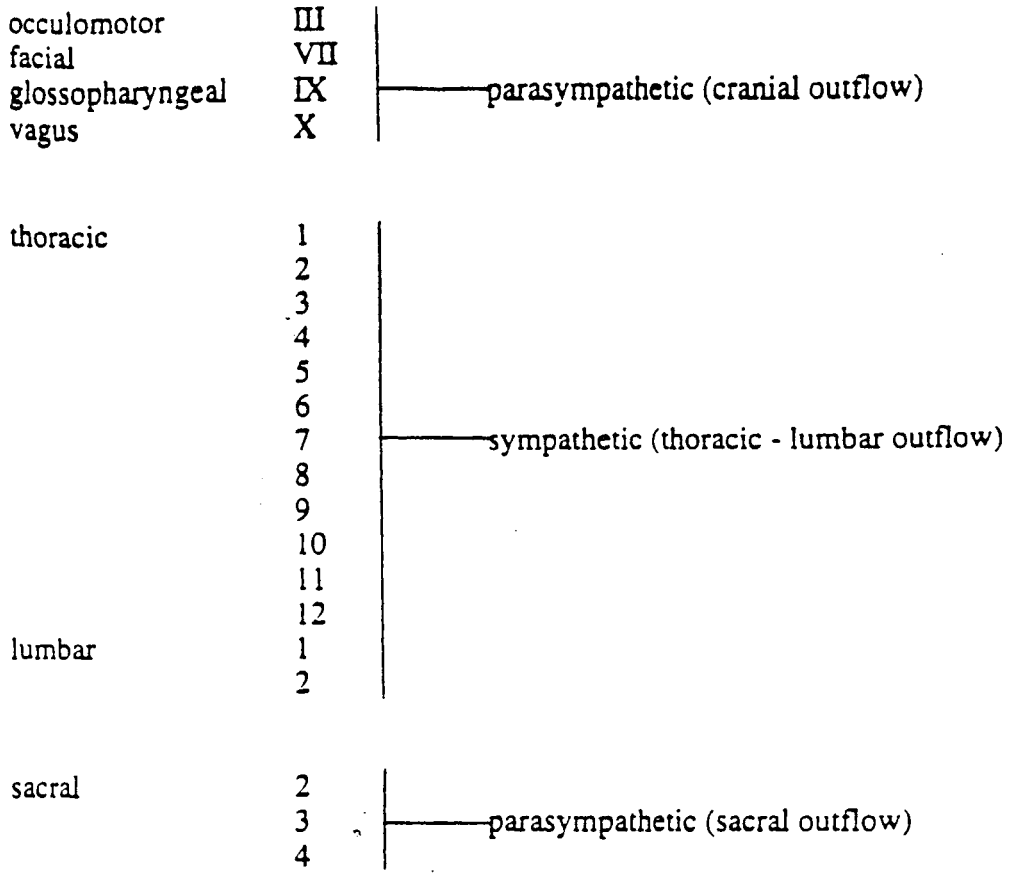
Cranial Sinuses



Superior View

AUTONOMIC NERVOUS SYSTEM

Diagram of Outflow



A. Autonomic Nervous System

1. General
   a. Physiological system,. only part of which can be grossly demonstrated
   b. Controls or modulates the visceral functions
   c. Ultimately controlled by the hypothalamus which controls other vegetative functions
   d. Autonomic fibers leave the central nervous system to run and distribute with the cranial or spinal nerves; synapse in ganglia scattered throughout body
   e. Physiologically, fibers named by the type of neuro-transmitter released
      1) Cholinergic release acetylcholine (enzyme breaking it down is acetylchoninesterase)
      2) Adrenergic release noradrenalin (enzyme breaking it down is methyltransferase), but removed mainly by re-uptake

2. Subdivided into sympathetic and parasympathetic systems which are part, but not always, antagonistic

3. Effect of a given system on organ not always predictable, and only empirically determined.

3. Functions
   a. Vasoconstriction (exception are certain fibers in muscle which cause vasodilation)
   b. Erector pili contraction (goose pimples)
   c. Coronary artery dilation
   d. Increased
      1) sweating
      2) heart rate
      3) bronchial dilation
      4) glucose release
      5) sphincter tone
   e. Decreased
      1) gut motility
      2) GI secretion

C. The Parasympathetic Nervous System

1. Location and organization
   a. Pre-ganglionic fibers are relatively long, and most ganglia are in or near the organ innervated.
   b. Pre-ganglionic fibers run with cranial nerves III, VII, XI, and X
      1) Those with III used in eye
      2) Those in VII and XI go to glands in head and neck
      3) Those in X (vagus) innervated all viscera except for last portion of colon and pelvic viscera
   c. Pre-ganglionic fibers also run in sacral nerves 2, 3, and 4
      1) Innervate last part of colon and pelvic structures
   d. Both pre- and post-ganglionic fibers release acetylcholine
   e. Do not distribute to periphery

2. Function
   a. Increased
      1) gut motility
      2) secretion of GI glands
      3) bronchial constriction
      4) coronary artery constriction
   b. Decreased
      1) heart rate
      2) sphincter tone
      3) vasoconstriction in vessels of erectile tissue

D. Autonomic Sensory Fibers

1. Derived from the dorsal root (sensory) ganglia or from the sensory ganglia associated with the cranial nerves
2. Run with both sympathetic and parasympathetic fibers, but do not synapse in any of their ganglia
3. Called the general visceral afferent fibers - GVA
4. Functions
   a. carry sensation for autonomic reflexes
   b. carry sensation which never reaches consciousness
   c. carry pain. sensation of nausea, hunger, etc.

BASIC TERMINOLOGY

- The cranial nerves contain various functional components designated GSA, SVA, GVA, GVE, GSE, SSA.
- First letter: General or Special
  G = General refers to primative structure or external structures of the body.
  S = Special refers to head, primary sense organs (hearing, seeing, equilibrium), special senses or muscles of special origin (i.e. muscles from branchial arches).
- Second letter: Somatic or Visceral
  S = related to structural body walls (i.e. skin, muscle, tendon, joints or fascua).
  V = related to organs of thoracic and abdominopelvic cavity (smooth muscle, glands).
- Third letter: Afferent or Efferent
  A = descriptive of direction of impulse within the nerve fibers, impulses travel from periphery (viscera or somatic) to brain.
  E = related or descriptive of nerve fibers which carry impulses from the brain to peripheral target (viscera or somatic structure) (motor).

COMBINATION OF PREFIXES:

GSA = General Somatic Afferent
GSE = General Somatic Efferent
GVA = General Visceral Afferent
GVE = General Visceral Efferent (also involves autonomics)

All these four combinations are related to spinal and cranial nerve.
SVA = Special Visceral Afferent - Related to cranial nerves
SVE = Special Somatic Efferent

SOME NERVES ARE SENSORY ONLY

- Olfactory (I)
- Optic (II)
- Vestibularcochlear (VIII)

SOME NERVES ARE MOTOR ONLY

- Oculomotor (III)
- Trochlear (IV)
- Abducens (VI)
- Accessory (XI)
- Hypoglossal (XII)

SOME NERVES ARE MIXED

- Trigeminal (V)
- Facial (VII)
- Glossopharyngeal (IX)
- Vagus (X)

GSA Component (black)

1. Unipolar cells
2. Cells located at the dorsal root ganglion
3. Peripheral processes form spinal nerves which conduct impulses from somatic receptors below the head.
4. Central process traverses the spinal cord (dorsal root ganglion) and terminates in the gray matter of spinal cord.

GSE Component (red)

1. Large multipolar cells
2. Cells located in the ventral horn of spinal cord (grey matter of spinal cord)
3. Peripheral processes leave spinal cord (SC) and join other components in the intervertebral foramen of the vertebral column and terminate into muscles (skeletal muscles)

GVA Component (purple)

1. Unipolar cells
2. Cell bodies in dorsal root ganglion
3. Central processes terminate in ventral horn
4. Conduct structures are related to blood vessels and other visceral structures.

GVE Component (blue)

1. Cell bodies located in SC (lower thoracic & upper lumbar)
2. Peripheral fibers (preganglionic sympathetic fibers) originate from SC and exit by way of ramus comunican to enter the paravertebral sympathetic trunk where:
   a. Preganglionic fibers may synapse there with nearest ganglion.
   b. May go up or down 2 or 3 levels of SC.
3. Postganglionic fibers from neurons of the sympathetic trunk pass by the ramus comunicans to all spinal nerves to supply:
   a. Smooth muscle
   b. Blood vessels
   c. Glands

CRANIAL NERVES

1. SVA - 1° related to taste and smell
2. SSA - 1° related to vision (sight) and equilibrium (vestibular) and hearing

OLFACTORY NERVE (CN 1)

1. Related to smell
2. Receptors located on Olfactory membrane
3. Bipolar neurons which make few contacts with Mitral and Sustentacular cells
4. Processes form the olfactory tract which send fibers to anterior fossa (cribiform plate)

OPTIC NERVE (CN 2)

1. SSA (related to vision)
2. Extension of the dicephalon (CNS)
3. Axons from Retinal Ganglion Cells form Optic nerve
4. These fibers leave the posterior part of the eyeball and pass through the ocular orbit and traverse the Optic Chiasma. The Chiasm is in direct association with the Sella Turcica (region for site of the Pituitary).

OCULOMOTOR NERVE

1. Two functional components - GSE & GVE
2. Nerve arises in the metencephalon of brain
3. GSE component (red)
   (a) arises from the oculomotor nucleus
   (b) Multipolar nuclei
   (c) Axons exit from the brain and are in close association with the Cavernous sinus; fibers then pass through the Superior Orbital fissure and then divide into:
      (i) Superior Branch: innervates Superior Palpebral muscle & Superior Rectus muscle.
      (ii) Inferior Branch: innervates medial rectus and inferior rectus, Inferior oblique muscles.
4. GVE component (blue)
   (a) Fibers which course in this nerve provide parasympathetic innervation to the Pupillary sphincter and Ciliary body)
   (b) Pupillary Sphincter constricts the pupil
   (c) Ciliary body functions to change the shape of the Lens of the eye for close vision known as accommodation.

(d) Preganglionic GVE fibers travels as "Hitchhiker" with the Oculomotor nerve through the Cavernous sinus and Superior Orbital Fissure.
Once in the orbit, the GVE fibers follow the division of the III nerve towards the Ciliary Ganglion where they synapse.
This synapse in the Ciliary Ganglion gives rise to the postganglionic GVE fibers which course directly to the posterior surface of the globe as the Short Ciliary Nerves..

(e) Only the GVE fibers of the Oculomotor Nerve (CN 3) are related to the Ciliary Ganglion not the GSE fibers.

TROCHLEAR NERVE (CN IV)

1. GSE (red)
2. Nucleus of nerve located in midbrain (Trochlear nucleus)
3. Processes from nucleus exit from dorsal surface of brain
4. Nerve leaves the brain, pierces the dura mater, enter the lateral wall of the Cavernous sinus and proceeds into the Superior Orbital Fissure.

TRIGEMINAL NERVE (CN V)

1. Nerve has two functional units (components)
   (a) GSA (sensory)
   (b) SVE (Special Visceral Efferent)

2. GSA (black)
   (a) Neurons lie in the peripheral ganglion in the middle cranial fossa of the skull.
   (b) Trigeminal ganglion = Semilunar Ganglion sensory fibers which go to the brain

3. Peripheral part
   (a) Trigeminal ganglion begins peripheral portion
   (b) Divides into three branches
      (i) Ophthalmic (VI)
      (ii) Maxillary (V2)
      (iii) Mandibular (V3)

A. Ophthalmic Branch (V1)
   (a) Made up entirely of GSA component
   (b) As it enters the skull it gives off a meningeal branch and it will pass in the lateral wall of the Cavernous Sinus, just behind the Superior Orbital Fissure, and will give off three branches.
      (1) Frontal

(2) Lacrimal
(3) Nasociliary

(1) Frontal Nerve
  (a) Divides into two branches
    (i) Supraorbital
    (ii) Supratrochlear
  NB: Both branches supply cutaneous innervation to nose, upper eyelid, forehead, central anterior part (2/3rd) of scalp.
(2) Lacrimal Nerve
  (a) Traverses Superior Orbital Fissure and Orbit and sends sensory fibers to Lacrimal Gland, conjunctiva, and skin over lateral side of orbit.
(3) Nasociliary Nerve (you will see all branches in lab)
  (a) Traverses Superior Orbital Fissure and distributes GSA fibers to the eyeball as Long Ciliary Nerve, and long root of Ciliary Ganglion. Will go into the mucosa of the Posterior Ethmoidal Air Cells and will supply sensory to Posterior Ethmoidal Cells and Sphenoid Sinus.
  (b) Infratrochlear branch: This branch of the nasociliary nerve supplies skin, conjunctiva, lacrimal sac and medial part of the orbit.
  (c) Anterior Ethmoidal Nerve of Nasociliary supplies Anterior ethmoidal cells, frontal sinus, nasal cavity.

B. MAXILLARY NERVE (V2)
  (a) GSA
  (b) Leaves trigeminal ganglion and passes to cavernous sinus and exits through the Foramen Rotundum
  (c) It then traverses the Pterygopalatine Fossa and passes through the Inferior Orbital Fissure and ends as the Inferior Orbital Nerve.
  (d) Maxillary nerve innervates nasal pharynx, nasal cavity, sphenoid sinus, Ethmoid Air Cells, Hard Palate.
  (e) Branch of the Maxillary nerve, the Zygomatic nerve, supplies skin over zygoma.
  (f) Maxillary nerve also supplies Maxillary sinus, teeth and gums via:
    (i) Posterior Alveolar Nerve
    (ii) Middle Alveolar Nerve
    (iii) Anterior Alveolar Nerve

C. MANDIBULAR NERVE:
  (a) GSA and SVE are functional components

(b) Nerve exits middle cranial fossa thru Foramen Ovale, to give off fibers anterior to the external ear (auricle) as the Auriculotemporal Nerve

(c) Buccinator nerve supplies sensory innervation over the buccinator muscle of the cheek and the mucous membrane of the lateral side of the mouth.

(d) Lingual Nerve courses between the Medial Pterygoid Muscle and the mandible, on its path to supply sensory innervation to the tongue.

(e) The terminal sensory branch of V3 will pass thru the Mandibular Foramen and divides into Inferior Alveolar and Mental Nerves to serve the teeth of the lower jaw and the skin of the jaw region respectively.

(f) Mandibular nerve conducts SVE fibers to the muscle of which arise from the First Branchial Arch. The motor fibers emerge in the trigeminal nerve from the brain, pass entirely into the mandibular division. They supply the muscles of the first pharyngeal arch of the embryo (e.g. muscles which move the mandible).

(1) Muscles of mastication
   (i) Temporalis
   (ii) Medial Pterygoid
   (iii) Lateral Pterygoid Muscle

Other muscles:
   (i) Tensor Tympani
   (ii) Tensor Veli palatini
   (iii) Anterior belly of the diastric
   (iv) Mylohyoid muscle

SYNONYMOUS NOMENCLATURE

- Nerve to Pterygoid Canal = Vidian Nerve
- Sphenopalatine Ganglion = Pterygopalatine Ganglion
- Nodose ganglion of Vagus = Superior Ganglion of X
- Jugular Ganglion of Vagus = Inferior Ganglion of X

FACIAL NERVE (CN VII)

- Nerve contains five functional components
  1. General Somatic Afferent (GSA)
  2. General Visceral Efferent (GSE)
  3. Special Visceral Efferent (SVE)
  4. Special Visceral Afferent (SVA)
  5. General Visceral Afferent (GVA)

SVE OF FACIAL NERVE (green)

1. Innervates all the skeletal muscles derived from mesenchyme of 2nd Brachial arch (2nd Hyoid Arch)
2. Origin: Multipolar cells in the brain
3. Fibers cross around the abducens nucleus, dorsomedially
4. Fibers pass to internal auditory meatus
5. Pass to this meatus with VIII (vestibular nerve)
6. Nerve enters Facial Canal (canal ascends to Petrous portion of the Temporal bone, is medial to middle ear
7. Facial nerve turns at the level of anterior part of ear
8. Nerve passes thru narrow hiatus of Facial Canal (connects facial canal with middle cranial fossa)
9. Fibers cross medially in wall of Tympanic membrane
10. Sends off small branch, Stapedius Nerve, to Stapedius Muscle
11. Main SVE fibers exit ear, then pass thru Styloid Mastoid Foramen
12. Meets with Posterior Auricular Nerve (from VII) to innervate Occipitalis muscle, and Posterior belly of the Digastric: Anterior belly of Digastric supplied by V3 via Mylohyoid nerve
13. Bulk of SVE passes thru Parotid gland (5 branches pass down to Platysma: (a) Temporal, (b) Zygomatic, (c) Buccal, (d) Mandibular, (e) Cervical

GVE COMPONENT OF THE FACIAL NERVE (CN VII)

1. GVE (blue) (Autonomic - parasympathetic)
2. Exits the brain and passes through internal auditory meatus to Facial Canal
3. Preganglionic fibers divide into:
   (a) To Facial canal to Stylomastoid foramen
   (b) Leaves Facial Nerve as Great Superficial Petrosal nerve
4. Fibers in Great Superficial nerve pass thru Petrous Pyramid via Lacerate foramen to enter Pterygoid canal. Here is called the Nerve of the Pterygoid canal - Vidian Nerve.
5. Vidian Nerve reaches the pterygopalatine ganglion (inferior to the Maxillary nerve)
6. GVE fibers synapse here in Pterygopalatine (Sphenopalatine) Ganglion. Some Postganglionic fibers go to the Lacrimal Gland - join Maxillary nerve to enter Orbit.
   (a) from Maxillary nerve have Zygomatic branch. This branch leaves to join Lacrimal nerve of VI (opthalmic branch of trigeminal) to go to Lacrimal gland (secretory fibers of gland).
   (b) Other postganglionic go to Glands of Nasal Cavity, Nasopharynx and Palate.

7. Preganglionic fibers (in * 3a of this component)First division of these fibers discussed in #4-6 above. Pass through the Styloid Foramen
8. Cross Chorda Tympani canal thru Facial Canal to Tympanic Cavity. It is now located medial to the Malleus and Tympanic Membrane.
9. Nerve now passes to Infratemporal Fossa via Petrotympanic fissure.
   (a) Within this fossa (infratemporal fossa) the Chorda Tympani joins the Lingual Nerve (a branch of the Mandibular V3 of Trigeminal).
10. Preganglionic fibers leave Lingual Nerve lateral to tongue.
11. Enter Submandibular, Sublingual Glands, mucous membrane of mouth.

SVA COMPONENT OF THE FACIAL NERVE (brown)

1. Essentially Taste
2. Origin is the Geniculate Ganglion
3. Nerve follows the same course of the Chorda Tympani and Lingual Nerve to facial canal
4. Supplies taste to the anterior 2/3rd of tongue. (Lingual supplies sense to anterior 2/3rd of tongue)
5. Some of the fibers exit the Facial Canal to the Great Superficial Petrosal Nerve.
6. Travels along Vidian Nerve (nerve to pterygoid canal)
7. Nerve does not synapse in Pterygopalatine Ganglion
8. Enters to supply palate, nose and nasopharynx

GVA COMPONENT OF THE FACIAL NERVE (purple)

1. Travels with the SVA fibers thru Greater Superficial Petrosal nerve to Pterygopalatine Ganglion without synapsing.
2. Distributed to membranes of soft palate and walls of Pharynx

GSA COMPONENT OF THE FACIAL NERVE (black)

1. Cell bodies in geniculate ganglion
2. Courses thru Facial Canal
3. Exits via Stylomastoid Foramen
4. Enters with Posterior Auricular branch of VII
5. Supplies sensory to the skin on posterior surface of ear

SUMMARY

Seventh nerve supplies structures derived from the second pharyngeal (brachial) arch of the embryo. VII nerve is predominately a motor nerve to muscles of facial expression, also to Posterior Belly of the Digastric, the Stylohyoid, and the Stapedius Muscle, and to many glands by preganglionic parasympathetic nerves

that pass to the pterygopalatine and submandibular ganglia. It also contains sensory fibers which originate in cells of its geniculate ganglion

CLINICAL CORRELATION OF FACIAL NERVE

Injury of the facial nerve is directly related to locale of the nerve lesion

1. If entire facial nerve is damaged:
   a. Deficit of lacrimal fluid
   b. Dry mouth
   c. Loss of stapedius muscle
   d. Loss of taste of 2/3rd of tongue
   e. Paralysis of the stylohyoid muscle
   f. Paralysis of posterior belly of digastric muscle
   g. Paralysis of auricular muscles
   h. Paralysis of facial expression muscles

VESTIBULOCOCHLEAR NERVE (CN VIII)

1. SVA Functional Component
2. This is a combined nerve conveying sensory information regarding hearing and balance (vestibular) to the brain
3. Peripheral projections end upon the Hair Cells of the Organ of Corti
4. Central fibers arise from these hair cells and course through the Temporal Bone, enter the Posterior Cranial Fossa via the Internal Acoustic Meatus, to then enter the brainstem.
5. The Vestibular Nerve, responsible for balance, arises from bipolar cells of the Vestibular Ganglion which project to the Cristae or Macula of the Semicircular canals of the middle ear.

GLOSSOPHARYNGEAL NERVE (CN IX)

1. The IX cranial nerve (Glossopharyngeal) supplies the structures that develop from the third Pharyngeal pouch (Brachial Arch).
2. The IX nerve is a mixed nerve with a large sensory element which supplies part of pharynx and the posterior one-third of the tongue, and as a motor part which supplies the Stylopharyngeus and the Middle Constrictor muscles (brachial motor) and the nerve also sends preganglionic nerve fibers to the Otic Ganglion.
3. Nerve contains 5 functional components.
   (a) GSA SVA
   (b) GVA SVE
   (c) GVE

GLOSSOPHARYNGEAL (IX)

1. GVA Functional component (purple)
2. This component conveys sensation from the mucous membrane of the Pharynx, Tympanic Membrane and area in the Carotid Bifurcation.
3. Fibers exit the brainstem and cranium through the Jugular Foramen. Inferior to the jugular foramen is located the cell bodies of this GVA component, Petrosal Ganglion.
4. The peripheral processes distribute into divisions:
   (a) Main Distribution: Spirals around the Stylopharyngeus passing along the muscle's posterior aspect, it then breaks up into a plexus, and enters wall of the Pharynx. It supplies the pharynx and posterior 1/3rd of tongue (taste), the anterior 2/3rd is supplied by the VII nerve.
   (b) Other distributions: Leaves the main trunk, supplies area of bifurcation of Carotid Artery to structure called the Carotid Sinus, which conveys information regarding pressure from baroreceptors located in the body wall (chemoreception)
   (c) Other distribution: leaves the IX nerve, enters the Tympanic Caniculus as a tympanic branch, passes to Tympanic Cavity where it breaks up into a Tympanic plexus. It innervates (Tympanic branch) the mucous membrane of the tympanic cavity and posterior part of Eustachian tube.

NB: Main Distribution: Nerve descends into neck between Internal Carotid artery and Internal jugular vein, then passing between internal and external carotids, curves behind Stylopharyngeus to enter the base of the tongue, close to palatine tonsil.

GLOSSOPHARYNGEAL NERVE (IX)

1. GSA functional component (black)
2. This component exits the brainstem and then exits the skull through the Jugular Foramen.
3. The cell bodies for GSA component are located just superior to Jugular Foramen at Superior ganglion.
4. These fibers will join the Aricular Branch of the Vagus Nerve to supply the skin of the external ear and the External Auditory Meatus.

GLOSSOPHARYNGEAL NERVE (CN IX)

1. GVE functional component (blue)
2. Origin is from the Inferior salivatory Nucleus
3. Preganglionic fibers (parasympathetic component) exits brainstem at jugular foramen and courses to the tympanic Caniculus.

4. Enters the trunk, courses through Superior Petrosal Ganglia
5. Then enters tympanic nerve then passes to tympanic caniculus, where nerve forms a tympanic plexus.
6. Nerve (regroup) continues as the Lesser Superficial Petrosal Nerve which pierces the roof of the Tegmen Tympani.
7. The nerve exits, traverses Foramen Ovale, courses to synapse with Otic Ganglion situated medial to the trunk of the Mandibular nerve.
8. Postganglionic fibers enter the Auriculotemporal nerve of Mandibular branch (V3) to reach Parotid gland.

GLOSSOPHARYNGEAL NERVE

GVA Functional component (purple)

1. This component conveys sensation from the mucous membrane of the pharynx, the tympanic membrane and Carotid Bifurcation.
2. Fibers exit the brainstem and exit cranium thru jugular foramen
3. Inferior to jugular foramen are located cell bodies of this component, the Petrosal ganglion.
4. At this point some fibers enter tympanic canaliculus in the company of the parasympathetic fibers to supply the Tympanic membrane and posterior Eustachian tube. Remaining fibers descend to pharynx passing along posterior part of Stylopharyngeus.

SVA Functional component (brown)

1. This component conveys taste to the posterior 1/3rd of the tongue (taste buds and adjacent pharyngeal wall)
2. Peripheral fibers travel with GVA fibers, pass thru main trunk. Enters pharyngeal plexus (just below Jugular foramen), to enter pharyngeal plexus.
3. Passes to tongue

SVE functional component

1. Innervates muscle derived from third brachial arch
2. To Stylopharyngeus muscles (raises pharynx)

VAGUS NERVE (CN X)

1. Vagus nerve is a mixed nerve.
2. It supplies:
   (a) Structures developed from 4th and 6th pharyngeal (brachial) arches of the embryo
3. It carries afferent nerve fibers from the pharynx, esophagus, stomach, small and large intestine, larynx, trachea, lungs, heart, pancreas, liver.

4. The motor fibers are:
   (a) preganglionic parasympathetic fibers distributed to the parasympathetic ganglia that innervate smooth muscle and gland cells.
   (b) fibers (brachial) directed to striated muscles of the larynx and pharynx.
5. The Vagus nerve has a small (Superior Ganglion) in the Jugular Foramen and a larger Inferior Ganglion, immediately below the Jugular Foramen.

VAGUS NERVE

1. Nerve has 5 functional components:
   (a) GVA (c) GVE (e) SVA
   (b) GSA (d) SVE
2. GSA Functional Component (black)
   (a) This component supplies sensation to dura mater of posterior cranial fossa, a portion of the external ear through meningeal and auricular branches.
   (b) Central fibers exit from brain stem, emerge from cranium through jugular foramen.
   (c) Just superior to jugular foramen is the loction of the cell bodies of this component, Superior Ganglion (jugular).
   (d) Fura receives other sensory fibers from CN V.
3. GVE functional component (blue)
   (a) The parasympathetic component of this nerve supplies organs of the thorax and abdomen
   (b) Preganglionic fiber cell bodies in Dorsal Motor Nucleus
   (c) Fibers emerge from the brainstem, exit the cranium through jugular foramen to course to individual thoracic and enteric ganglia.
   (d) Fibers are related to the carotid sheath, infact , in the neck the vagus descends vertically in the Carotid Sheath to enter the superior mediastinum.
4. SVE functional component (green)
   (a) This component supplies muscles derived from the fourth brachial arch through pharyngeal, superior and inferior laryngeal branches.
   (b) Cells of origin are in the Nucleus Ambiguus in the brain (medulla).
   (c) Fibers leave vagus in many pharyngeal branches to the Pharyngeal plexus to supply:
      (i) Pharyngeal constrictor muscles
      (ii) Palatoglossus muscle
      (iii) Palatopharyngeal muscle
      (iv) Levator Palatini
      (v) Uvular muscle

(d) Other fibers enter the Superior Laryngeal nerve, travel to external branch to supply Cricothyroid muscle.

(e) Other SVE fibers of Vagal trunk pass to aortic arch on left and anterior subclavian on the right side. These fibers become the Recurrent Laryngeal Nerve (found between trachea and esophagus).

(f) Fibers also of esophagus, cricopharyngeus and lower part of inferior pharyngeal constrictor

(g) The inferior laryngeal nerve becomes the recurrent laryngeal nerve at lower border of cricoid cartilage. Innervates all the intrinsic muscles of the larynx, except Cricothyroid, which is supplied by the Superior Laryngeal Nerve.

5. GVA functional component (purple)
   1. Conveys general sensation from the mucous membranes and soft tissues of the larynx.
   2. Cell bodies in nodose ganglion (inferior ganglion)
   3. Peripheral plexus supplements fibers of the GVA from glassopharyngeal (IX) branches inferior to jugular foramen.
   4. Supplies esophagus, larynx and trachea via recurrent and inferior laryngeal nerves
   5. The peripheral fibers from the nerve will course along the SVE components as pharyngeal, superior laryngeal and recurrent laryngeal nerve.
6. SVA functional component (black)
   1. Responsible for epiglottic taste sensation, the fibers of this component exit through the brainstem, exit the cranium through jugular foramen.

   2. Just below the jugular foramen, the cell bodies of this component are situated in the nodose ganglion inferior ganglion. The peripheral fibers from this nerve will course inferiorly toward the pharynx to supply the epiglottis with taste sensation.

ACCESSORY NERVE (CN XI)

1. SVE functional component
2. Supplies the derivative of the sixth pharyngeal (brachial) arch.
3. Innervates the Trapezius and Sternocleidomastoid muscle
4. Origin: first cervical nucleus (accessory nucleus) in cord
5. Fibers enter posterior cranial fossa, nerve courses toward jugular foramen to enter foramen. Nerve passes medial to styloid process to innervate muscles.

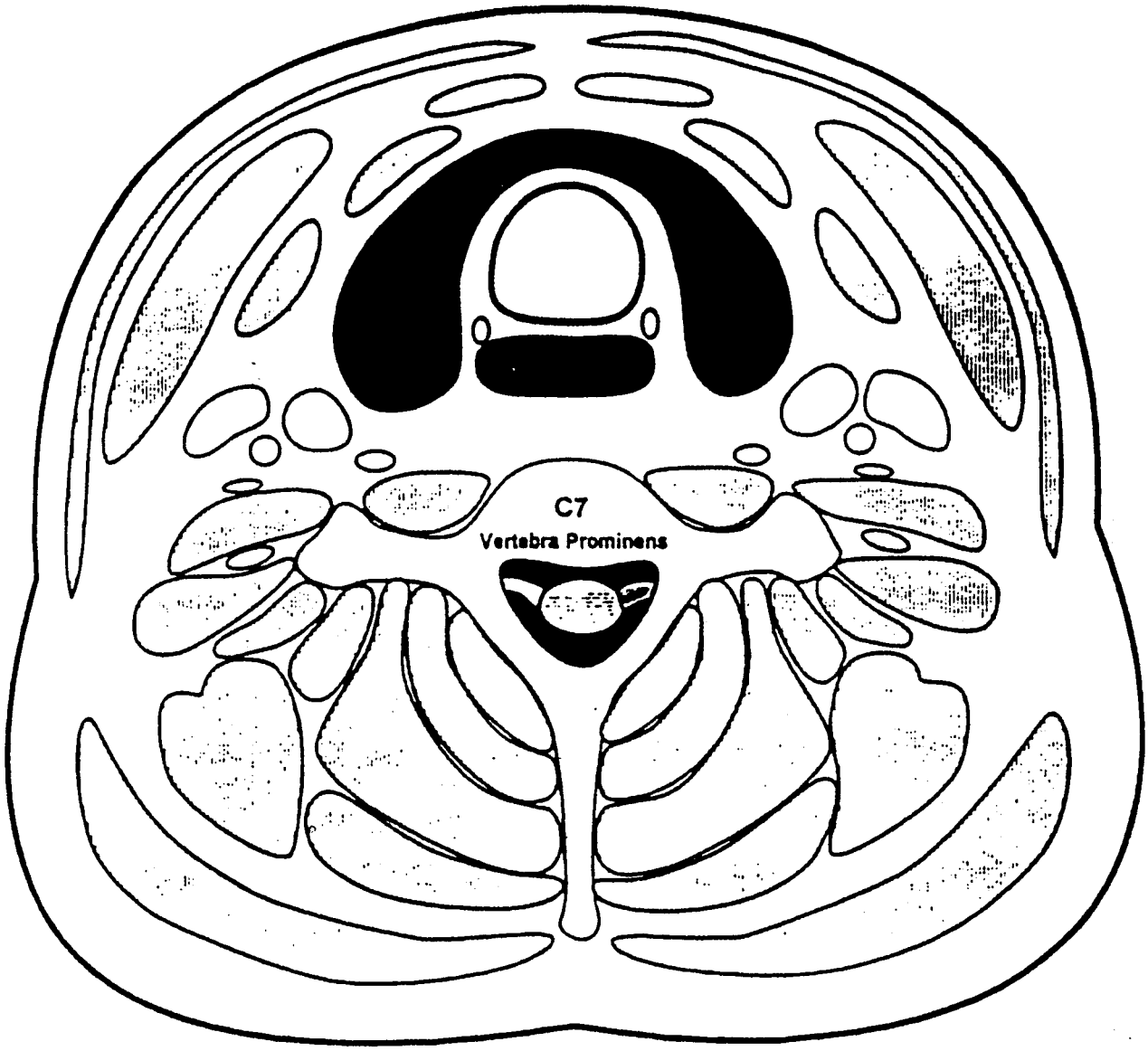
HYPOGLOSSAL (CN XII)

1. GSE functional component
2. Supplies motor innervation to intrinsic and extrinsic muscles of the tongue (e.g. Styloglossus, Hypoglossus, Genioglossus)
3. Nerve arises from motor nucleus in medulla, courses anteriorly, exits cranium thru hypoglossal foramen.

VAGUS NERVE

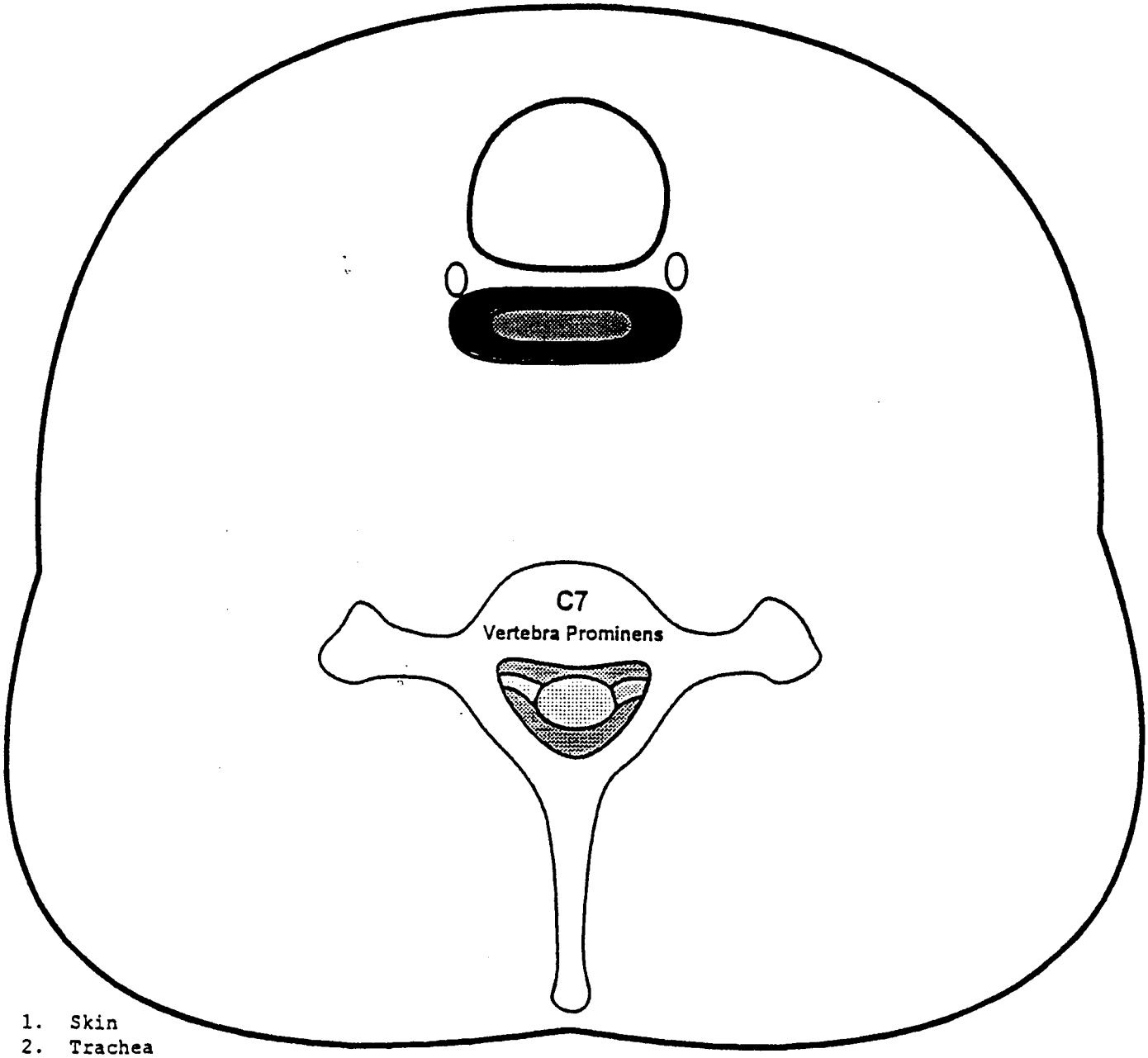
1. General Comments:
   (a) Auricular branch of Vagus receives a contribution from the Tympanic branch of the Glossopharyngeal Nerve (IX) and entering the Mastoid Canaliculus on the lateral wall of the Jugular fossa, is joined by a branch of the Facial nerve (VII).
   (b) This complex emerges from the tympanomastoid fissure and supplies the inferior part of the tympanic membrane and the floor of the external acoustic meatus.
   (c) The importance of this branch lies in the fact that irritation of this region, e.g. a foreign body in the external acoustic meatus in children, may mimic irritation of other parts of the sensory distribution and give rise to coughing and vomiting.

Fascial Layers of Neck

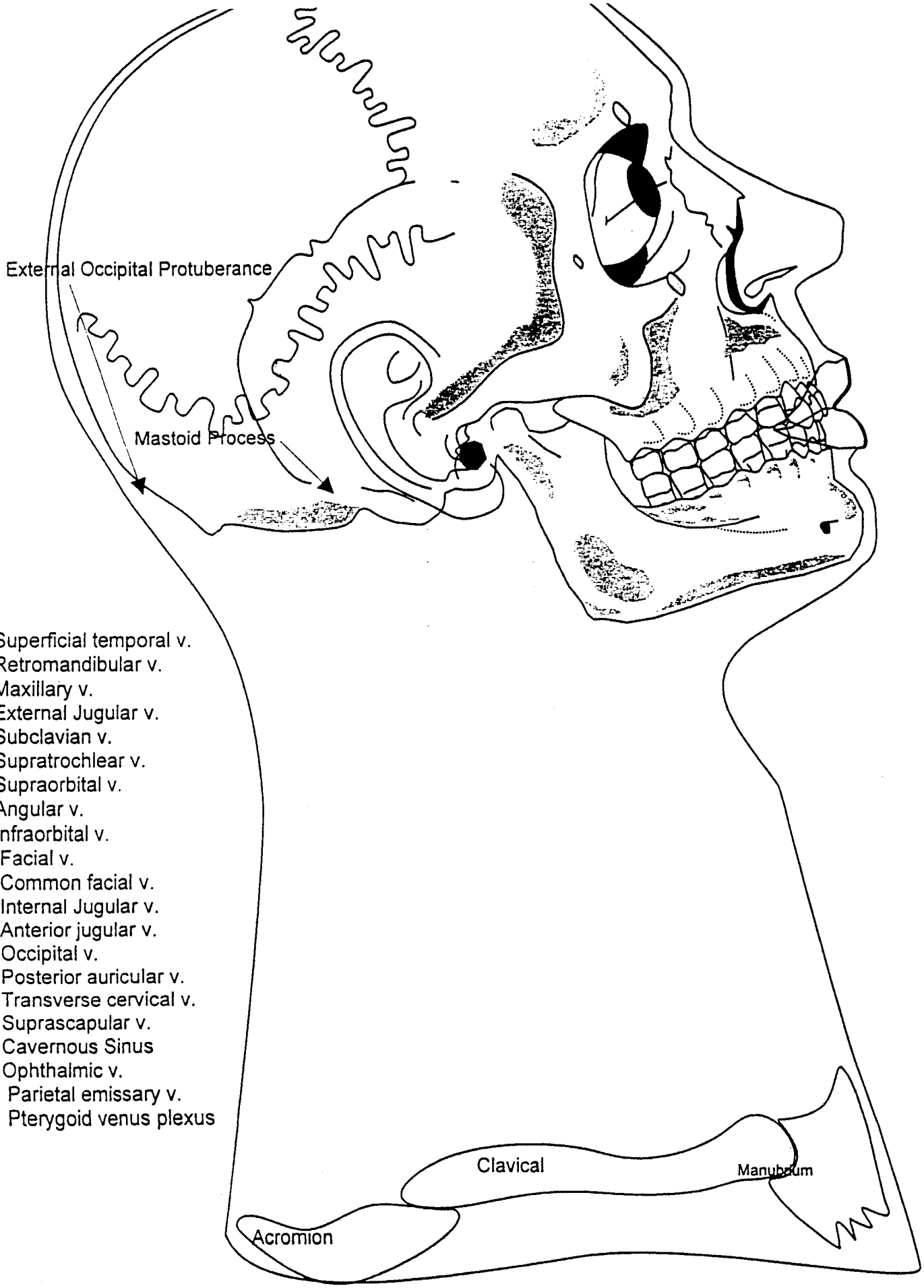


1. Platysma muscle
2. Sternocleidomastoid muscle
3. Trapezius muscle
4. Superficial investing (cervical) fascia
5. Prevertebral fascia
6. Alar fascia
7. Carotid sheath
8. Common carotid artery
9. Internal jugular vein
10. Vagus nerve (CN 10)
11. Pretracheal visceral fascia
12. Buccopharyngeal visceral fascia
13. Thyroid gland
14. Trachea
15. Esophagus
16. Recurrent laryngeal nerve
17. Retropharyngeal space (retrovisceral)
18. Levator Scapula
19. Scalenus anterior
20. Scalenus medius
21. Scalenus posterior
22. Ventral ramus brachial plexus (C8)
23. Phrenic Nerve
24. Symphathetic trunk
25. Sternohyoid muscle
26. Sternothyoid muscle
27. Omohyoid muscls (anterior belly)
28. "Danger Space"
29. Longus Colli Muscle

Cervical Fascia (Coronal) -- Fascial Spaces

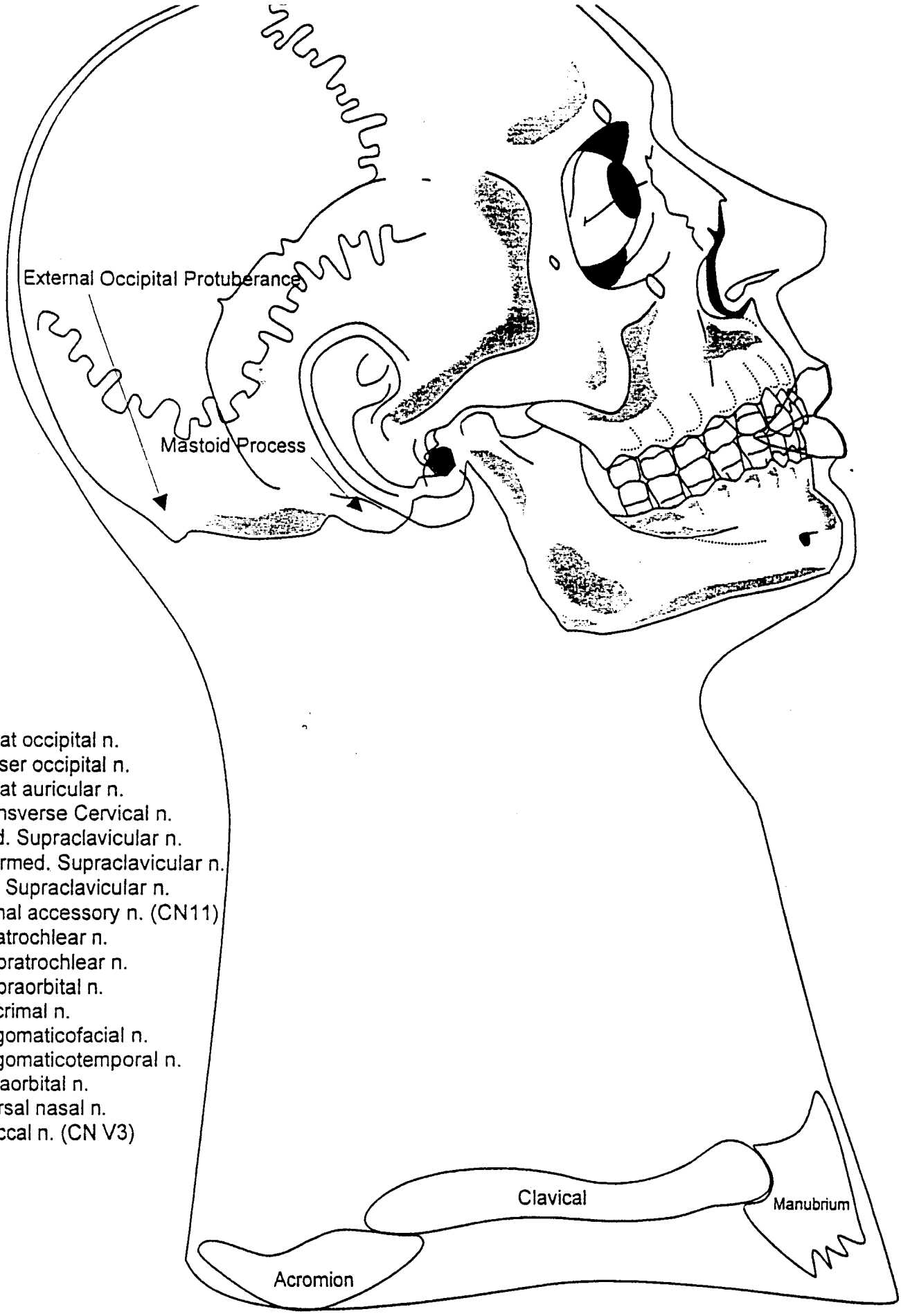


1. Skin
2. Trachea
3. Esophagus
4. Superficial cervical f.
5. Tela Subcutania
6. Prevertebral f.
7. Alar layer
8. Pretracheal f.
9. Buccopharyngeal f.
10. Carotid sheath
11. Internal jugular v.
12. Common carotid a.
13. Vagus n.
14. Pretracheal space
15. Retropharyngeal space
16. "Danger" space



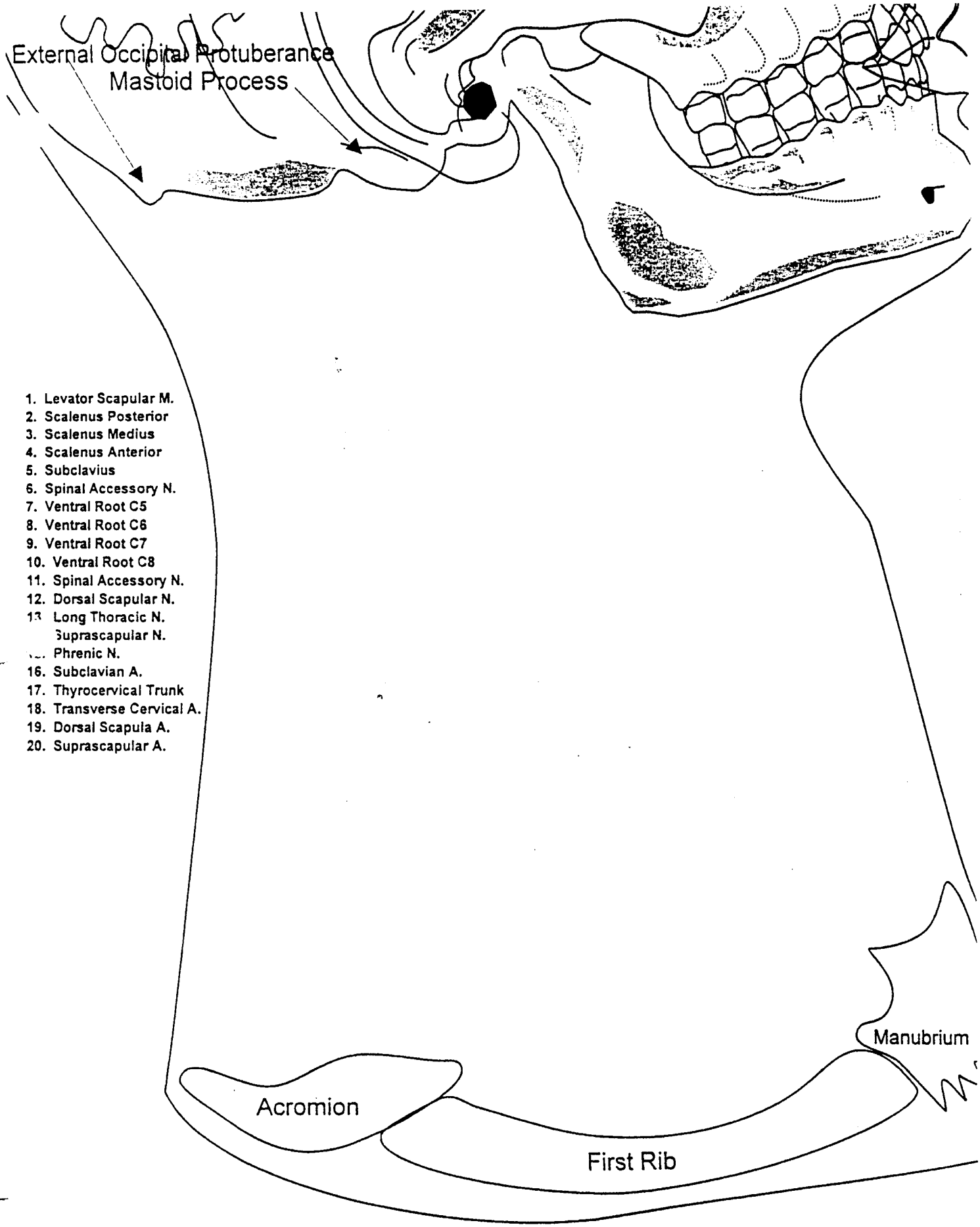
Superficial temporal v.
Retromandibular v.
3. Maxillary v.
4. External Jugular v.
5. Subclavian v.
6. Supratrochlear v.
7. Supraorbital v.
8. Angular v.
9. Infraorbital v.
10. Facial v.
11. Common facial v.
12. Internal Jugular v.
13. Anterior jugular v.
14. Occipital v.
15. Posterior auricular v.
16. Transverse cervical v.
17. Suprascapular v.
18. Cavernous Sinus
19. Ophthalmic v.
20. Parietal emissary v.
21. Pterygoid venus plexus

Posterior Triangle - Boundaries and Superficial Venous Drainage

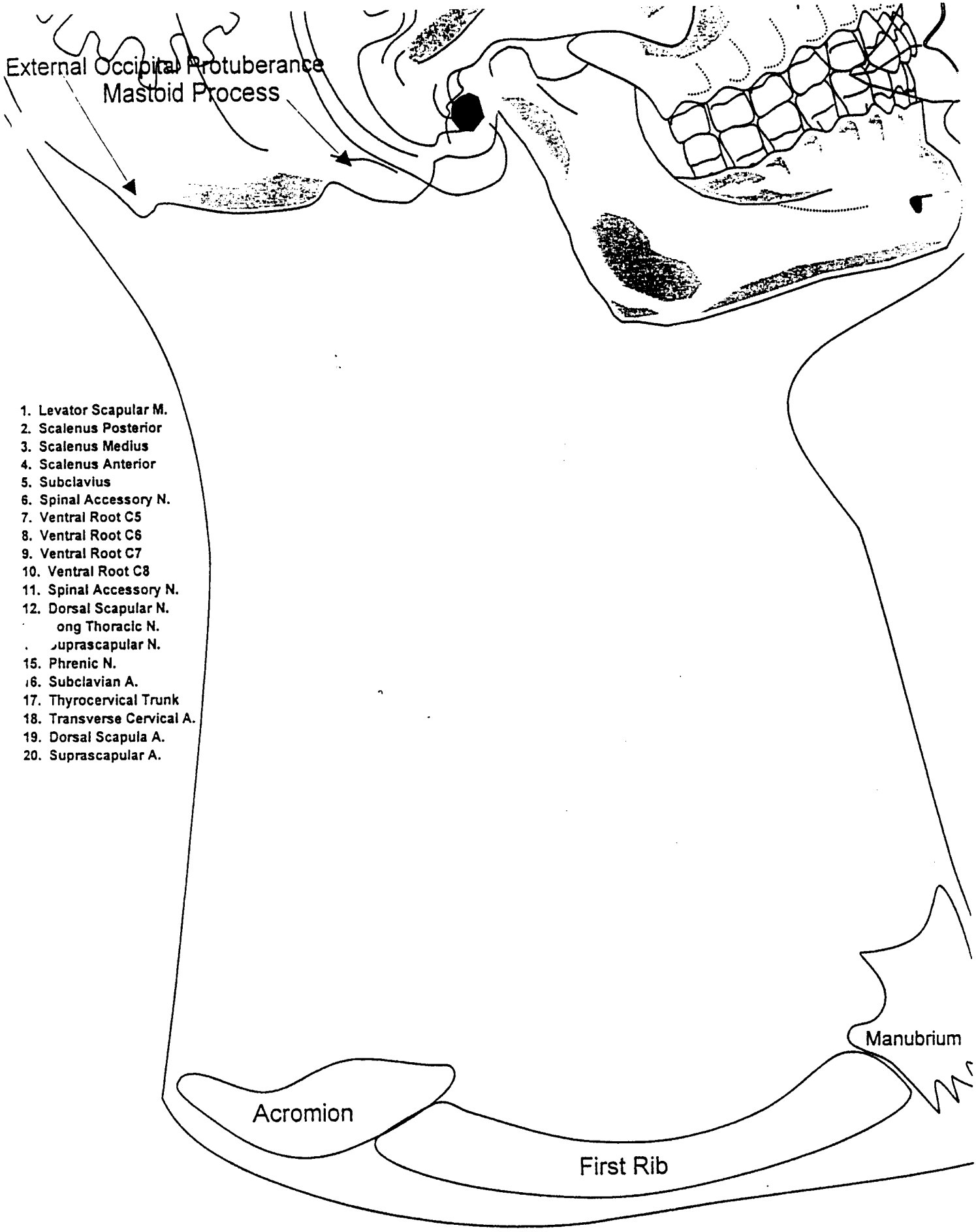


1. Great occipital n.
2. Lesser occipital n.
3. Great auricular n.
4. Transverse Cervical n.
5. Med. Supraclavicular n.
6. Intermed. Supraclavicular n.
7. Lat. Supraclavicular n.
8. Spinal accessory n. (CN11)
9. Infratrochlear n.
10. Supratrochlear n.
11. Supraorbital n.
12. Lacrimal n.
13. Zygomaticofacial n.
14. Zygomaticotemporal n.
15. infraorbital n.
16. Dorsal nasal n.
17. Buccal n. (CN V3)

Posterior Triangle - Cutaneous Nerves and Facial Artery

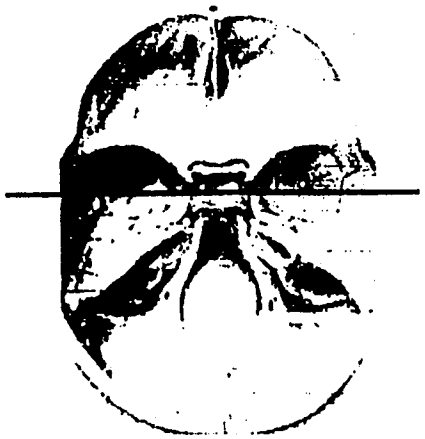


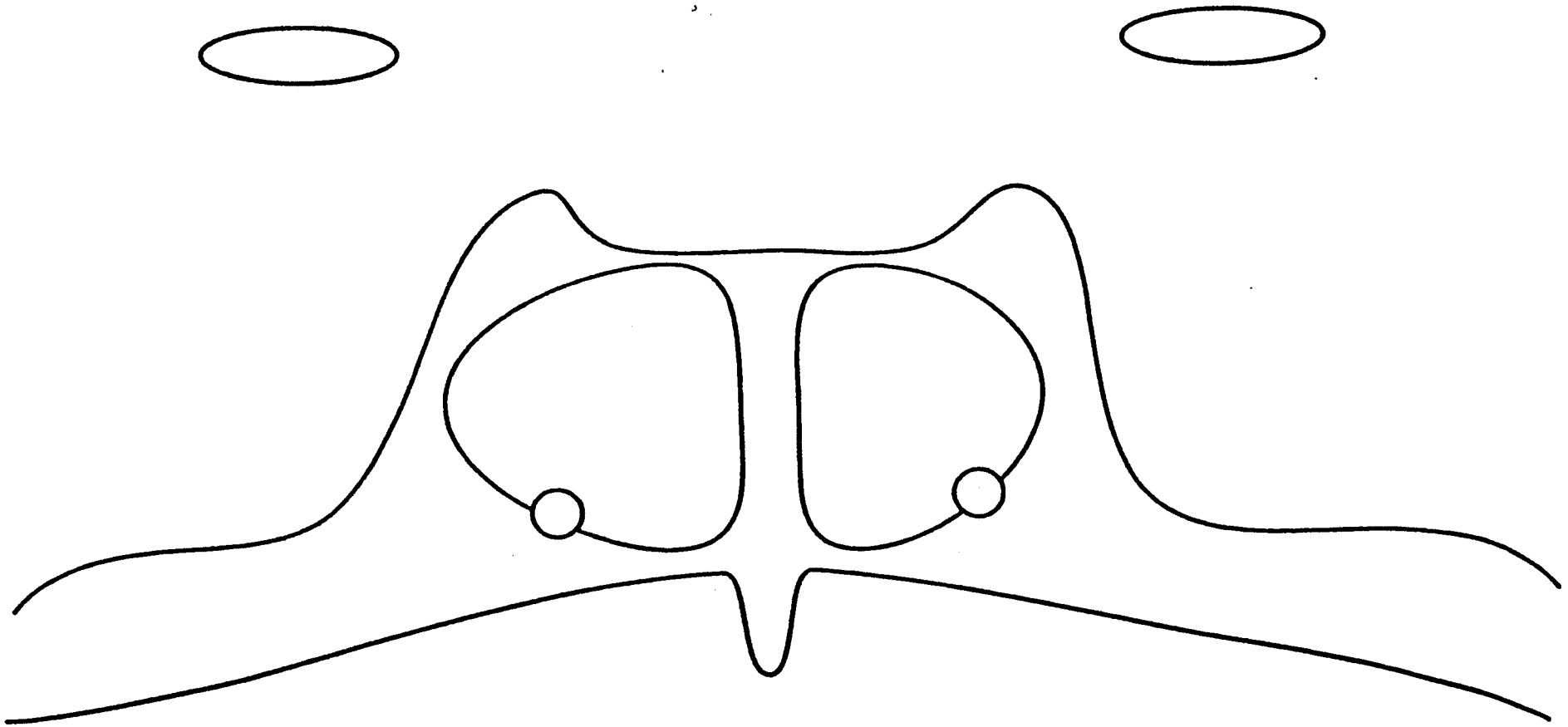
Posterior Triangle - Deep Nerves



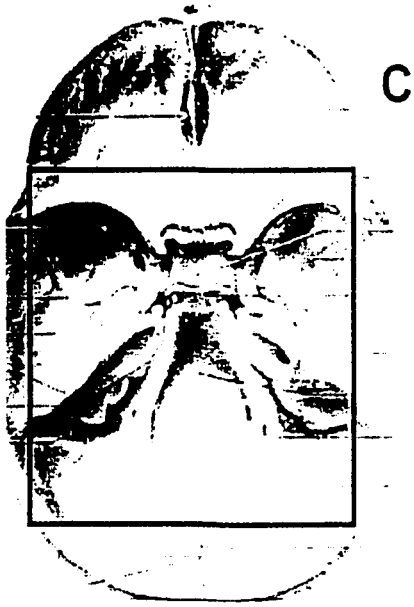
Posterior Triangle - Interscalene Triangle

Cavernous Sinus - Coronal Section

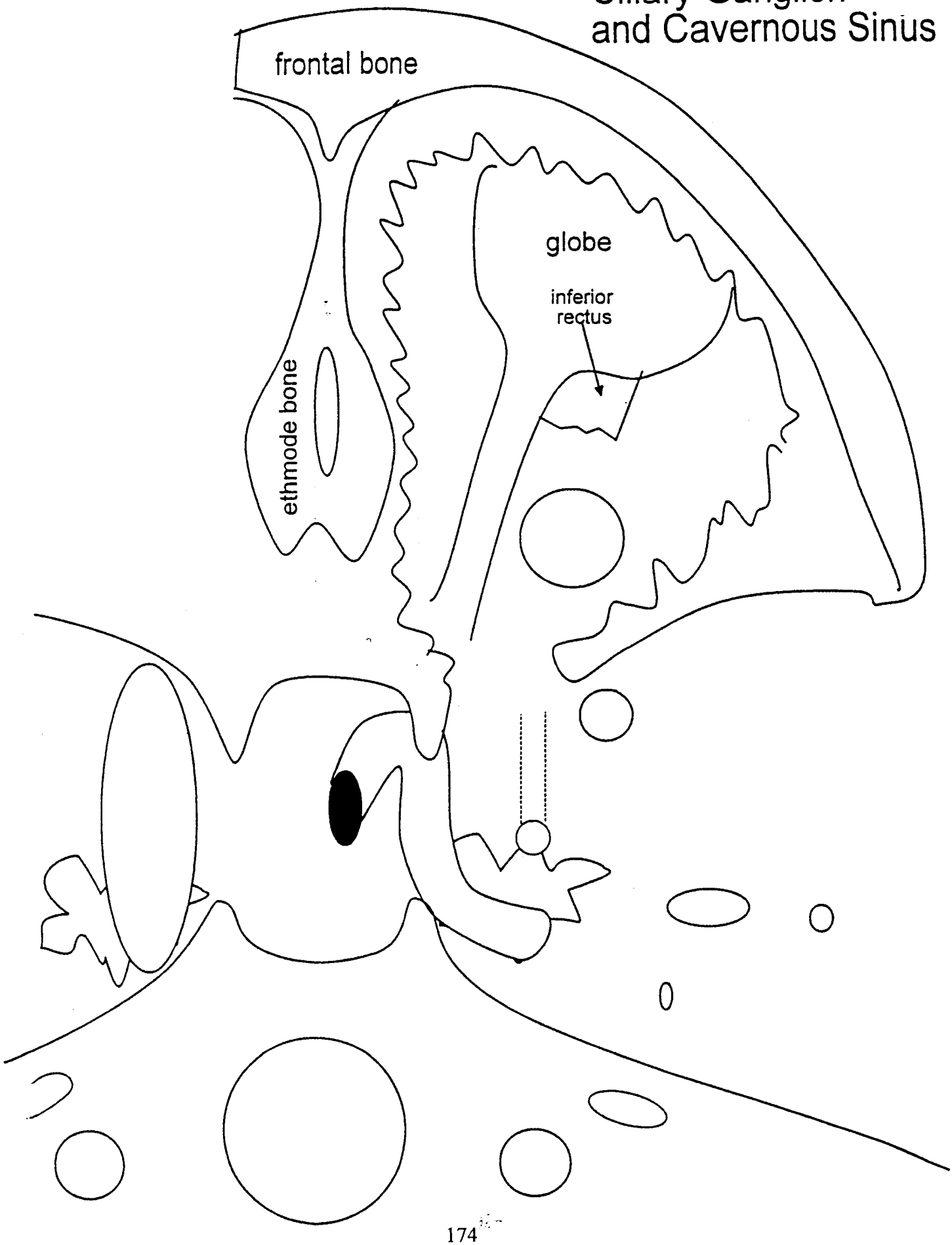




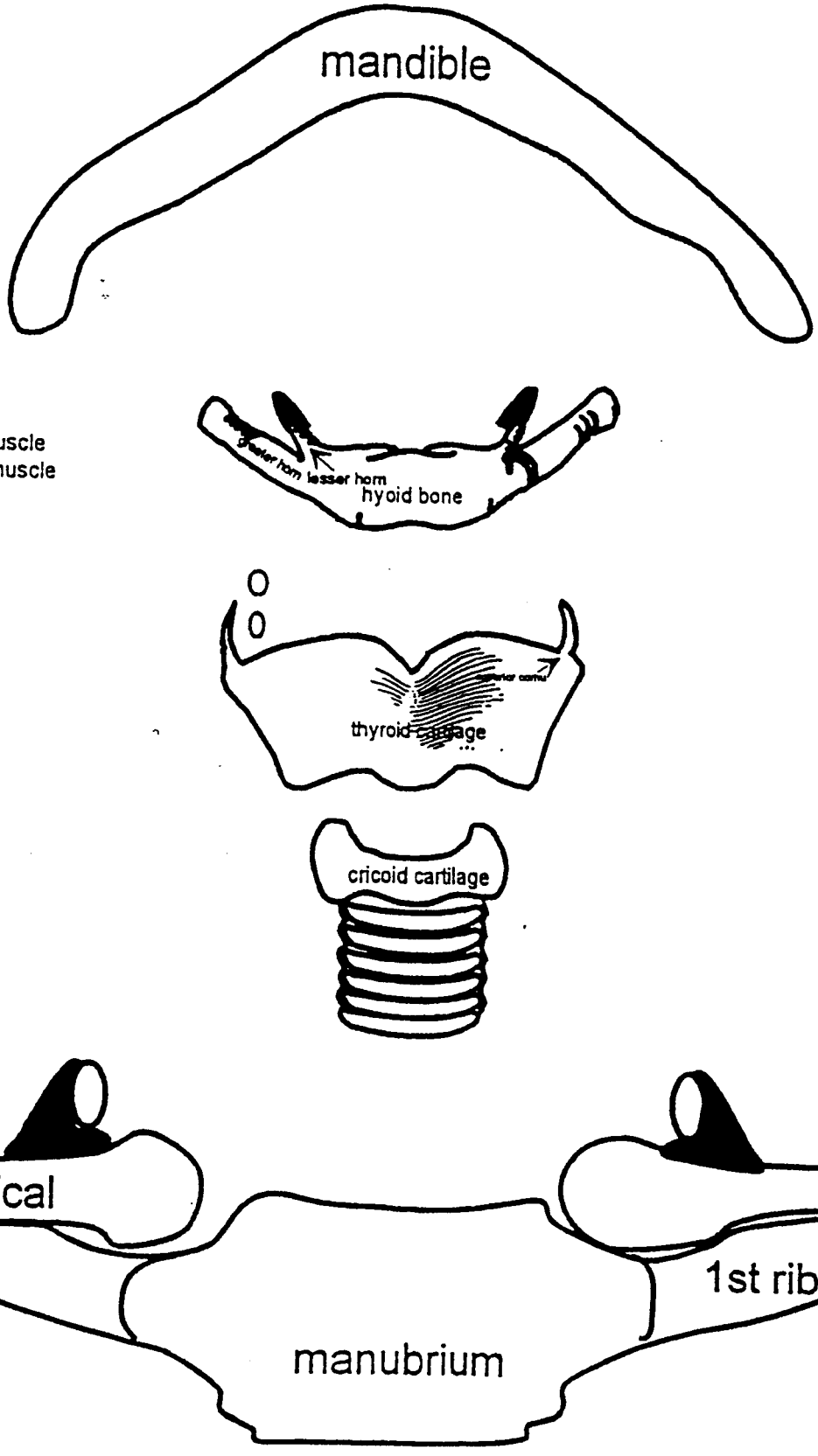
Cavernous Sinus and Middle Cranial Fossa



Ciliary Ganglion and Cavernous Sinus

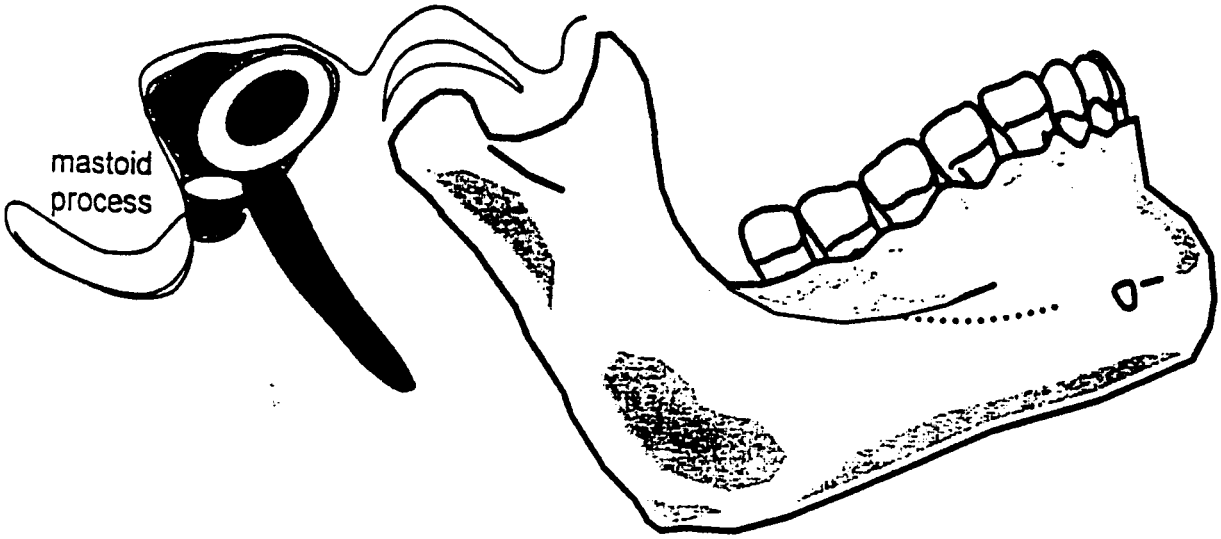


Anterior Triangle - Strap Muscles

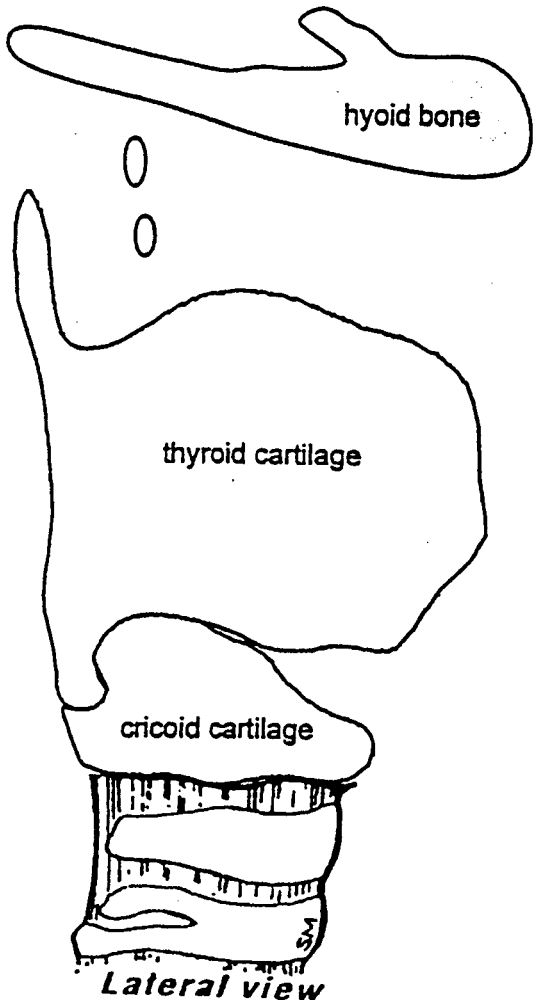


1. Anterior belly of digastric muscle
2. Posterior belly of digastric muscle
3. Mylohyoid muscle
4. Thyrohyoid membrane
5. Thyrohyoid muscle
6. Cricothyroid membrane
7. Cricothyroid muscle
8. Sternothyroid muscle
   Sternohyoid muscle
   Superior belly omohyoid
11. Posterior belly omohyoid
12. Thyroid gland
13. Laryngeal prominence
14. Vagus nerve
15. Recurrent laryngeal nerve
16. Superior laryngeal nerve
17. Internal laryngeal nerve
18. External laryngeal nerve
19. Lingual nerve
20. Hypoglossal nerve
21. Nerve to mylohyoid
22. Facial nerve (digastric br.)
23. Superior thyroid artery
24. Inferior thyroid artery
25. Superior laryngeal artery

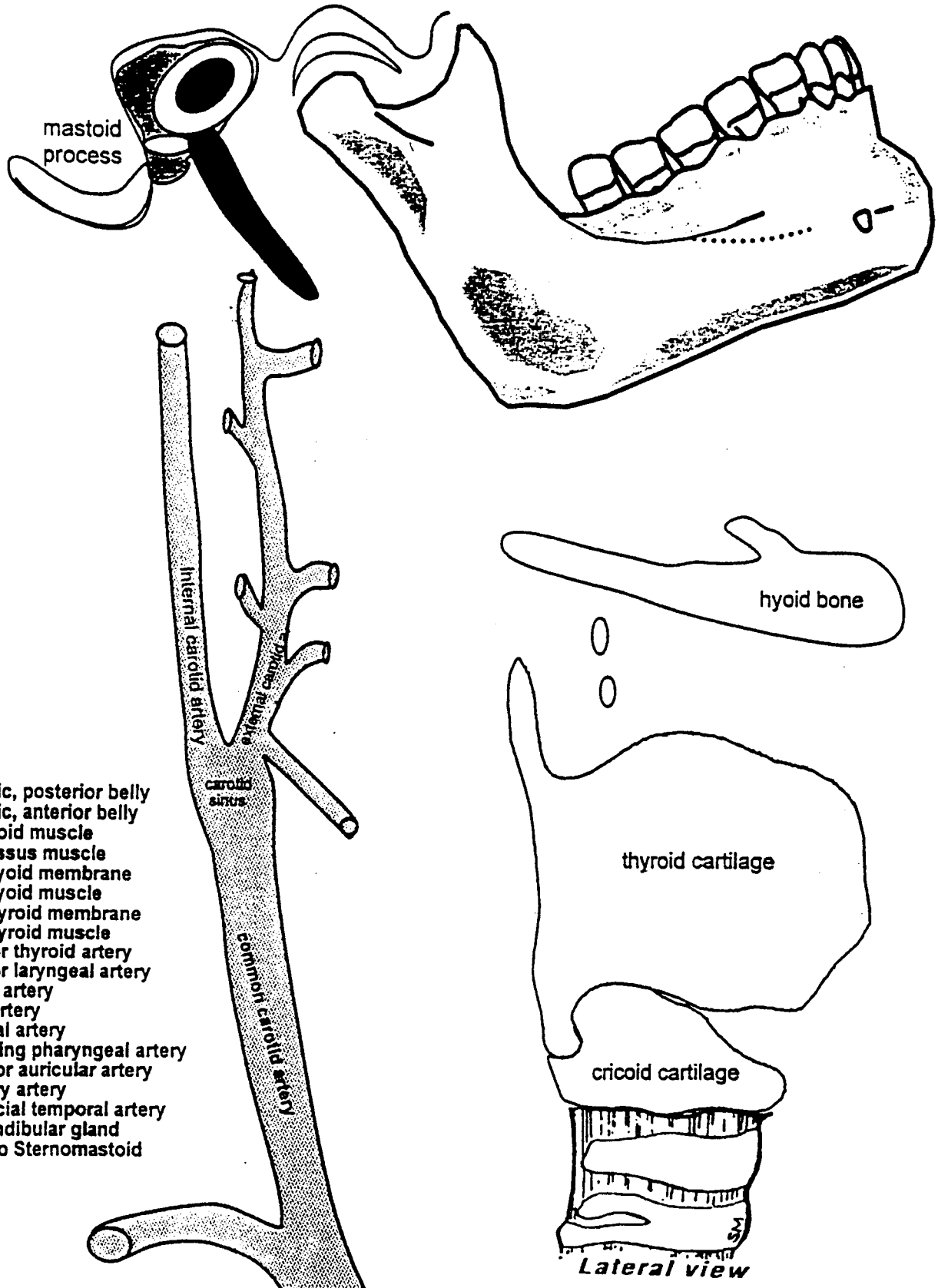
Anterior Triangle (Lateral View) - Nerves



1. Digastric, posterior belly
2. Digastric, anterior belly
3. Mylohyoid muscle
4. Hyoglossus muscle
5. Thyrohyoid membrane
6. Thyrohyoid muscle
7. Cricothyroid membrane
8. Cricothyroid muscle
9. Auriculotemporal nerve
10. Facial nerve
11. Nerve to mylohyoid
12. Lingual nerve
13. Hypoglossal nerve
14. Nerve to thyrohyoid
15. Superior root ansa cervicalis
16. Inferior root ansa cervicalis
17. Vagus nerve
18. Superior laryngeal nerve
19. Internal laryngeal nerve
20. External laryngeal nerve
21. Recurrent laryngeal nerve

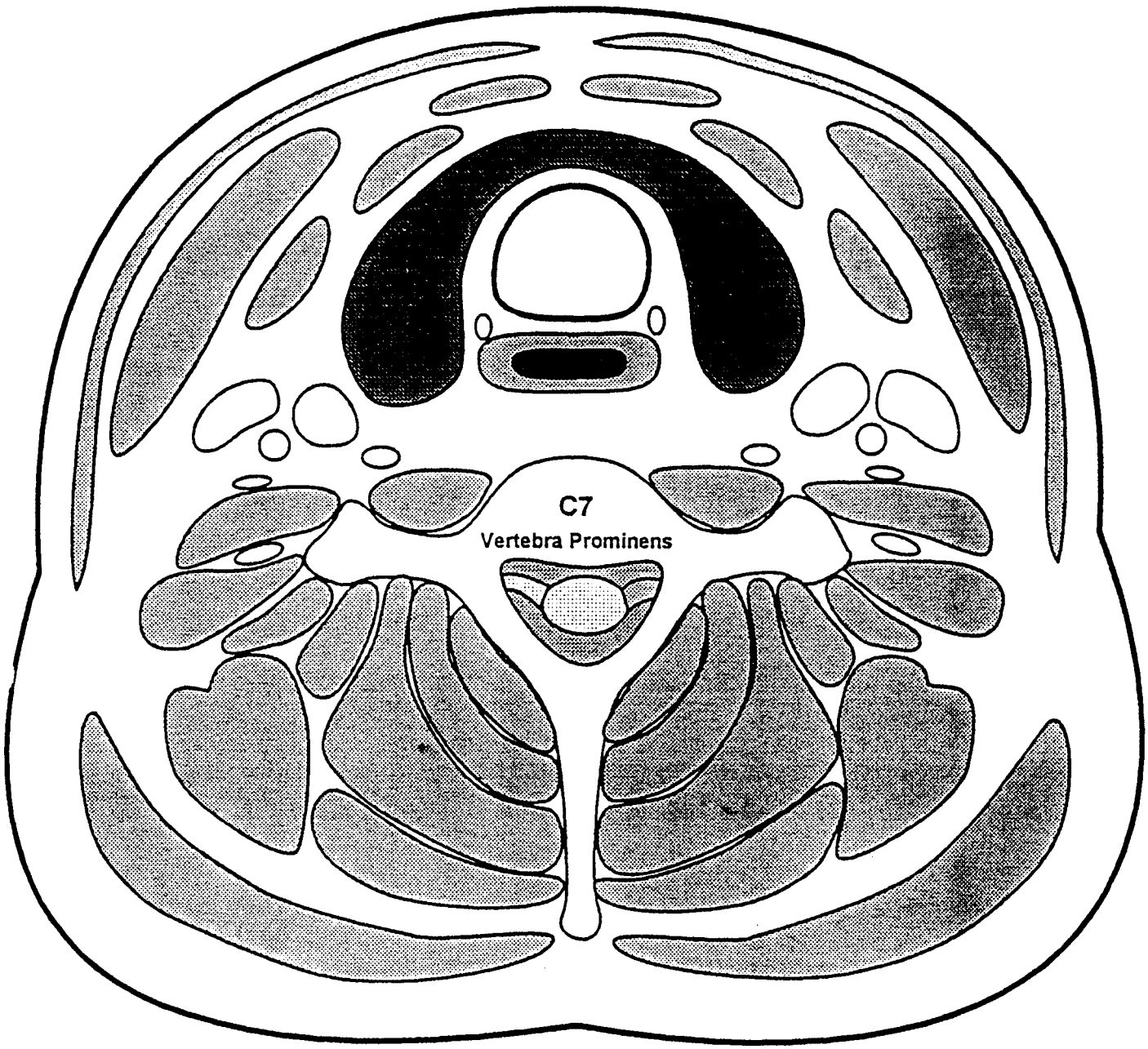


Anterior Triangle (Lateral View) - Arteries



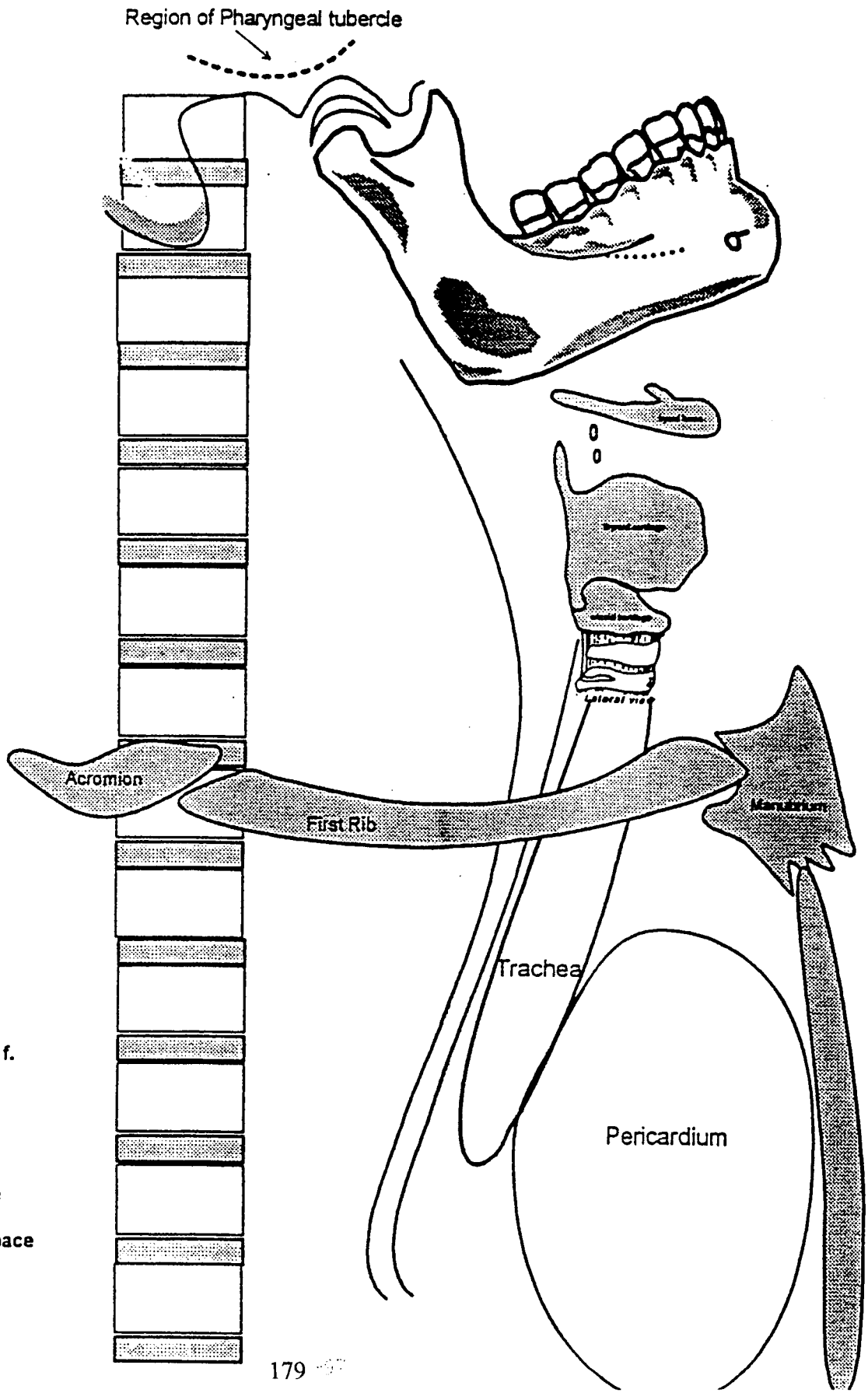
1. Digastric, posterior belly
2. Digastric, anterior belly
3. Mylohyoid muscle
4. Hyoglossus muscle
5. Thyrohyoid membrane
6. Thyrohyoid muscle
7. Cricothyroid membrane
8. Cricothyroid muscle
9. Superior thyroid artery
10. Superior laryngeal artery
11. Lingual artery
12. Facial artery
13. Occipital artery
14. Ascending pharyngeal artery
15. Posterior auricular artery
16. Maxillary artery
17. Superficial temporal artery
18. Submandibular gland
19. Artery to Sternomastoid

Fascial Layers of Neck - Pg. 77



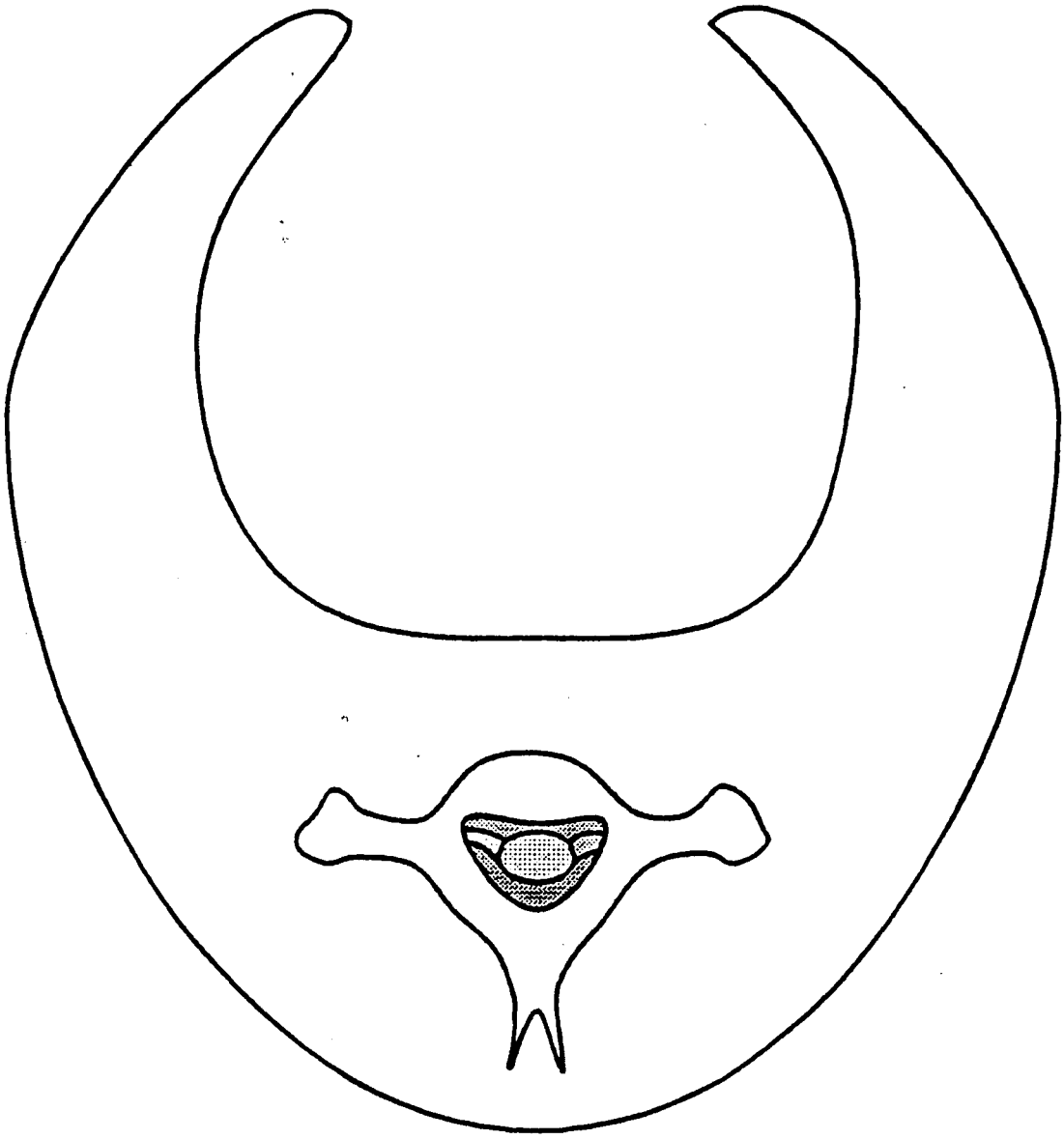
1. Platysma muscle
2. Sternocleidomastoid muscle
3. Trapezius muscle
4. Superficial investing (cervical) fascia
5. Prevertebral fascia
6. Alar fascia
7. Carotid sheath
8. Common carotid artery
9. Internal jugular vein
10. Vagus nerve (CN 10)
11. Pretracheal visceral fascia
12. Buccopharyngeal visceral fascia
13. Thyroid gland
14. Trachea
15. Esophagus
16. Recurrent laryngeal nerve
17. Retropharyngeal space (retrovisceral)
18. Levator Scapula
19. Scalenus anterior
20. Scalenus medius
21. Scalenus posterior
22. Ventral ramus brachial plexus (C8)
23. Phrenic Nerve
24. Symphathetic trunk
25. Sternohyoid muscle
26. Sternothyoid muscle
27. Omohyoid muscls (anterior belly)
28. "Danger Space"
29. Longus Colli Muscle
30. Pretracheal space

Cervical Fascia - Saggital View



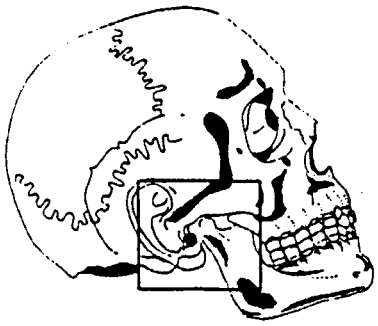
1. Skin
2. Trachea
3. Esophagus
4. Superficial cervical f.
5. Tela Subcutania
6. Prevertebral f.
7. Alar layer
8. Pretracheal f.
9. Buccopharyngeal f.
10. Suprasternal Space
    . Pretracheal space
    . Retropharyngeal space
13. "Danger" space

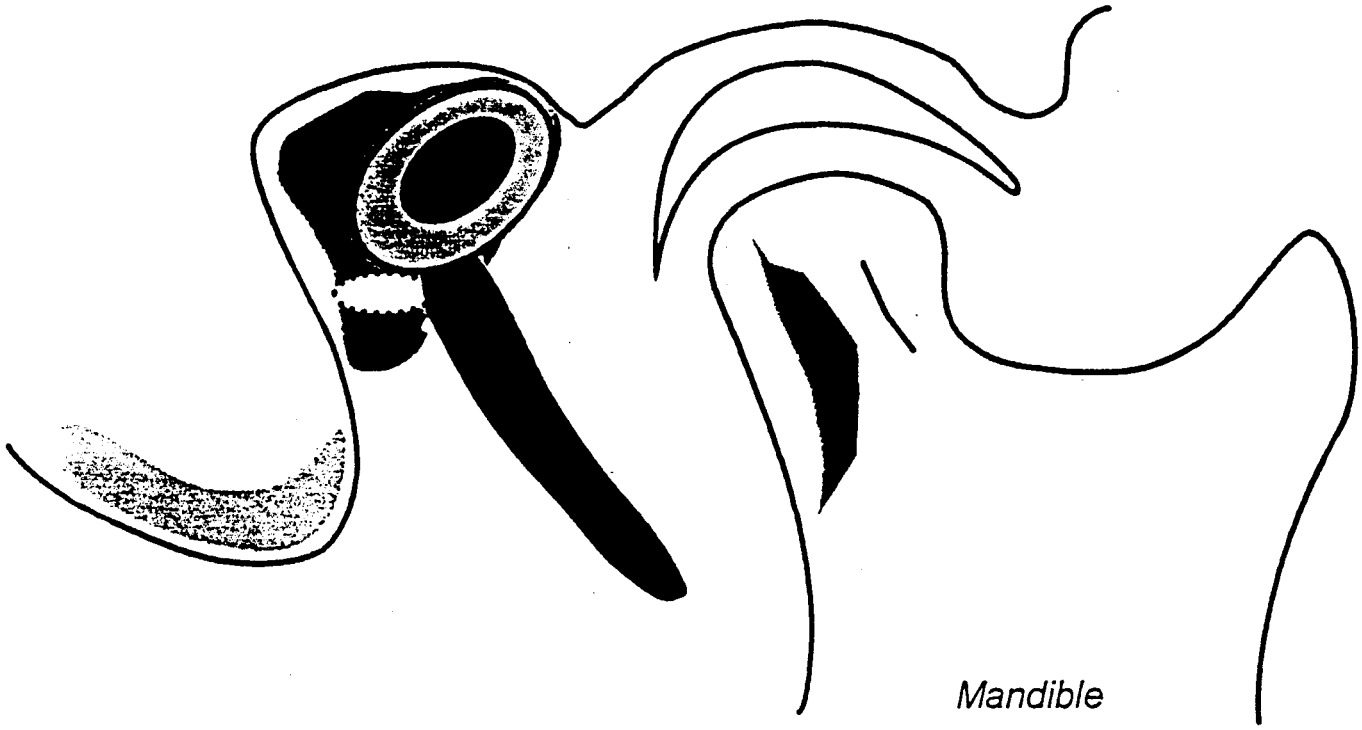
Cervical Fascia - Cross Section Through Oropharynx



1. Skin
2. Oral mucosa
3. Buccopharyngeal fascia
4. Pharyngobasilar fascia
5. Pterygomandibular raphe
6. Median raphe of superior constrictor
7. Buccinator muscle
8. Superior constrictor muscle
9. Prevertebral fascia
10. Alar layer prevertebral fascia
11. Carotid sheath
12. Internal carotid artery
13. Retropharyngeal space
14. "Danger" space

Temporomandibular Joint

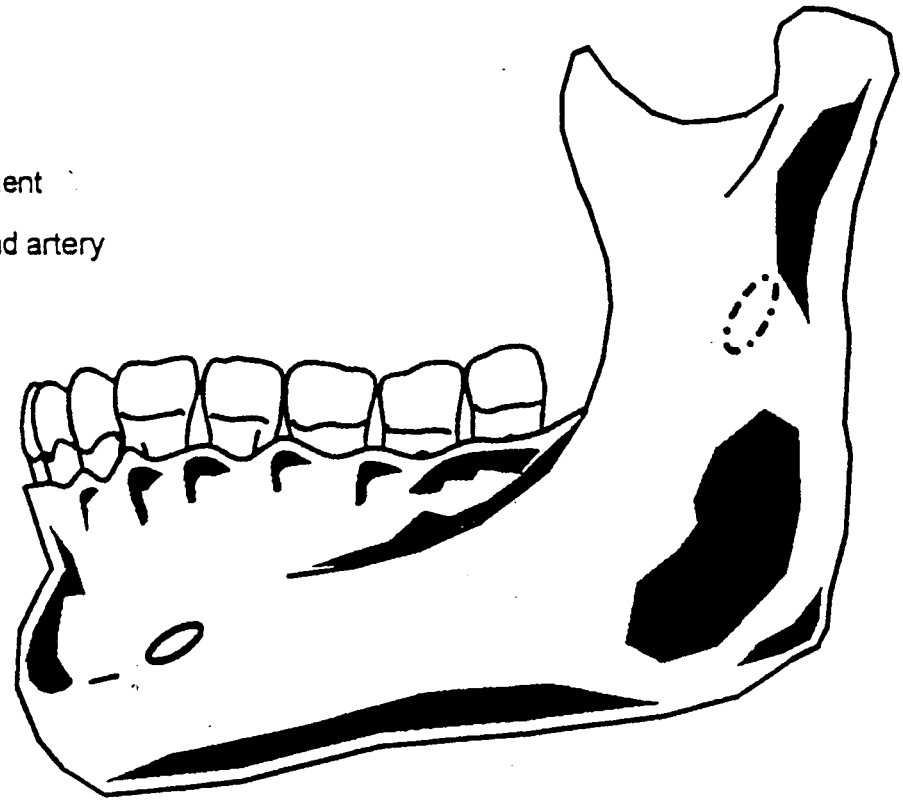


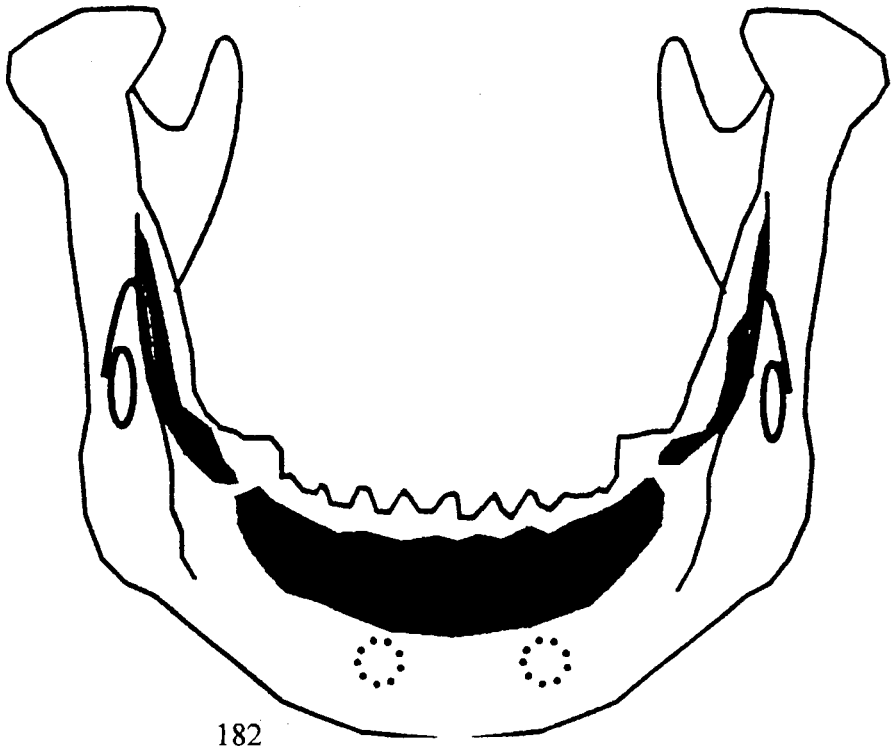


1. Mastoid process
2. Styloid process
3. Stylomastoid foramen
4. External acoustic meatus
5. Postglenoid tubercle
6. Madibular fossa
7. Articular tubercle
8. Condyle
9. Mandibular notch
10. Masseteric artery
11. Masseteric nerve
12. Coronoid process
13. Articular capsule
14. Superior synovial cavity
15. Articular Disk
16. Inferior synovial cavity
17. Superior head of lateral pterygoid
18. Inferior head of lateral pterygoid
19. Posterior fibers of temporalis
20. Anterior fibers of temporalis
21. Facial nerve
22. Auriculotemporal nerve
23. Communicating branch (parasympathetics)
24. Posterior belly digastric
25. Stylohyoid muscle
26. Lesser occipital nerve
27. Great auricular nerve
28. Parotid Gland

Lateral and Posterior View of Mandible

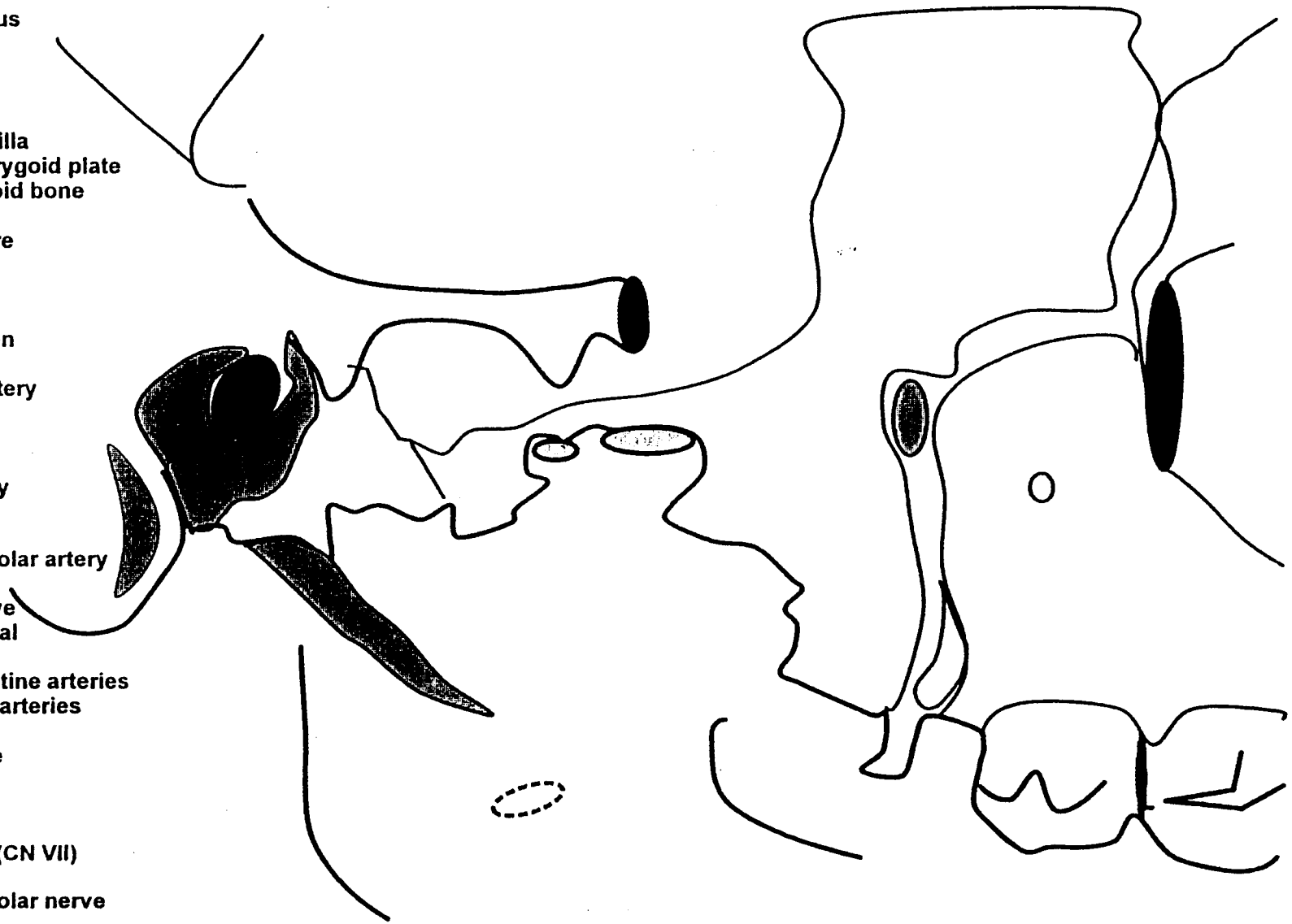
1. Condyle
2. Neck
3. Coronoid process
4. Mandibular notch
5. Ramus
6. Angle
7. Body
8. Inferior alveolar process
9. Mandibular foramen
10. Lingula
11. Sphenomandibular ligament
12. Mental foramen
13. Inferior alveolar nerve and artery
14. Inferior dental plexus
15. Temporalis muscle
16. Masseter muscle
17. Medial pterygoid muscle
18. Mental nerve and artery



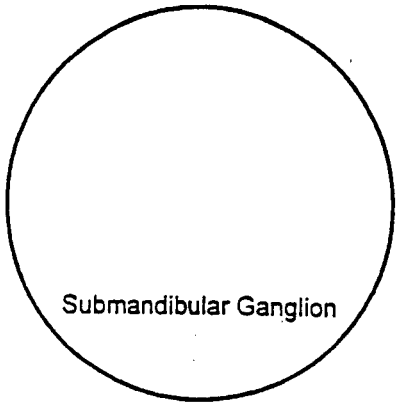


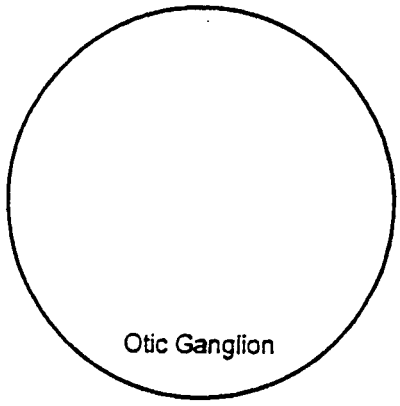
Arteries of the Infratemporal Fossa

1. Zygomatic process temporal bone
2. Mastoid process
3. External auditory meatus
4. Styloid process
5. Petrotympanic fissure
6. Lateral pterygoid plate
7. Maxilla
8. Temporal process maxilla
9. Hamulus of medial pterygoid plate
10. Greater wing of sphenoid bone
11. Inferior orbital fissure
12. Pterygomaxillary fissure
13. Pterygopalatine fossa
14. Foramen spinosum
15. Foramen ovale
16. Sphenopalatine foramen
17. External carotid artery
18. Superficial temporal artery
19. Maxillary artery
20. Deep auricular artery
21. Inferior alveolar artery
22. Middle meningeal artery
23. Deep temporal arteries
24. Buccal artery
25. Posterior superior alveolar artery
26. Infraorbital artery
27. Artery of maxillary nerve
28. Artery of pterygoid canal
29. Pharyngeal artery
30. Greater and lesser palatine arteries
31. Lateral posterior nasal arteries
32. Mandibular nerve
33. Auriculotemperal nerve
34. Inferior alveolar nerve
35. Lingual nerve
36. Buccal nerve
37. Chorda tympani nerve (CN VII)
38. Maxillary nerve
39. Posterior superior alveolar nerve
40. Infraorbital nerve
41. Mandibular Foramen
42. Facial Nerve
43. Communicating branch - parasympathetics

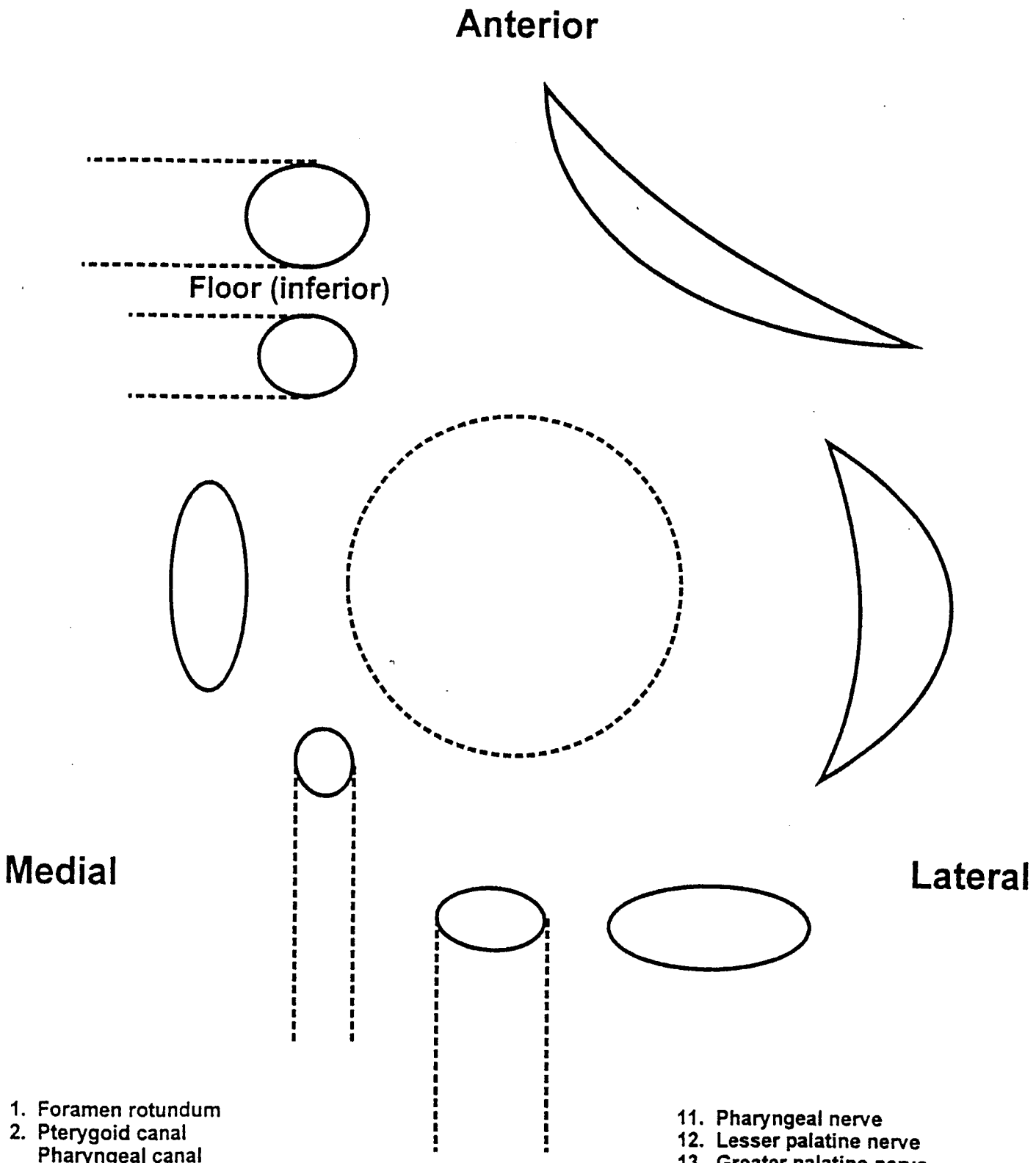


Parasympathetic Ganglia - Submandibular and Otic



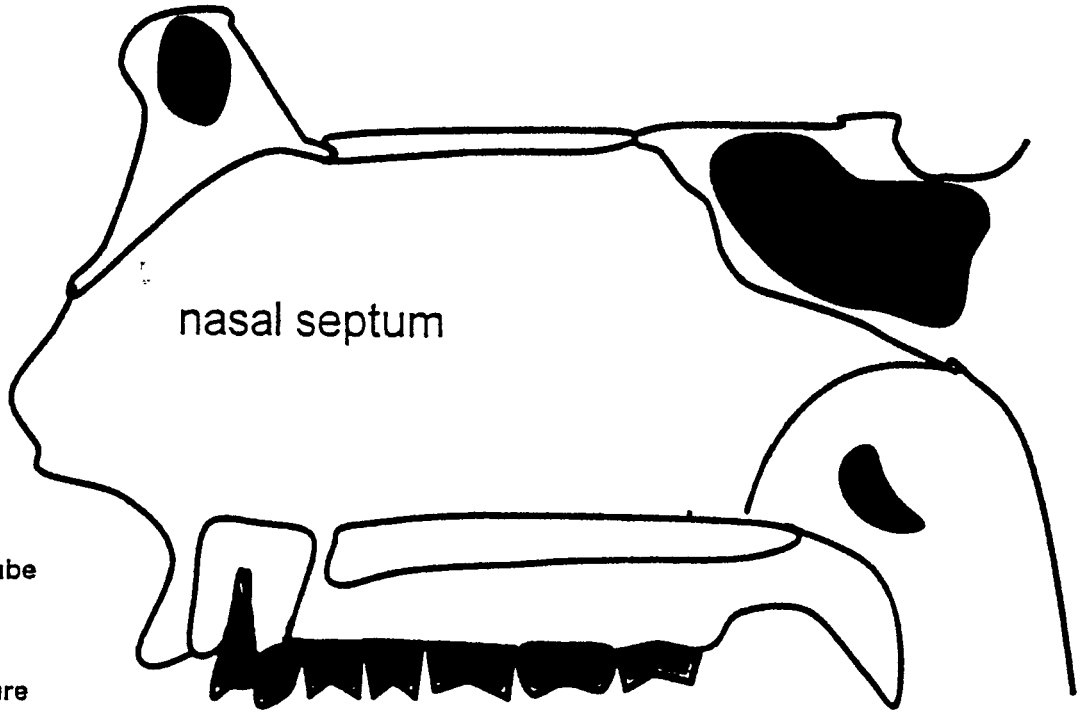


Schematic of Pterygopalatine Fossa and Ganglion

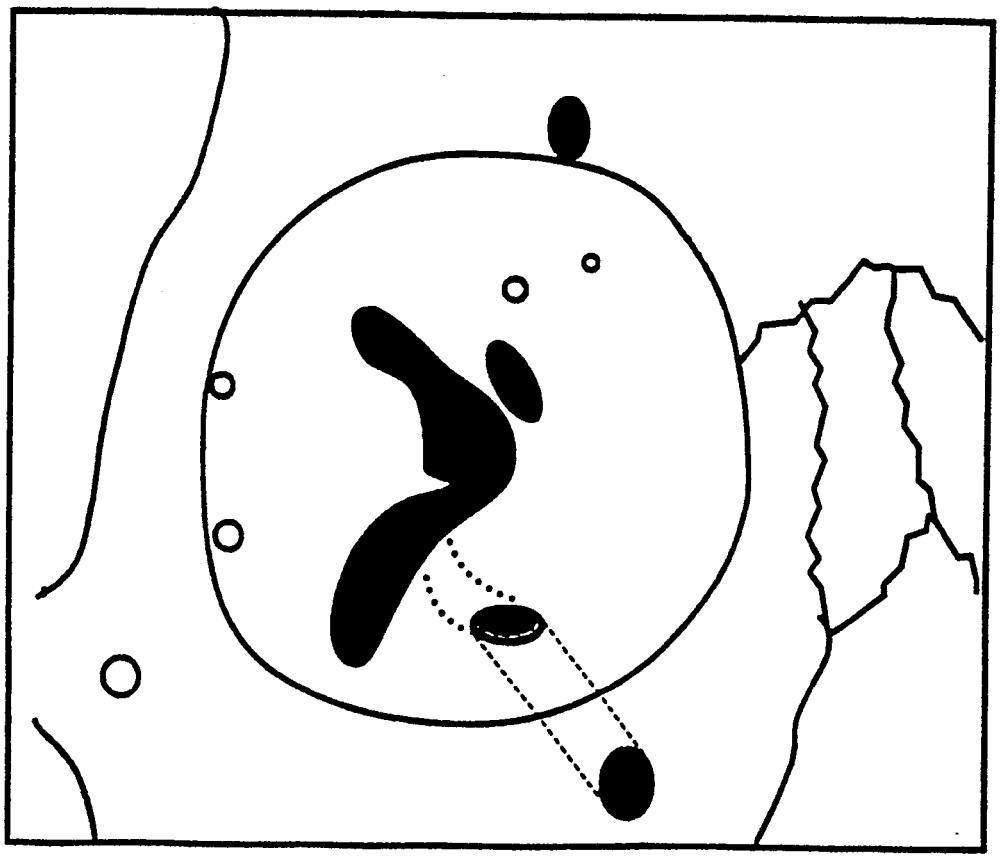


1. Foramen rotundum
2. Pterygoid canal
   Pharyngeal canal
3. Lesser palatine canal
5. Greater palatine canal
6. Sphenopalatine foramen
7. Inferior orbital fissure
8. Pterygomaxillary fissure
9. Pterygopalatine ganglion
10. Maxillary nerve
11. Pharyngeal nerve
12. Lesser palatine nerve
13. Greater palatine nerve
14. Lateral posterior nasal nerves
15. Nasopalatine nerve
16. Infraorbital nerve
17. Posterior superior alveolar nerve
18. Greater superficial petrosal nerve
19. Deep petrosal nerve

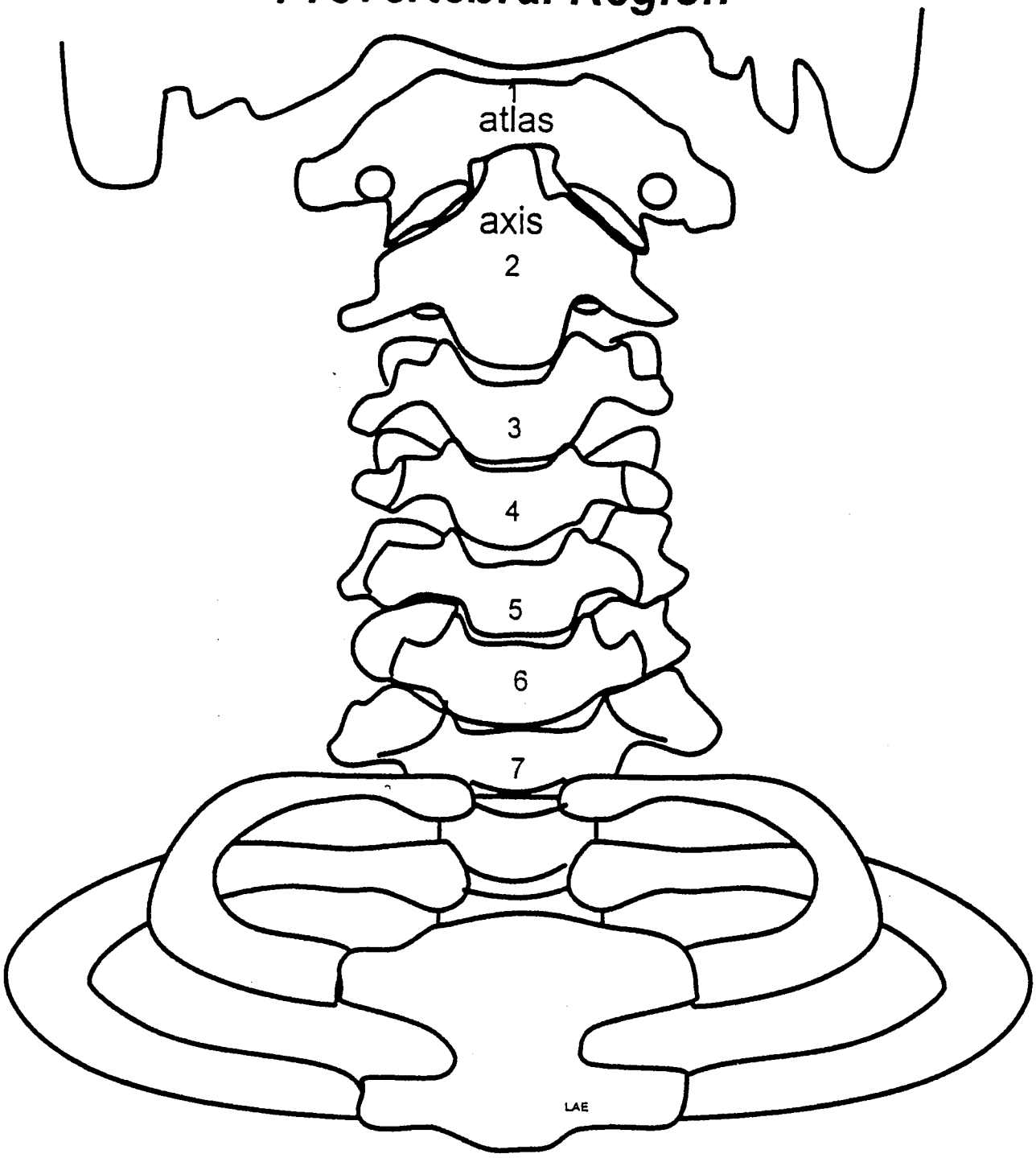
Trigeminal Nerve Branches
Nasal Septum and Orbit



1. Frontal sinus
2. Sphenoid sinus
3. Ostium of auditory tube
4. Incisive canal
5. Nasopalatine nerve
6. Optic canal
   Superior orbital fissure
7. Inferior orbital fissure
9. Infraorbital groove
10. Infraorbital canal
11. Infraorbital foramen
12. Lacrimal gland
13. Lacrimal nerve
14. Infraorbital nerve
15. Zygomatic nerve
16. Zygomaticotemporal nerve
17. Zygomaticofacial nerve
18. Communicating branch
    (parasympathetics)

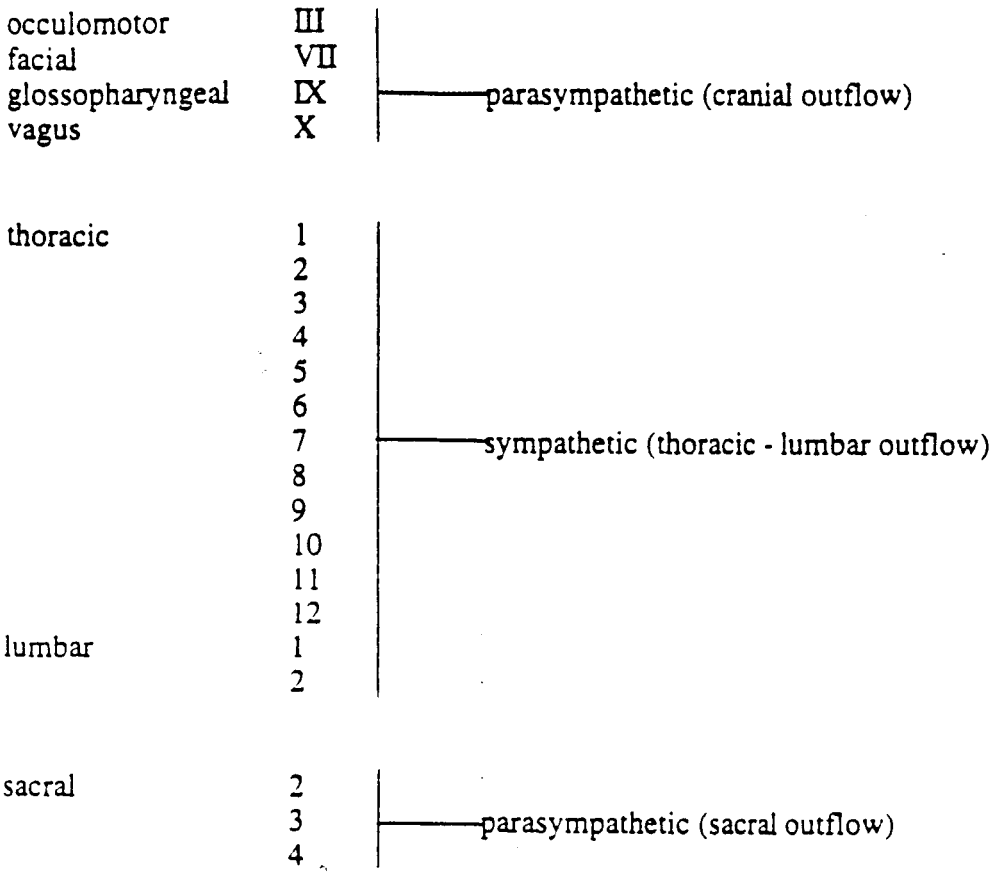


Prevertebral Region



1. Mastoid process
2. Groove for posterior belly digastric
3. Styloid process
4. Stylomastoid foramen
5. Facial nerve
6. Jugular foramen
7. Internal jugular vein
8. Glossopharyngeal nerve (CN IX)
9. Vagus nerve (CN X)
10. Spinal accessory nerve (CN XI)
11. Hypoglossal nerve (CNXII)
12. Longus colli muscle
13. Longus capitus muscle
14. Subclavian artery
15. Common carotid artery
16. Vertebral artery
17. Transverse foramen of atlas
18. Thyrocervical trunk
19. Inferior thyroid artery
20. Ascending cervical artery
21. Transverse cervical artery
22. Suprascapula artery
23. Thoracic sympathetic trunk
24. Stellate ganglion
25. Vertebal cervical sympathetic ganglion
26. Middle cervical sympathetic ganglion
27. Superior cervical sysmpathetic ganglion
28. Internal carotid artery
29. Internal carotid nerve and plexus
30. Ansa subclavia

Diagram of Outflow



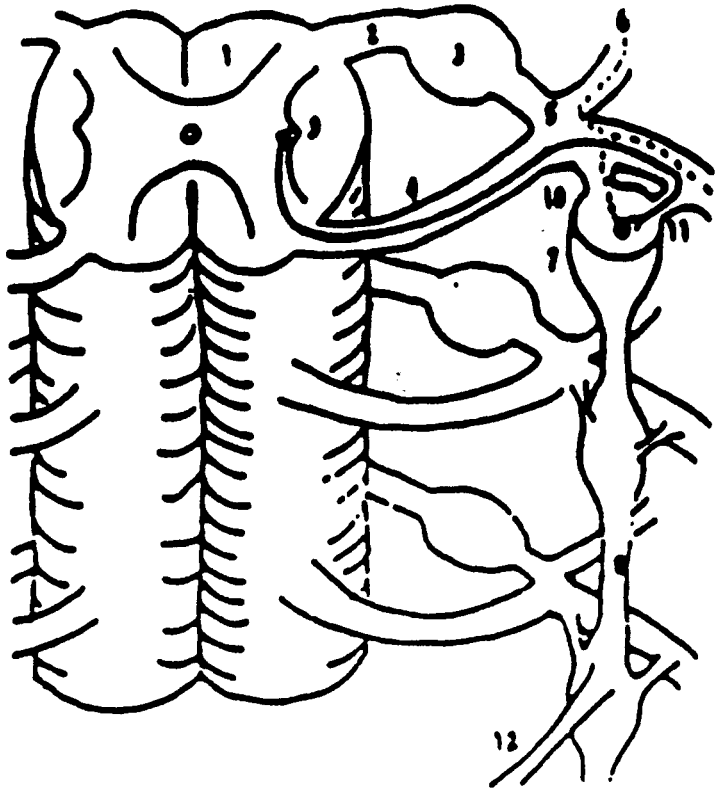
A. Autonomic Nervous System

1. General
   a. Physiological system,. only part of which can be grossly demonstrated
   b. Controls or modulates the visceral functions
   c. Ultimately controlled by the hypothalamus which controls other vegetative functions
   d. Autonomic fibers leave the central nervous system to run and distribute with the cranial or spinal nerves; synapse in ganglia scattered throughout body
   e. Physiologically, fibers named by the type of neuro-transmitter released
      1) Cholinergic release acetylcholine (enzyme breaking it down is acetylchoninesterase)
      2) Adrenergic release noradrenalin (enzyme breaking it down is methyltransferase), but removed mainly by re-uptake

2. Subdivided into sympathetic and parasympathetic systems which are part, but not always, antagonistic

3. Effect of a given system on organ not always predictable, and only empirically determined.

B. The Sympathetic Nervous System



1. spinal cord
2. sensory or dorsal root
3. dorsal root ganglion
4. motor or ventral root
5. spinal nerve
6. posterior primary ramus
7. sympathetic ganglion
8. sympathetic chain
9. intermediate gray horn
10. gray ramus communicants (post-ganglionic)
11. white ramus communicants (pre-ganglionic)
12. splanchnic nerves

1. Location
   a. Two chains of paravertebral ganglia running from the base of the skull to the tip of the sacrum
   b. Scattered ganglia in plexuses, especially in abdomen
   c. Adrenal medulla (specialized ganglion)

2. Organization
   a. Preganglionic fibers
      1) Fibers are relatively short in length
      2) Pass out from central system with ventral (motor) roots or thoracic nerves T1 to T12 and L1 and L2
      3) Leave ventral root via white rami communicants to enter sympathetic chain
      4) May synapse in ganglion, or pass up or down to synapse in a ganglion above or below; some fibers may pass through ganglia without synapsin and go to the scattered ganglia of the plexuses.
      5) Release neuro-transmitter acetylcholine at ganglionic synapse
   b. Post-ganglionic fibers
      1) Rejoin cranial and spinal nerves via gray rami communicants
      2) Go to peripheral blood vessels, sweat glands, and erector pili muscles
      3) Release noradrenalin (exceptions are certain fibers to the blood vessels or muscles and most sweat glands)
      4) Post-ganglionic fibers to many organs distributed with the blood vessels, rather than with spinal nerves

3. Functions
    a. Vasoconstriction (exception are certain fibers in muscle which cause vasodilation)
    b. Erector pili contraction (goose pimples)
    c. Coronary artery dilation
    d. Increased
        1) sweating
        2) heart rate
        3) bronchial dilation
        4) glucose release
        5) sphincter tone
    e. Decreased
        1) gut motility
        2) GI secretion

C. The Parasympathetic Nervous System

1. Location and organization
    a. Pre-ganglionic fibers are relatively long, and most ganglia are in or near the organ innervated.
    b. Pre-ganglionic fibers run with cranial nerves III, VII, XI, and X
        1) Those with III used in eye
        2) Those in VII and XI go to glands in head and neck
        3) Those in X (vagus) innervated all viscera except for last portion of colon and pelvic viscera
    c. Pre-ganglionic fibers also run in sacral nerves 2, 3, and 4
        1) Innervate last part of colon and pelvic structures
    d. Both pre- and post-ganglionic fibers release acetylcholine
    e. Do not distribute to periphery

2. Function
    a. Increased
        1) gut motility
        2) secretion of GI glands
        3) bronchial constriction
        4) coronary artery constriction
    b. Decreased
        1) heart rate
        2) sphincter tone
        3) vasoconstriction in vessels of erectile tissue

D. Autonomic Sensory Fibers

1. Derived from the dorsal root (sensory) ganglia or from the sensory ganglia associated with the cranial nerves
2. Run with both sympathetic and parasympathetic fibers, but do not synapse in any of their ganglia
3. Called the general visceral afferent fibers - GVA
4. Functions
    a. carry sensation for autonomic reflexes
    b. carry sensation which never reaches consciousness
    c. carry pain. sensation of nausea, hunger, etc.

THE INFRATEMPORAL REGION

I. The infratemporal fossa: an irregularly shaped space behind the maxilla; communicates with the temporal fossa via the interval between the zygomatic arch and the skull which is traversed by the temporalis muscle and by the deep temporal nerves and vessels.

II. Bony boundaries of the infratemporal fossa:
   i. lateral wall - the ramus of the mandible
   ii. medial wall - the lateral pterygoid plate
   iii. ant. wall - the infratemporal surface of the maxilla
   iv. post. wall - the condyle process of the mandible and the styloid process of the temporal bone

III. The flat roof of the infratemporal fossa: formed by the inferior surface of the greater wing of the sphenoid bone; separated from the temporal fossa by a ragged edge called the infratemporal crest. The foramen ovale is in the roof.

IV. Contents of the infratemporal fossa: the temporalis muscle, med. and lat. pterygoid muscles, maxillary artery, pterygoid venous plexus, mandibular nerve, chorda tympani (nerve), otic ganglion, as well as the inferior alveolar, lingual and buccal nerves.

STUDY QUESTIONS
Head and Neck

1. Give the location of cell bodies of each of the following groups of nerve fibers:
   a. epiglottic taste
   b. deep petrosal n.
   c. motor root of otic ganglion
   d. motor fibers to buccinator
   e. olfactory nerve
   f. conjunctival pain
   g. cervical sympathetic trunk
   h. pharyngeal touch
   i. secretory fibers in sublingual gland
   j. equilibratory

2. Discuss briefly, the drainage of the paranasal sinuses.

   Name the paranasal sinuses and, for each, give the innervation and blood supply to its mucosal lining and its course of drainage to the nasal cavity.

3. An abscess or embolism in the cavernous sinus may affect a number of important structures in immediate relationship to that sinus. In the form of a chart such as that indicated below, name the structures that would be involved, show the functional-anatomical result(s) of each involvement, and the clinically-detectable symptoms which would result in the patient.

Structure	Anatomical Result(s)	Clinical Symptom(s)
Example: hypoglossal n.	paralysis of styloglossus hypoglossus, genioglossus & intrinsic muscles of the tongue (GSE fibers)	muscle atrophy on side of lesion & deviation of protruded tongue toward side of fibers

4. Discuss the structure of the limits (i.e., roof, floor and walls) of the oral cavity.

5. With respect to muscles responsible and movements within the temporomandibular articulation, briefly describe protraction and retraction of the mandible.

6. The pterygopalatine fossa communicates with several other named spaces of the skull; list those spaces and name the route of communication (i.e., foramen, canal, or other) with each.

7. In outline from (do not discuss) trace the parasympathetic innervation of the lacrimal and submandibular gland.

8. Discuss the role played by the fifth cranial nerve in distribution of parasympathetic nerve fibers in the head and neck. Be specific and comprehensive.

9. Cite relevant anatomical facts to support, deny, or clarify the following statement: Half of the cranial nerves are functionally related, at least in some degree, to functions in the orbit.

10. Clearly differentiate between functional losses which would result from the following sets of lesions in nerves:

    a. facial nerve at internal acoustic meatus - versus - facial nerve at prominence of facial canal
    b. maxillary nerve at cavernous sinus - versus - maxillary nerve at origin of infraorbital canal
    c. mandibular nerve below foramen ovale - versus - lingual nerve at level of occlusal plane of teeth

11. Assume that you wished to expose, mobilize and remove the thyroid gland. Base your answers to the following questions on your knowledge of anatomy rather than surgery, but assume that you are dealing with a living individual.

    a. What "layers" will be incised and retracted in exposing the gland's surface?
    b. What major vessels would you expect to identify and ligate? Mention location or some characteristic or relationship which would be useful in identifying each.
    c. What nerve(s) would be identified and avoided? Indicate location or identifying characteristics you would employ here.
    d. What glandular tissue would be identified and not removed in this procedure?

12. Discuss briefly, the actions of the extraocular muscles. Trace the pathway a tear would take from its site of production in the lacrimal gland into the nasal cavity.

13. List briefly the innervation(s) and function(s) of the extrinsic muscle(s) of the tongue.

14. What is the relationship of the inferior thyroid artery to the recurrent laryngeal nerve. Why is this important surgically?

15. What is the arterial supply to the thyroid gland?

16. What is the carotid sheath, and what are its contents?

17. What is the ansa cervicalis?

18. What is the significance of the retropharyngeal space?

19. What area of the body refers pain to the skin supplied by the supraclavicular nerve? Can you think of a reason why?

20. Describe the superficial venous drainage of the head and neck.

21. What is the function of the buccinator muscle?

22. What nerve(s) supply sensation to:

    a. the skin over the angle of the jaw
    b. the tip of the nose
    c. the chin
    d. the cornea

23. What nerve supplies secreto-motor fibers to the parotid gland?

24. Where is the mandibular branch of VII very vulnerable to damage?

25. Discuss the opthalmic divisions of the trigeminal nerve and areas they supply.
26. Discuss the relationships of the cavernous sinus. What is the clinical significance of the cavernous sinus?

27. Discuss the cranial parasympathetic system, including the cranial nerves, preganglionic fibers, ganglion and postganglionic fibers and the area supplied.

28. What are the actions of the muscles of mastication?

29. What is the chorda tympani?

30. Outline the course of the lesser petrosal nerve.

31. Discuss the lymphatic drainage of the face and scalp.

32. Outline the course (routes) of tears from the lacrimal gland to the inferior nasal meatus.

33. What structures are found in the posterior triangle of the neck?

34. What is your understanding of the ciliary ganglion?

35. Discuss the common tendinous ring (anulus tendinous). What structure passes through this structure?

36. Discuss the nasociliary nerve and the structure(s) supplied.

37. Thrombosis of the cavernous sinus or aneurysm of the internal carotid artery in that structure can produce a series of neurological symptoms and problems. Describe the anatomical basis for this statement and indicate the deficits that might be expected.

38. Describe the drainage of the paranasal sinuses and for each sinus state how the head might be positioned to facilitate drainage of that particular sinus.

39. Trace the parasympathetic and sympathetic innervation to the parotid gland.