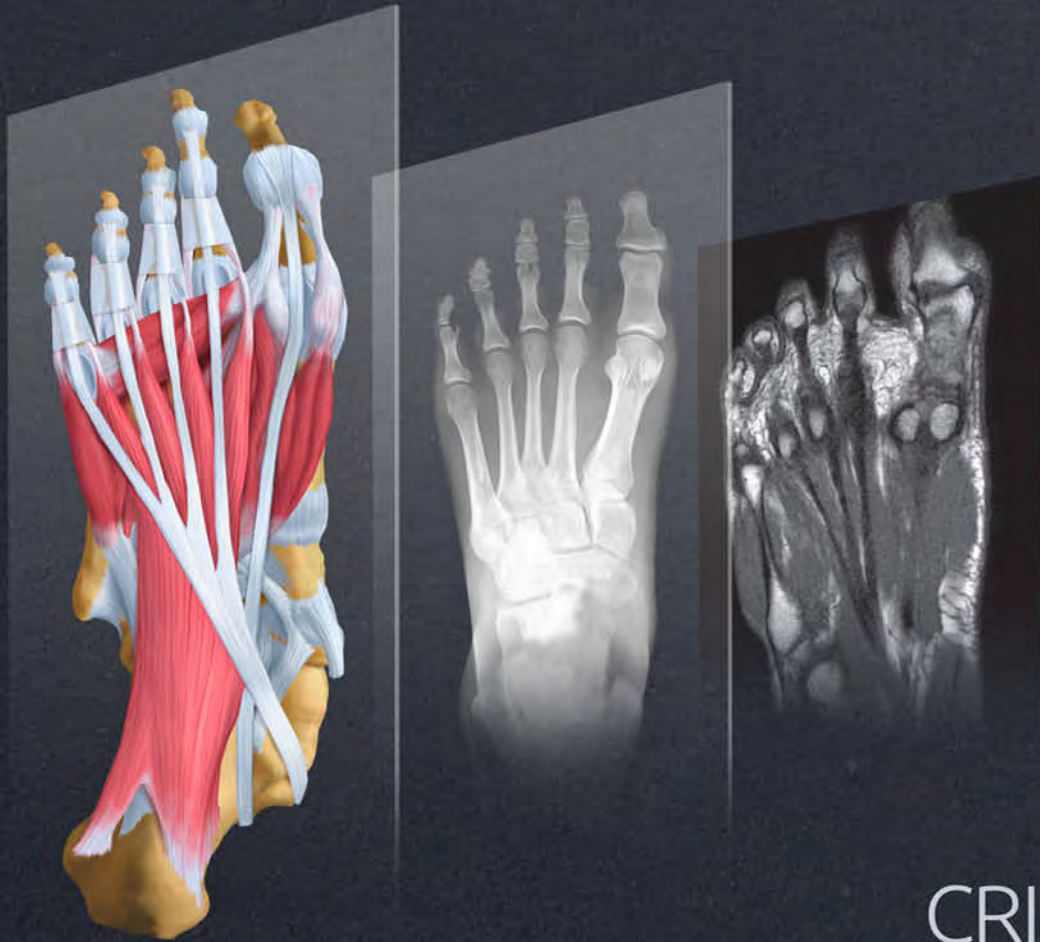


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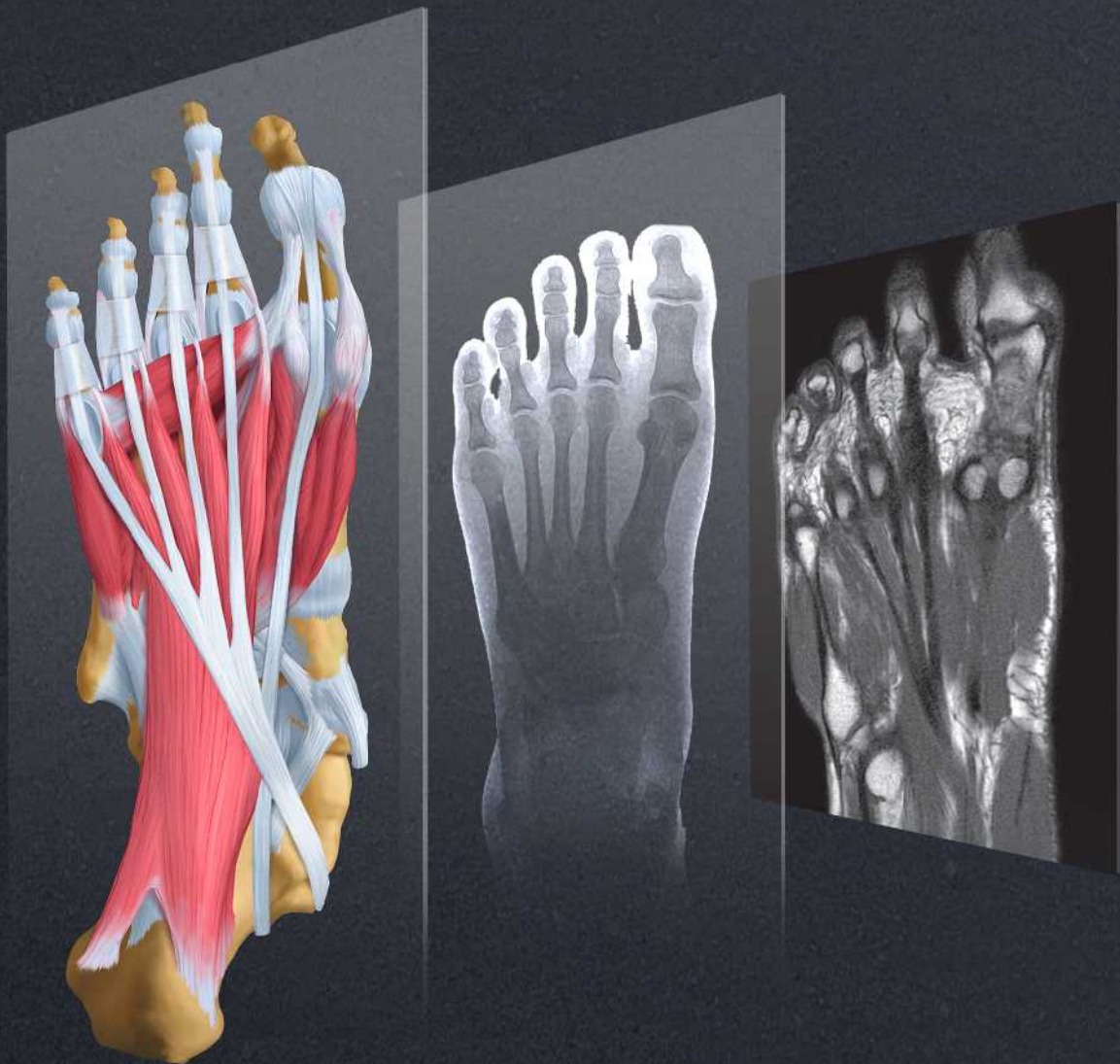


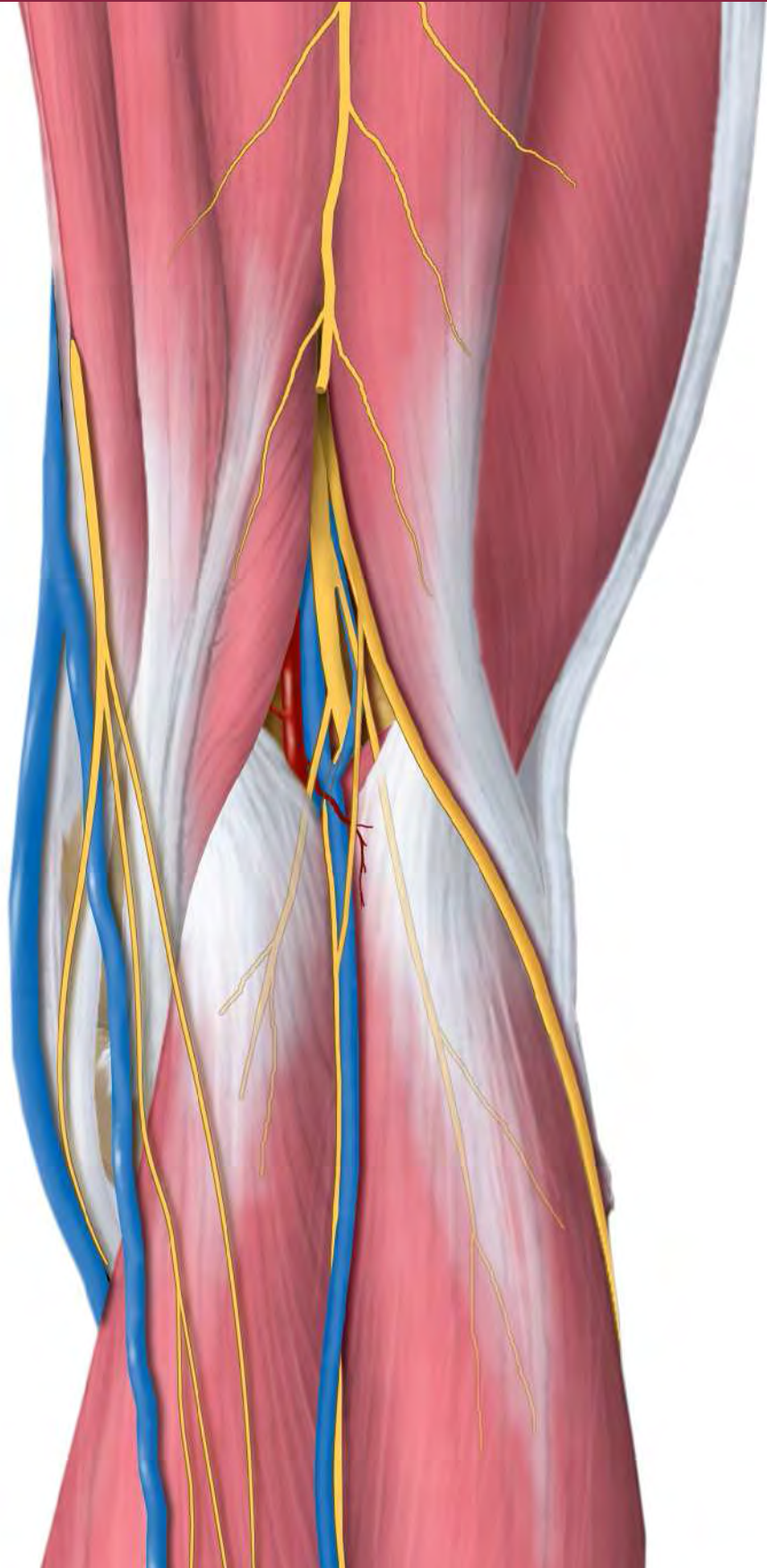
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Publisher Cataloging-in-Publication Data

Names: Crim, Julia R.

Title: Imaging anatomy. Knee, ankle, foot / [edited by] Julia R. Crim.

Other titles: Knee, ankle, foot.

Description: Second edition. | Salt Lake City, UT : Elsevier, Inc., [2017] | Includes bibliographical references and index.

Identifiers: ISBN 978-0-323-47780-2

Subjects: LCSH: Knee--Anatomy--Handbooks, manuals, etc. | Ankle--Anatomy--Handbooks, manuals, etc. | Foot--Anatomy--Handbooks, manuals, etc. | Knee--Imaging--Handbooks, manuals, etc. | Ankle--Imaging--Handbooks, manuals, etc. | Foot--Imaging--Handbooks, manuals, etc. | MESH: Knee--anatomy & histology--Atlases. | Ankle--anatomy & histology--Atlases. | Foot--anatomy & histology--Atlases.

Classification: LCC QM549.I43 2017 | NLM WE 17 | DDC 612'.98--dc23

International Standard Book Number: 978-0-323-47780-2

Cover Designer: Tom M. Olson, BA

Cover Art: Richard Coombs, MS

Printed in Canada by Friesens, Altona, Manitoba, Canada

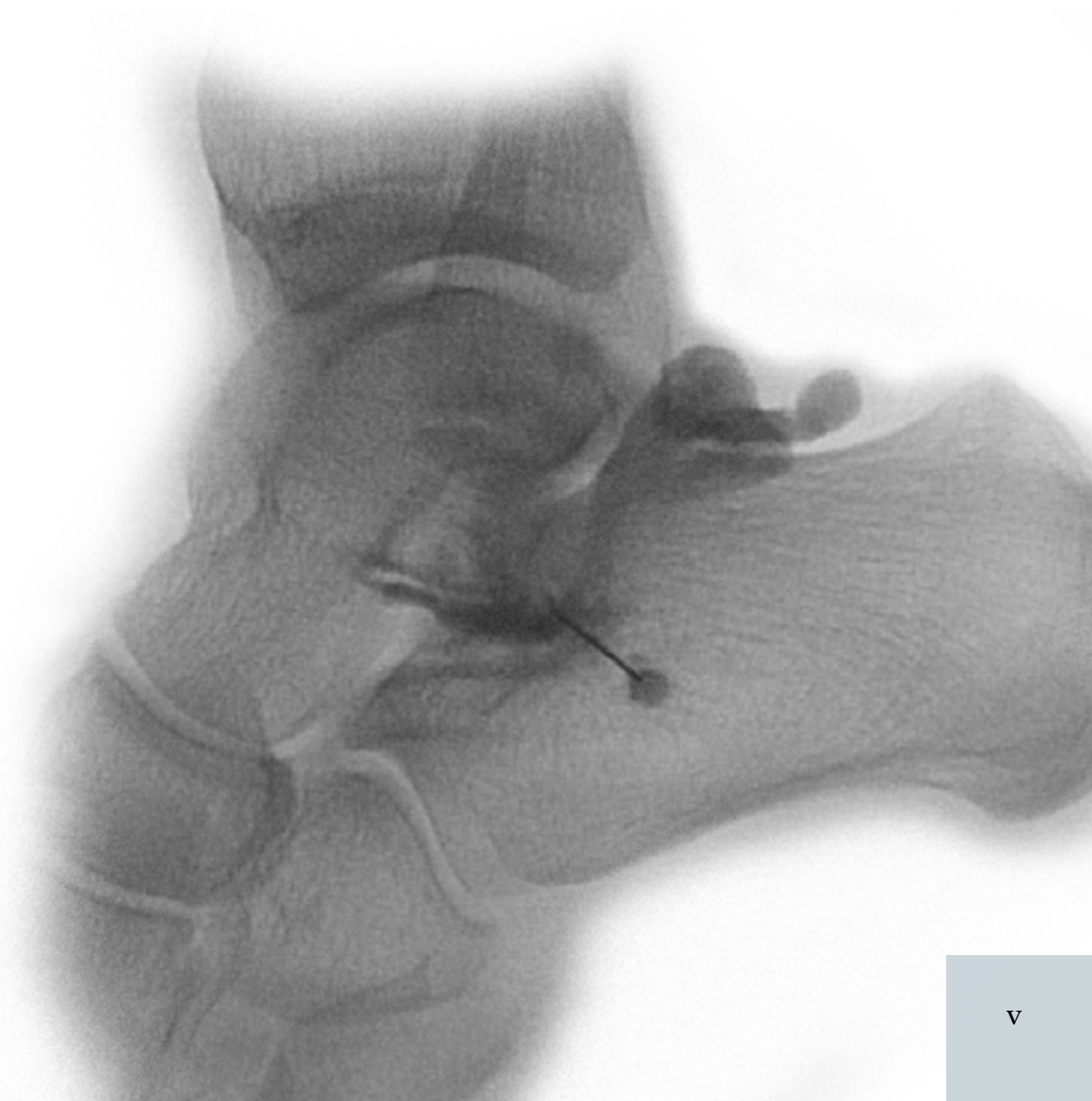
Last digit is the print number: 9 8 7 6 5 4 3 2 1

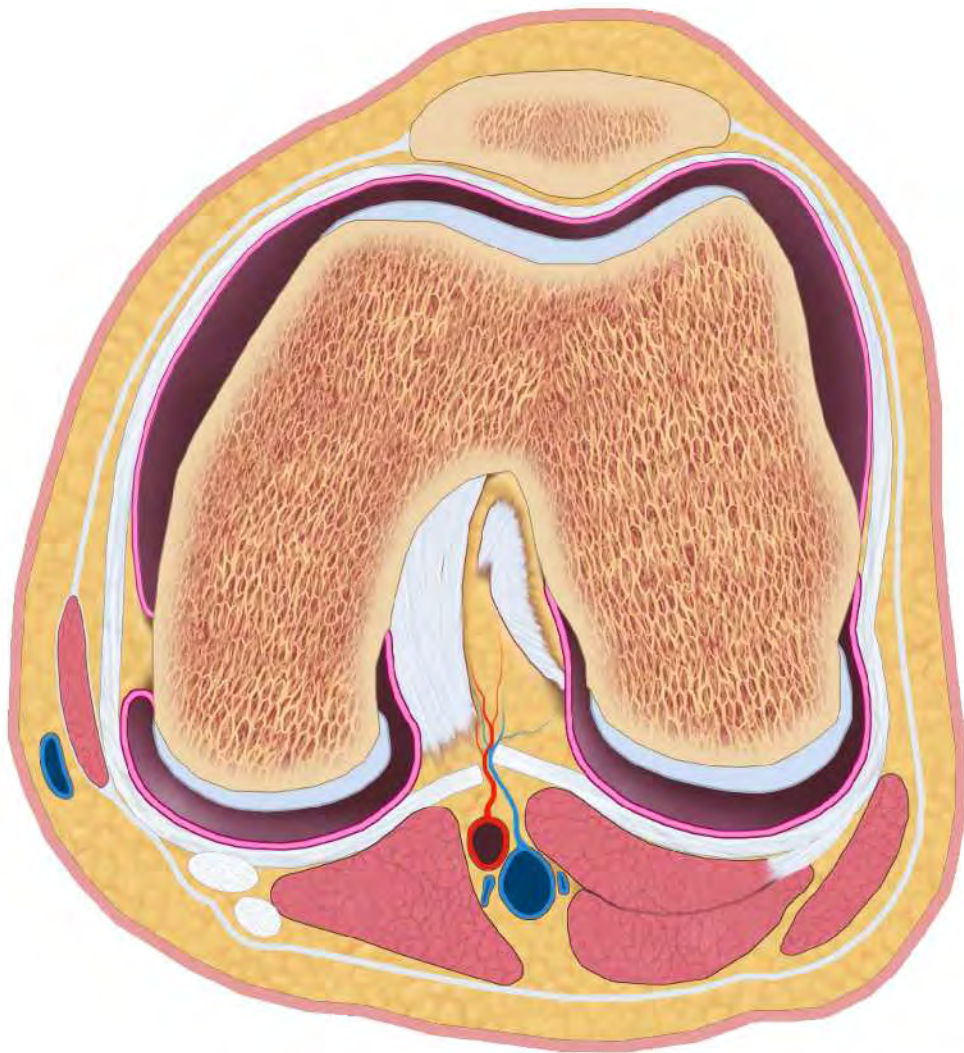


Dedication

*To Philip and Eleanor, in recognition of their courage,
perseverance, and dedication to helping others.*

JRC

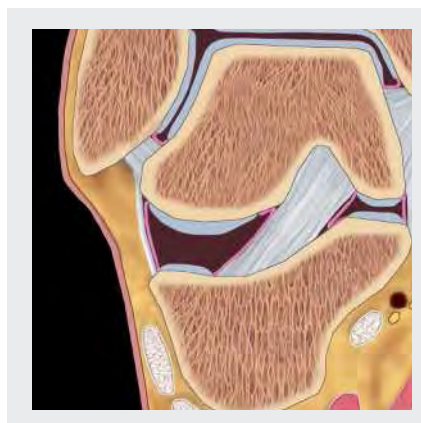


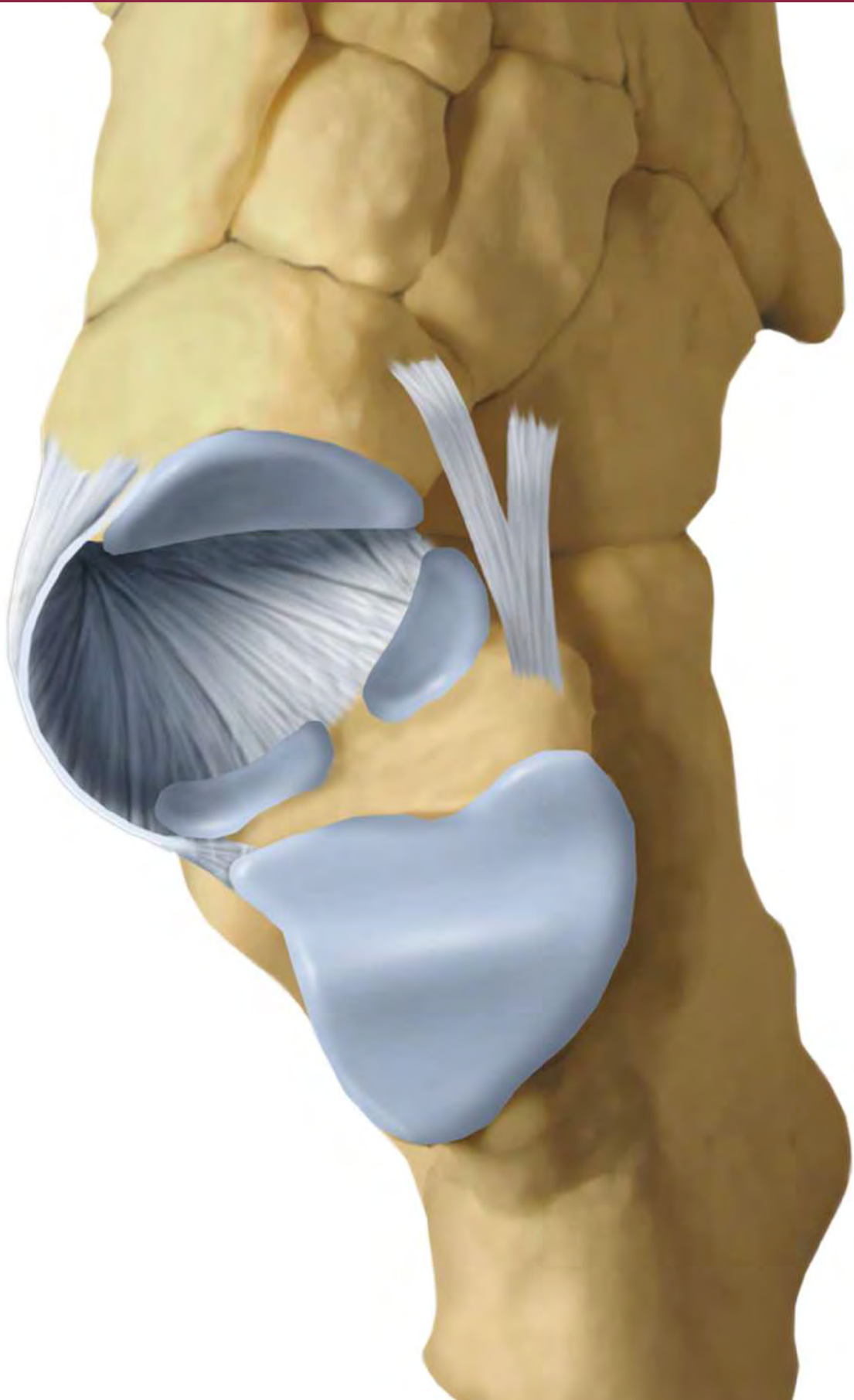


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Preface

The first edition of *Imaging Anatomy: Knee, Ankle, Foot* was a successful venture, designed to serve clinicians in medical imaging and each area's related surgical and allied health specialists in sports medicine and pain management and surgeons operating on the foot and ankle. The second edition has been revised and expanded to include new information, new clinical concerns, and ultrasound imaging. Although anatomy does not change, our medical understanding of it continues to evolve, and that is reflected in our second edition.

The high-resolution CT, MR, ultrasound, and radiographic images are richly labeled. The anatomy is further elucidated by color graphics. The text is designed to give you, the busy medical professional, rapid answers to imaging anatomy questions at a level beyond what is found online or in other anatomy texts. For easy reference, *Imaging Anatomy: Knee, Ankle, Foot*, second edition is subdivided into separate sections that cover detailed normal anatomy of the knee, ankle, and foot. The joints, muscles, tendons, ligaments, nerves, and adjacent bones are discussed for each area. In addition, special sections on normal variants as well as relevant angles and measurements for the knee/leg and ankle/foot are included. Finally, needle approaches for aspiration/injection are delineated in detail.

We believe you will find that this resource for subspecialty imaging enables you to make more accurate and sophisticated diagnoses in areas of complex anatomy.

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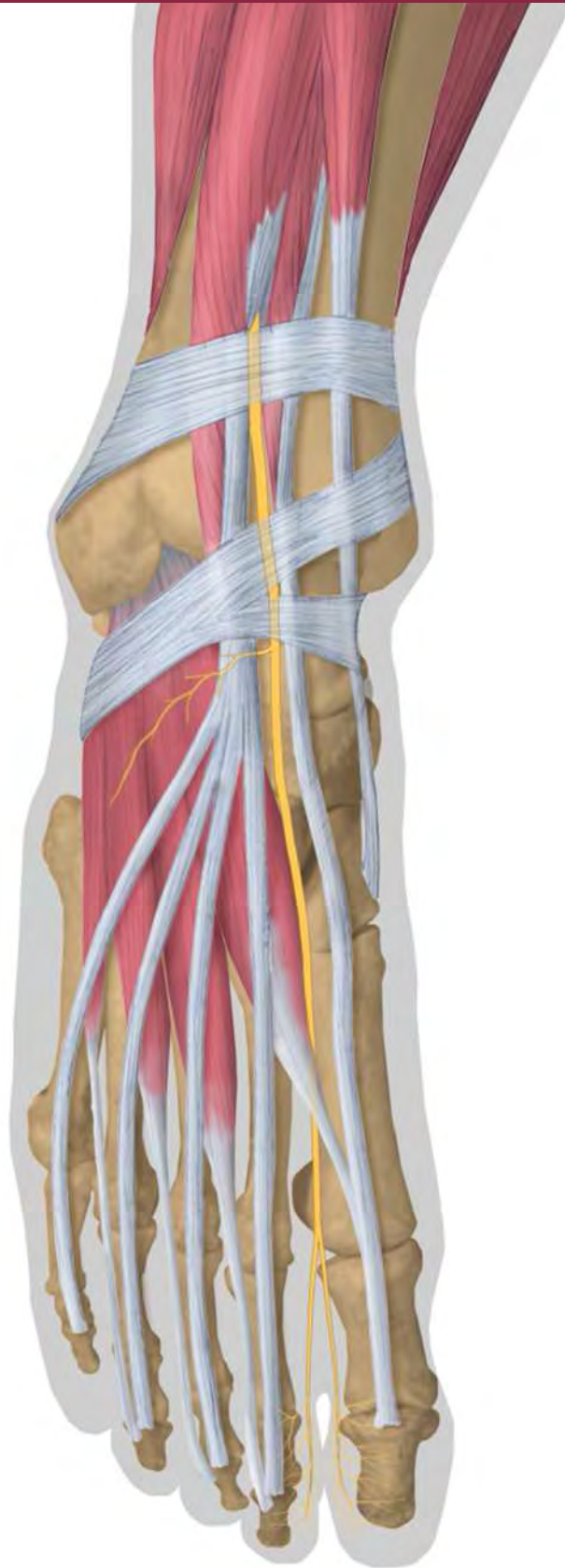
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SECTION 4: FOOT

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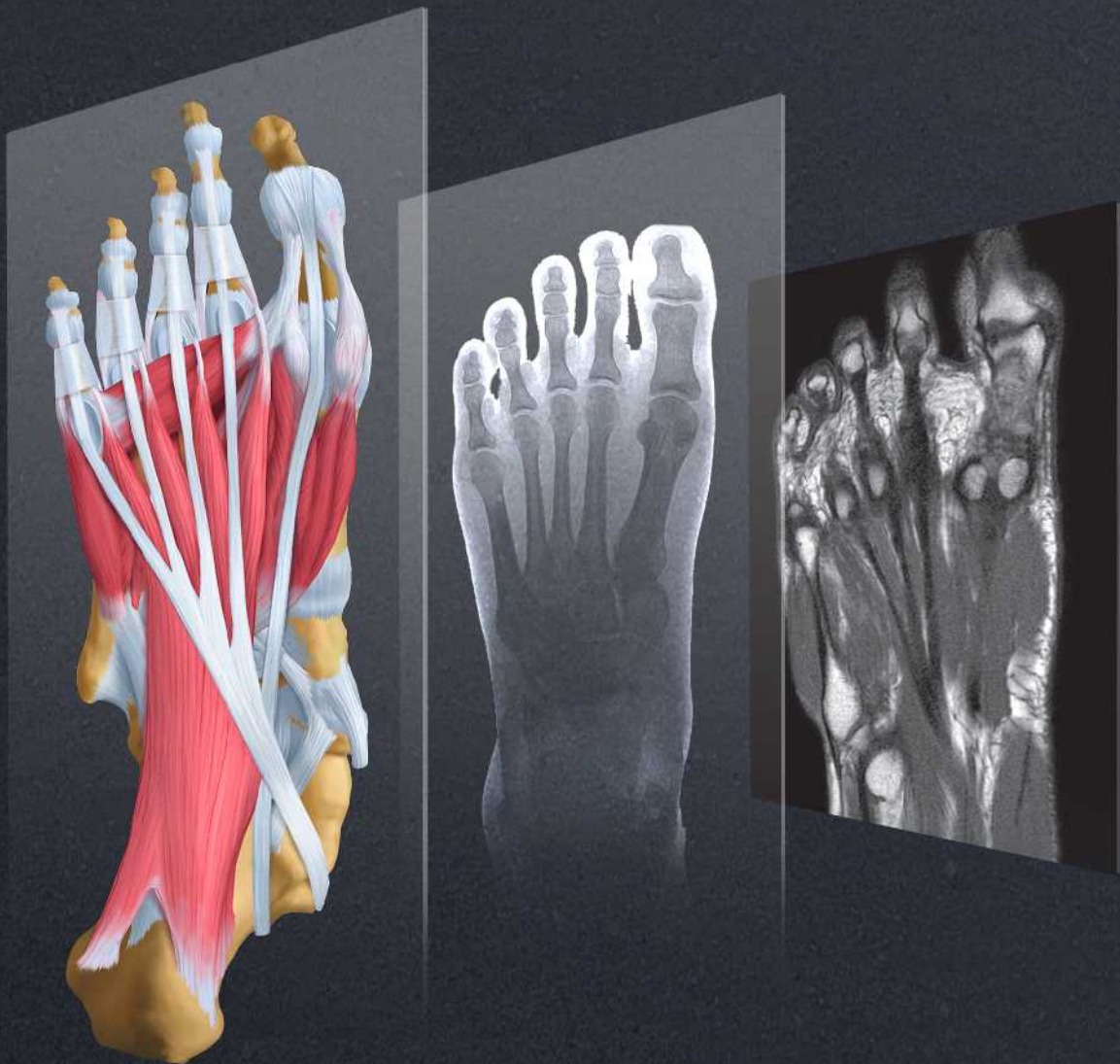
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IMAGING ANATOMY
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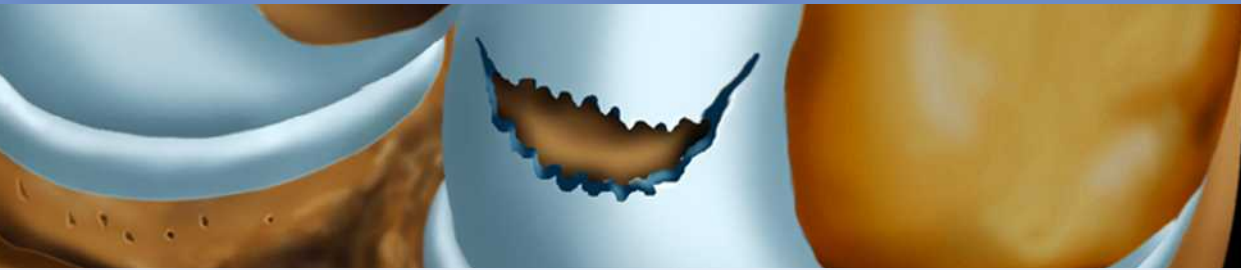
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SECTION 1

Knee



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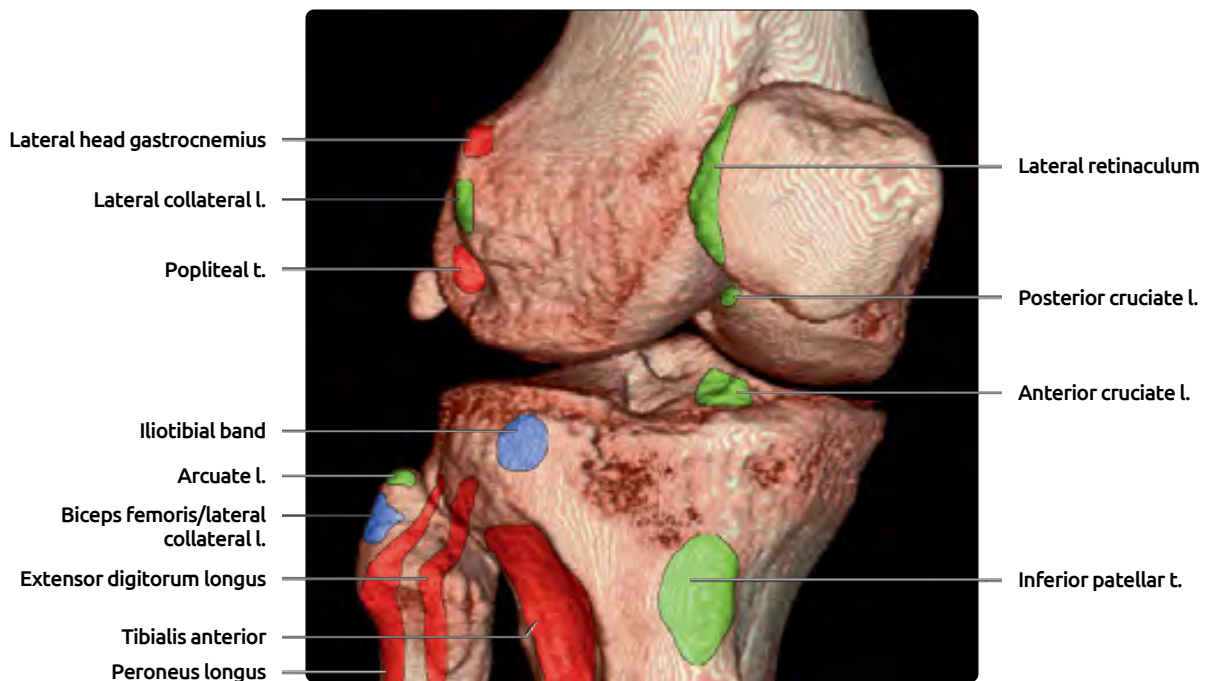
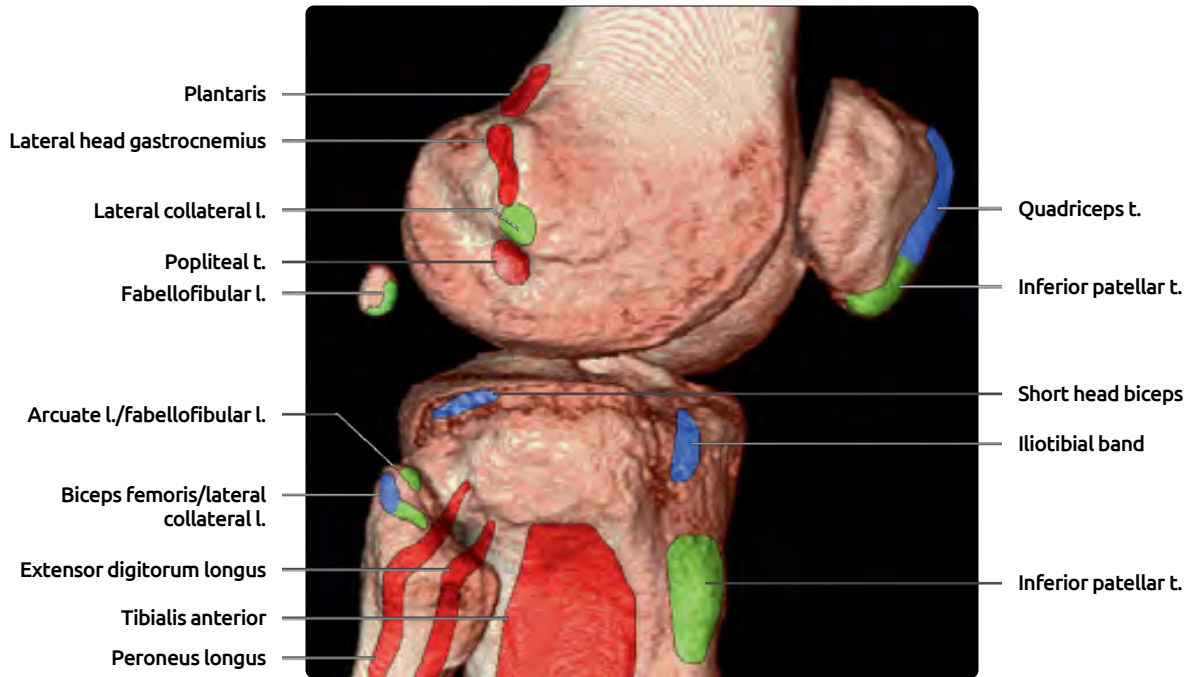
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Overview

- Largest and most complex joint
 - Hinge joint throughout its greatest range of motion
 - In all positions, femur in contact with tibia, with large areas of contact
 - In all positions, patella in contact with femur
 - Bones do not interlock; stability maintained by ligaments, tendons, capsule, and menisci
- **Motion** of knee and relationship of osseous structures
 - In full flexion
 - Posterior surfaces of femoral condyles articulate with posterior tibial condyles
 - Lateral facet of patella in contact with lateral femoral condyle
 - Supporting ligaments are not taut, and rotation of leg is allowed
 - During motion of extension
 - Patella slides upwards on femur, passing 1st on to its middle facet and then its lower facets
 - Femoral condyles roll forward on tibial condyles and menisci
 - Lateral femoral condyle shorter anteroposteriorly than medial and reaches full extension earlier
 - Medial femoral condyle continues to slide after lateral stops, rotates slightly medially on tibia and medial meniscus ("screwing it home"), tightens anterior cruciate ligament, collateral ligaments, and posterior capsular ligaments, turning knee into rigid pillar
 - Initiating flexion from fully extended knee
 - Requires slight medial rotation of tibia, produced by popliteus
 - "Unlocks" joint, allowing remainder of motion to take place
- **Muscles acting on knee joint: Extensors (4 parts of quadriceps femoris)**
 - Rectus femoris
 - Origin straight head: Anterior inferior iliac spine; origin reflected head: Groove immediately superior to acetabulum
 - Insertion: Patella and continuation to inferior patellar tendon
 - Action: Crosses both hip and knee joints, flexing hip and extending knee
 - Innervation: Femoral nerve
 - Vascular supply: Lateral circumflex femoral artery
 - Vastus lateralis
 - Origin: Superior portion of intertrochanteric line, anterior and inferior borders of greater trochanter, superior portion of lateral lip of linea aspera, and lateral portion of gluteal tuberosity of femur
 - Insertion: Lateral base and border of patella; also forms lateral patellar retinaculum and lateral side of quadriceps femoris tendon
 - Action: Extends knee
 - Innervation: Femoral nerve
 - Vascular supply: Lateral circumflex femoral artery
 - Vastus medialis
 - Origin: Inferior portion of intertrochanteric line, spiral line, medial lip of linea aspera, superior part of medial supracondylar ridge of femur, and medial intermuscular septum
 - Insertion: Medial base and border of patella; also forms medial patellar retinaculum and medial side of quadriceps femoris tendon
 - Action: Extends knee
 - Innervation: Femoral nerve
 - Vascular supply: Femoral artery, profunda femoris artery, and superior medial genicular branch of popliteal artery
 - Vastus intermedius
 - Origin: Superior 2/3 of anterior and lateral surfaces of femur; also from lateral intermuscular septum of thigh
 - Insertion: Lateral border of patella; also forms deep portion of quadriceps tendon
 - Action: Extends knee
 - Innervation: Femoral nerve
 - Vascular supply: Lateral circumflex femoral artery
- **Muscles acting on knee joint: Flexors**
 - Biceps femoris
 - Origin: Long head, common tendon with semitendinosus from superior medial quadrant of posterior portion of ischial tuberosity; short head, lateral lip of linea aspera, lateral supracondylar ridge of femur, and lateral intermuscular septum of thigh
 - Insertion: Primarily on fibular head; also on lateral collateral ligament and lateral tibial condyle
 - Action: Flexes knee and also rotates tibia laterally; long head also extends hip joint
 - Innervation: Long head, tibial nerve; short head, common peroneal nerve
 - Vascular supply: Perforating branches of profunda femoris artery, inferior gluteal artery, and superior muscular branches of popliteal artery
 - Sartorius
 - Origin: Anterior superior iliac spine
 - Insertion: Anteromedial tibial metaphysis near tibial tuberosity
 - Action: Crosses both hip and knee joints, flexes both hip and knee joints, rotating thigh laterally to bring limbs into position adopted by cross-legged tailor
 - Innervation: Femoral nerve
 - Vascular supply: Muscular branches of femoral artery
 - Gracilis
 - Origin: Inferior margin of pubic symphysis, inferior ramus of pubis, and adjacent ramus of ischium
 - Insertion: Medial tibial metaphysis, just posterior to sartorius
 - Action: Adducts thigh, flexes knee, and rotates flexed leg medially
 - Innervation: Anterior division of obturator nerve
 - Vascular supply: Obturator artery, medial circumflex femoral artery, and muscular branches of profunda femoris artery
 - Semitendinosus
 - Origin: From common tendon with long head of biceps femoris from superior medial quadrant of posterior portion of ischial tuberosity

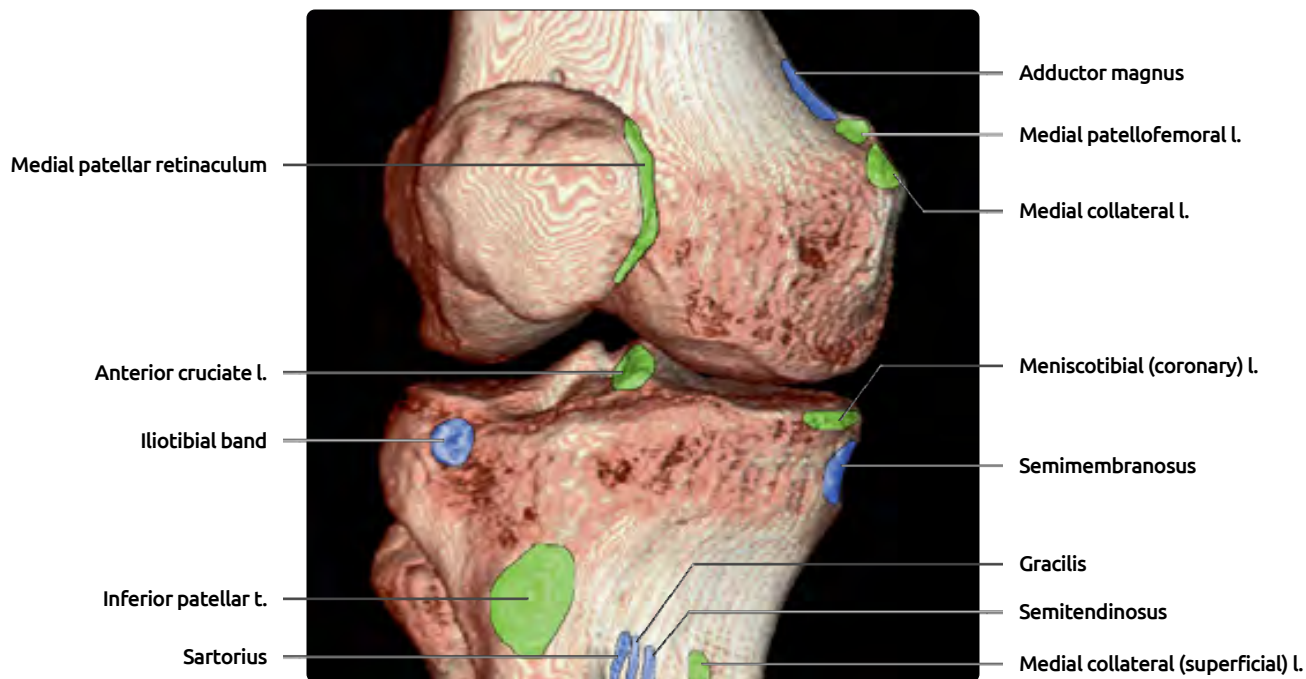
- Insertion: Medial tibial metaphysis, just posterior to gracilis
- Action: Crosses both hip and knee joints, extends hip, flexes knee, medially rotates flexed leg
- Innervation: Tibial nerve
- Vascular supply: Perforating branches of profunda femoris artery, inferior gluteal artery, and superior muscular branches of popliteal artery
- Semimembranosus
 - Origin: Superior lateral quadrant ischial tuberosity
 - Insertion: Wide insertion posterior and medial tibial condyle
 - Action: Crosses both hip and knee joints, extends hip, flexes knee, medially rotates flexed knee
 - Innervation: Tibial nerve
 - Vascular supply: Perforating branches of profunda femoris artery, inferior gluteal artery, and superior muscular branches of popliteal artery
- Popliteus
 - Origin: Anterior part of popliteal groove on lateral surface of lateral femoral condyle
 - Insertion: Posterior surface of tibia in fan-like fashion, just superior to popliteal line
 - Action: Flexes knee and medially rotates tibia at beginning of flexion
 - Innervation: Tibial nerve
 - Vascular supply: Medial inferior genicular branch of popliteal artery and muscular branch of posterior tibial artery
- **Muscles acting on knee joint: Superficial flexors of knee**
 - Gastrocnemius
 - Origin: Medial head from posterior nonarticular surface of medial femoral condyle; lateral head from posterior edge of lateral epicondyle; heads unite to form main bulk of muscle
 - Insertion: Unites with deep tendon of soleus to form Achilles tendon, inserting on middle 1/3 of posterior calcaneal surface
 - Action: Flexes knee and plantar flexes ankle
 - Innervation: Tibial nerve
 - Vascular supply: Sural branch of popliteal artery
 - Plantaris
 - Origin: Superior and medial to lateral head of gastrocnemius origin, as well as from oblique popliteal ligament
 - Insertion: Middle 1/3 of posterior calcaneal surface, just medial to Achilles tendon
 - Action: Flexes knee and plantarflexes ankle
 - Innervation: Tibial nerve
 - Vascular supply: Sural arteries
 - Note: Absent in 7-10% of population
- **Muscles acting on knee joint: Internal rotators of leg**
 - Popliteus, gracilis, sartorius, semitendinosus, semimembranosus
- **Muscles acting on knee joint: External rotator of leg**
 - Biceps femoris
- **Extensor mechanism**
 - Quadriceps tendon and retinacula converge to inferior patellar tendon
- **Internal structures**
 - Menisci
- Cushion lubricate and stabilize knee
- Cruciate ligaments
 - Major stabilizing structures to anteroposterior motion
- Medial supporting structures
 - Pes anserinus, medial collateral ligament, capsular layers, and posterior oblique ligament
- Lateral supporting structures
 - Iliotibial band, biceps femoris, quadriceps retinaculum, fibular collateral ligament, arcuate ligament, and several small inconstant posterolateral structures
- **Nerves of knee joint**
 - **Femoral nerve** supplies
 - 3 branches, 1 to each of vasti and to anterosuperior part of joint
 - Largest is nerve to vastus medialis, which accompanies descending genicular artery
 - **Common peroneal nerve** supplies
 - Superior lateral genicular nerve descends into popliteal fossa and supplies superolateral part of joint, passing deep to biceps, through lateral intermuscular septum above femoral condyle
 - Inferior lateral genicular nerve: Small and sometimes absent; arises with superior lateral genicular nerve and curves downwards and forwards over lateral head of gastrocnemius, passing between capsule and fibular collateral ligament
 - Recurrent genicular nerve: Small twigs reaching anteroinferior part of joint
 - **Tibial nerve** supplies
 - Superior medial genicular nerve: Runs medially around femur above medial condyle, deep to adductor magnus, then through vastus medialis to superomedial part of joint
 - Middle genicular nerve: Runs forward through fibrous capsule to cruciate ligaments
 - Inferior medial genicular nerve: Largest, running along upper border of popliteus, passing forward between shaft of tibia and medial collateral ligament, curving superiorly to inferomedial part of capsule
 - **Obturator nerve**: Sends genicular branch through adductor magnus to join popliteal artery, running to posterior aspect of joint
- **Vessels of knee joint**: 8 arteries supply large anastomosis
 - **Popliteal** artery supplies 5 genicular branches
 - **Anterior tibial** artery supplies 2 recurrent branches
 - **Femoral** artery supplies descending genicular branch
 - **Lateral circumflex** artery supplies descending genicular branch

3D CT: ORIGINS AND INSERTIONS (LATERAL, ANTEROLATERAL)



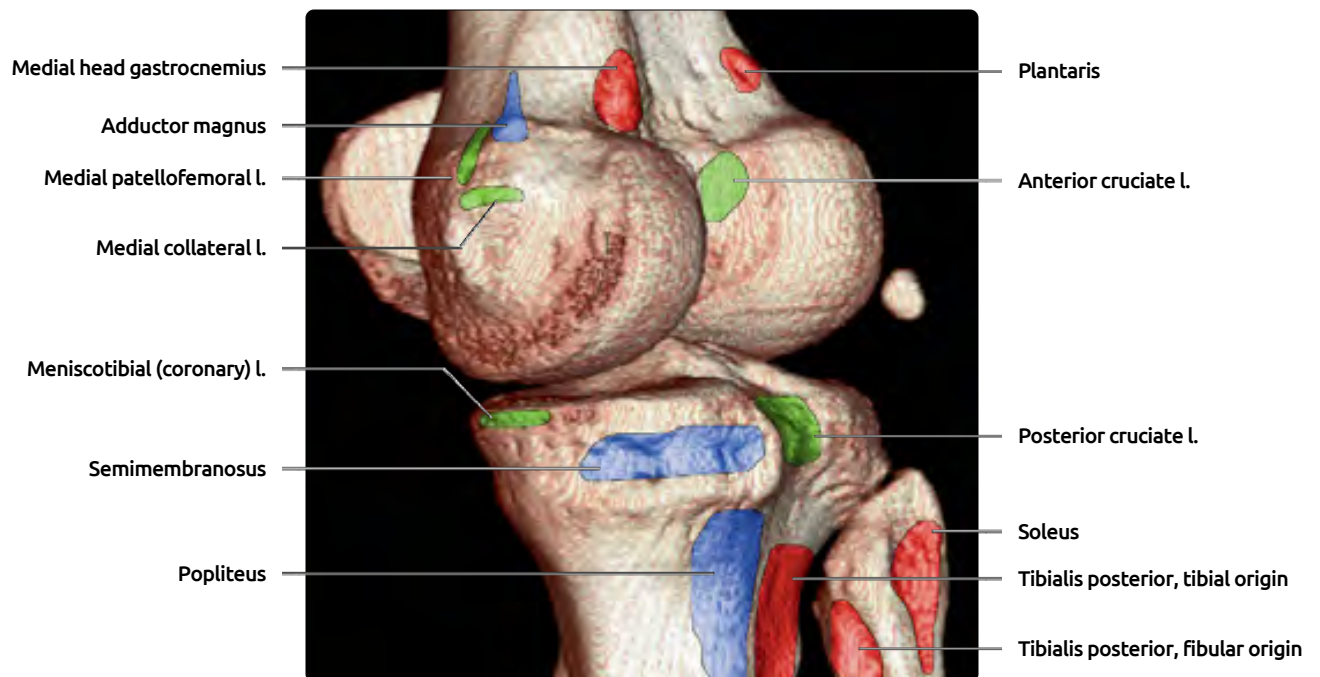
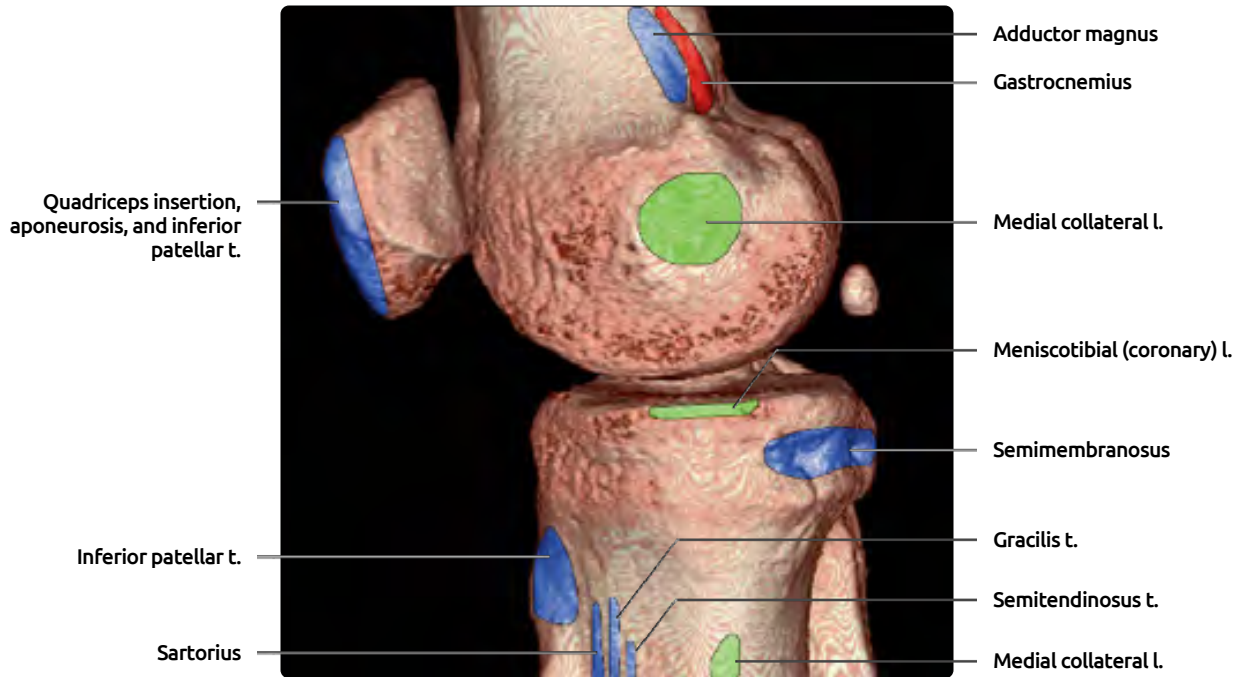
(Top) Lateral view of the knee shows lateral stabilizing structures. Origins of anterior and lateral leg muscles are seen as well. **(Bottom)** This slightly anterolateral view shows the lateral stabilizers of the knee and patella. These consist primarily of the lateral collateral ligament, arcuate ligament, popliteal tendon, iliotibial band, and biceps femoris. Origins of several leg muscles are seen. The tibialis anterior, extensor digitorum longus, and peroneus longus origins extend several centimeters distally beyond the regions indicated here.

3D CT: ORIGINS AND INSERTIONS (ANTEROMEDIAL)



(Top) Slightly anteromedial view shows the medial stabilizers of the knee and patella. Note that only the uppermost portion of the insertions of the pes anserinus (sartorius, gracilis, and semitendinosus), as well as superficial medial collateral ligament, are shown. These insertions actually extend several cm distally on the tibia. **(Bottom)** Anteromedial knee shows medial stabilizers of knee (primarily medial collateral ligament, superficial and deep fibers, secondarily pes anserinus), as well as medial stabilizers of patella (superiorly medial patellofemoral ligament, mid medial retinaculum, inferiorly patellotibial ligament).

3D CT: ORIGINS AND INSERTIONS (MEDIAL, POSTEROMEDIAL)



(Top) First of 8 volume-rendered topographic CT images is shown. Image shows the medial aspect of the knee with associated muscle, tendon, and ligament origins/insertions. **(Bottom)** Posterior CT, oblique to medial, is shown. Note the extensive insertions of both semimembranosus and popliteus on the posteromedial tibia.