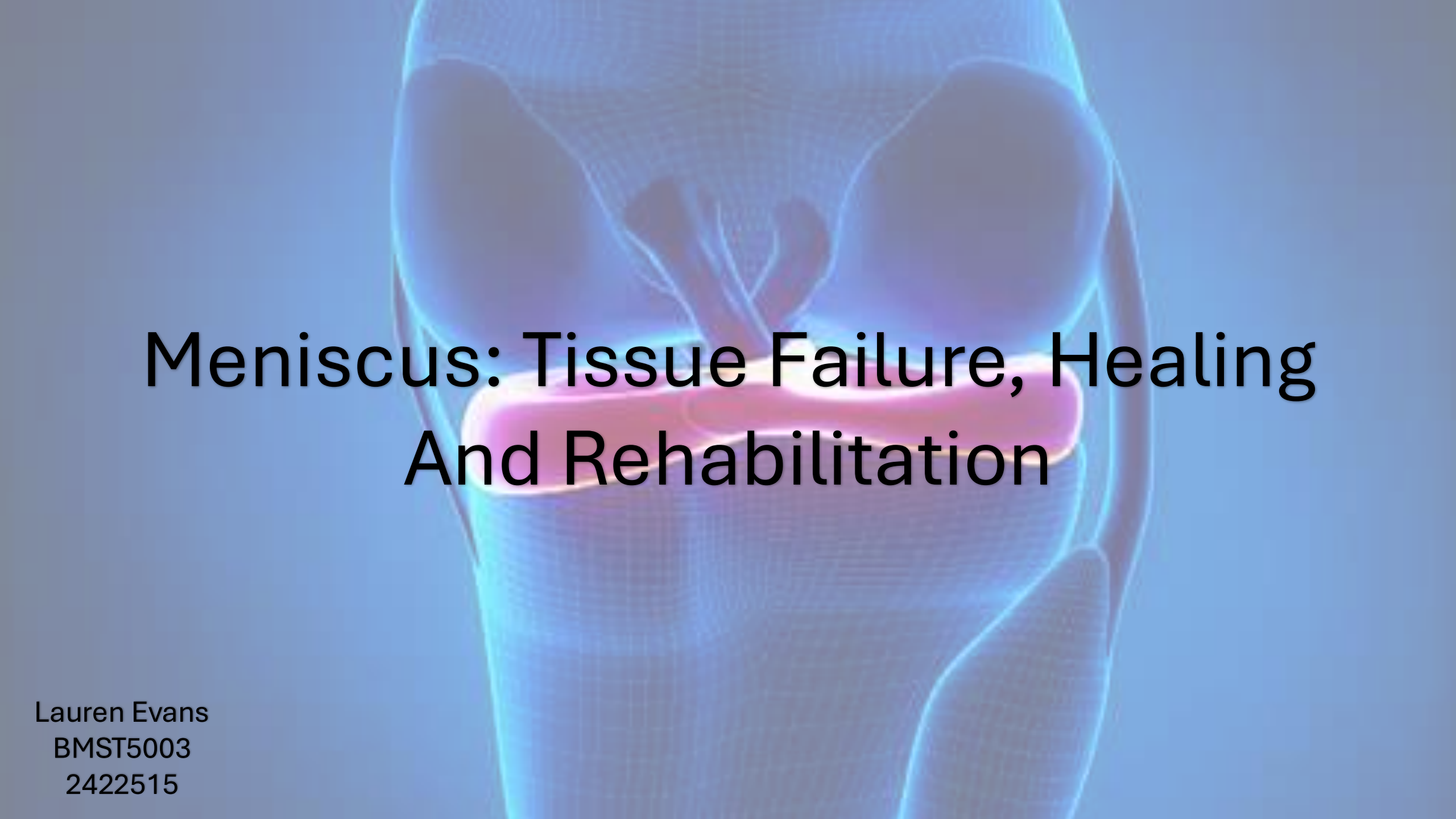


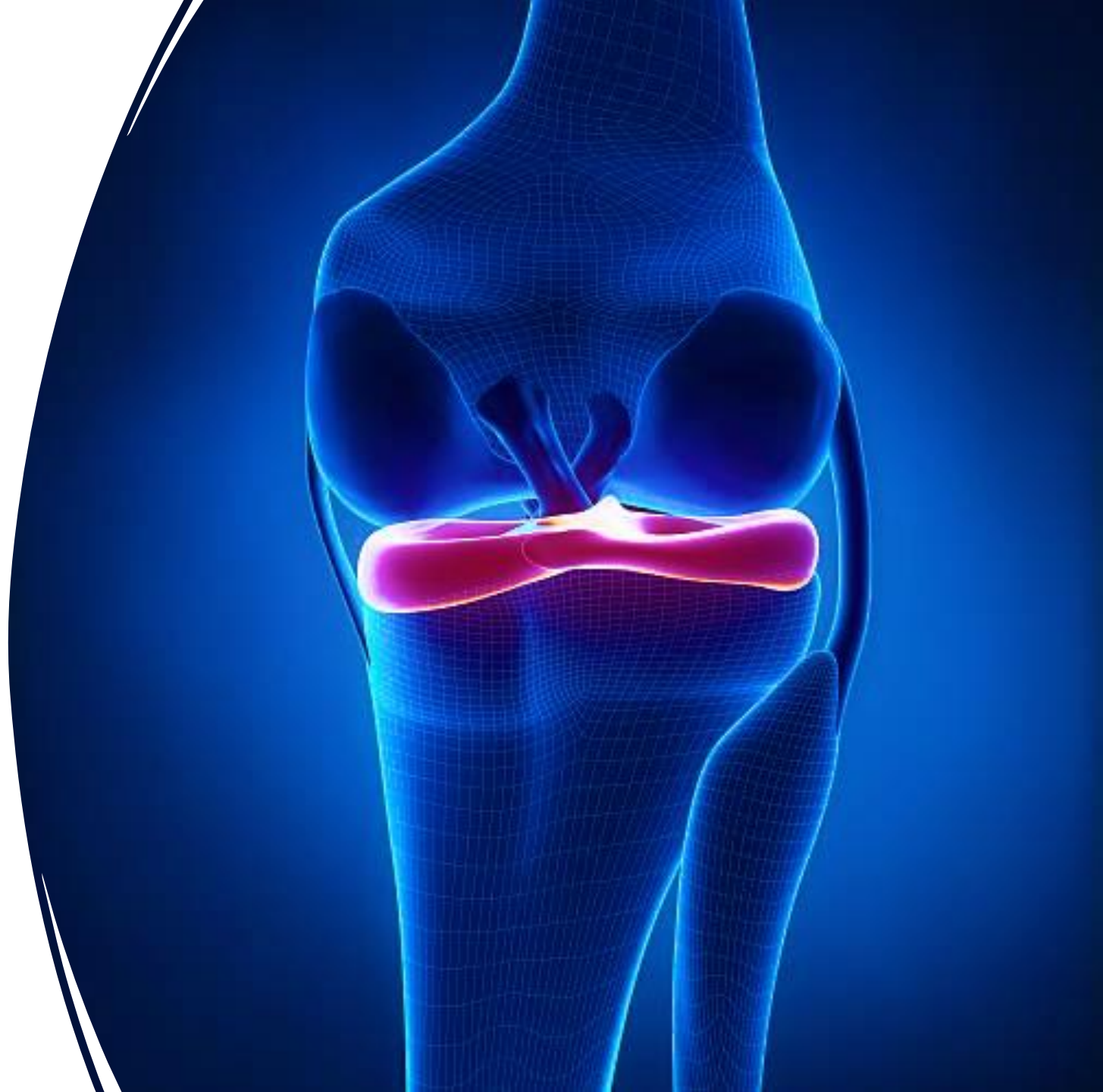
An anatomical illustration of a human knee joint in a sagittal view. The femur (thigh bone) is at the top, and the tibia (shin bone) is at the bottom. The meniscus, a wedge-shaped piece of cartilage, is highlighted in a bright yellow-orange color between the two bones. The surrounding ligaments and joint capsule are shown in a semi-transparent blue. The title text is overlaid on the center of the image.

Meniscus: Tissue Failure, Healing And Rehabilitation

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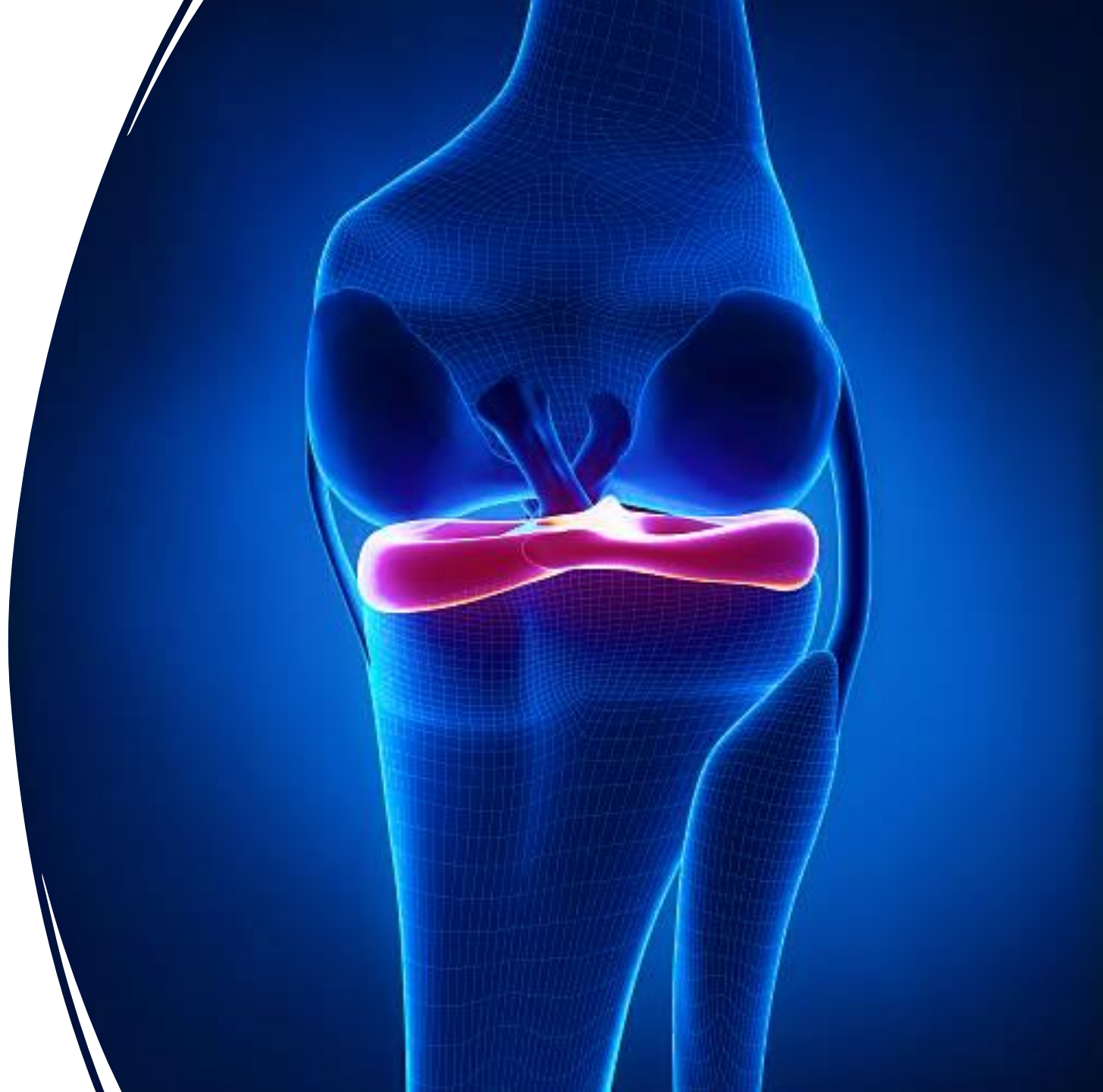
Tissue Overview

- Knee Meniscus – Medial and Lateral
- Fibrocartilage
- Load transmission & joint protection



Meniscal Anatomy & Function

- Medial vs Lateral Meniscus
- Wedge Shaped
- Red-Red/Red-White/White-White Zones



Forces that CAN be tolerated

- Axial Compression -> walking, standing
- Closed-Chain loading -> squat, lunge
- Low-Velocity Sagittal Plane Motion – wall sits, step ups

(Simonetta et al., 2023)



Forces that CAN'T be tolerated

- Shear Forces - changing direction
- Tibial Rotations – pivoting in netball
- Deep Flexion – deep squatting
- Sudden Deceleration – landing in netball

(Simonetta et al., 2023)



Stress Strain Curve

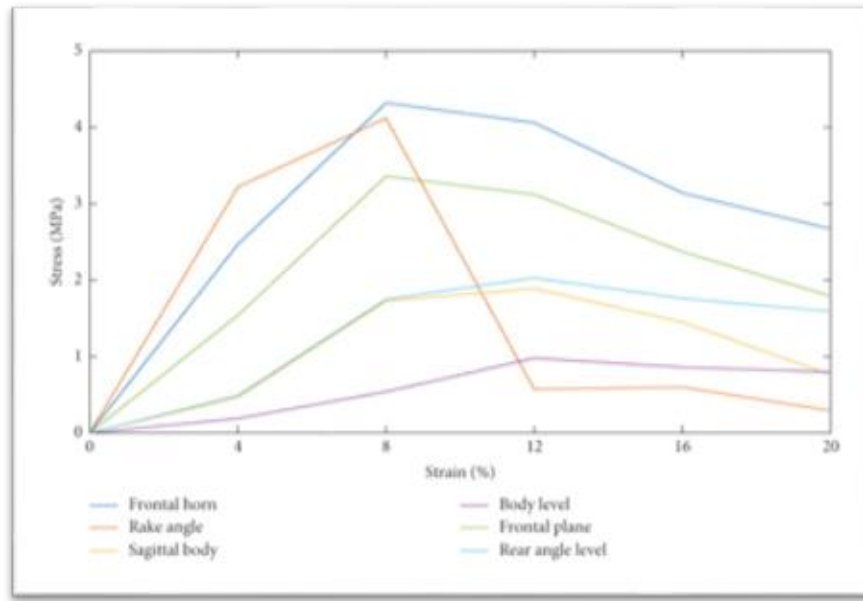
- Toe Region – uncrimping and alignment of collagen fibers with minimal resistance.
- Linear Region – collagen fibers are fully aligned, stress and strain increase proportionally, elastic deformation.
- Yield Point – transition from elastic to plastic deformation, micro-failure of collagen fibers begin.
- Failure – Macroscopic rupture of tissue, load carrying capacity is lost.

(Trams and Kamiński, 2024)

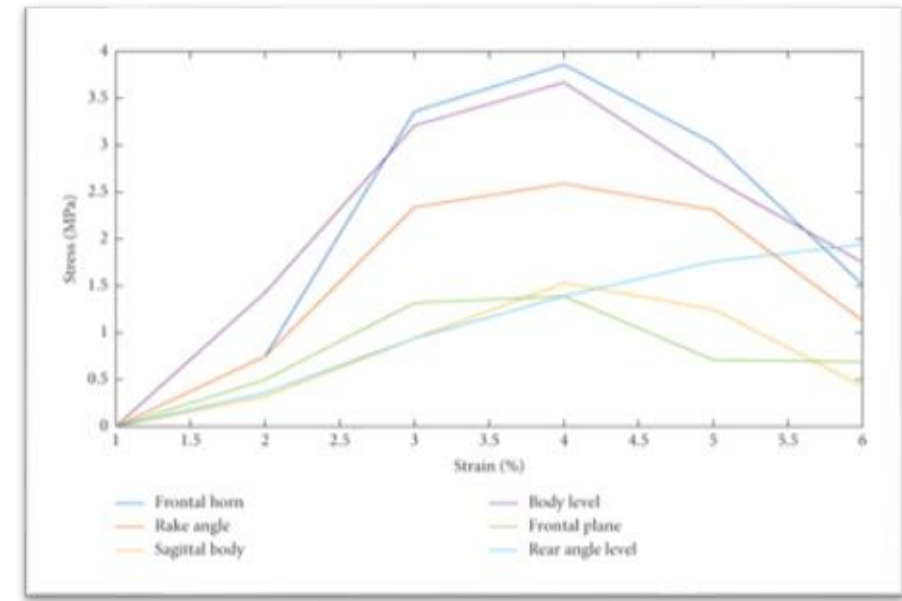


Clinical Application of Stress Strain

- Rehab Loading = Toe - Linear Region
- Early Overload = Beyond yield point, Re-Tear
- Underload = Below toe region, Poor Tissue Quality



Medial



Lateral

(Trams and Kamiński, 2024)

Types of Meniscal Tears



Health Meniscus



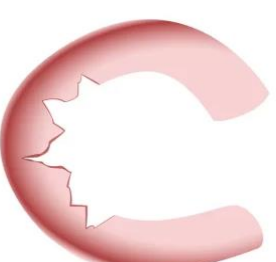
Radial Tear



Longitudinal Tear



Flap Tear



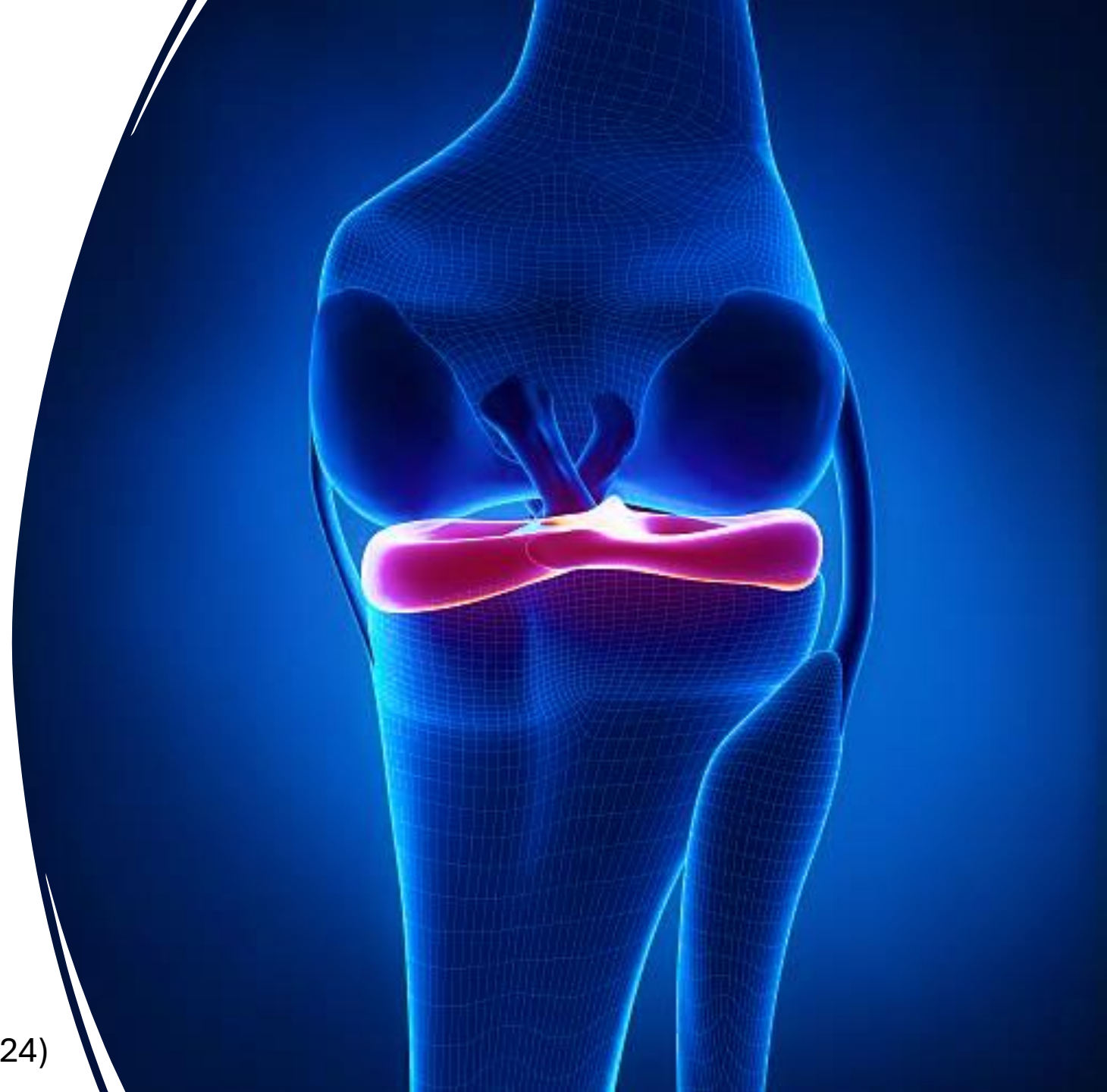
Complex (degenerative) Tear



Buckle Handle Tear



Horizontal Tear

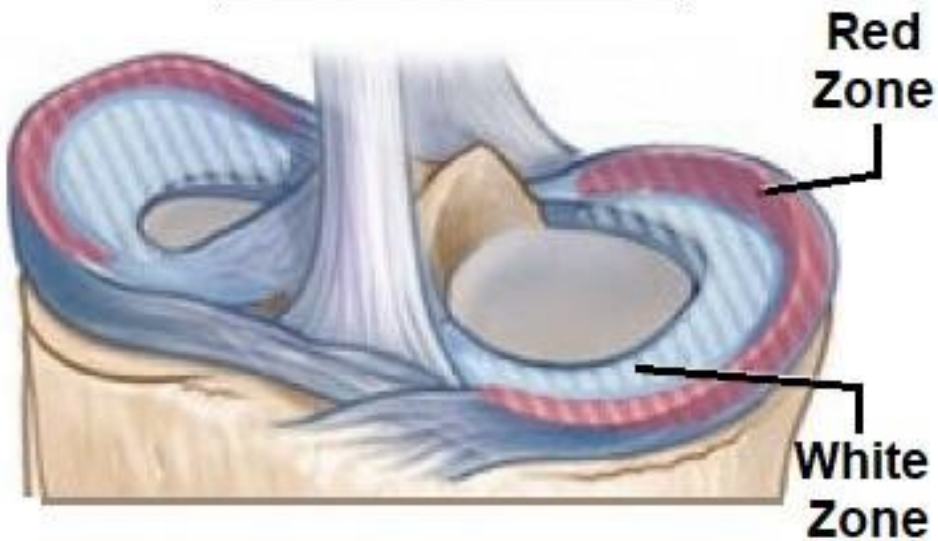


(Zhang, 2024)

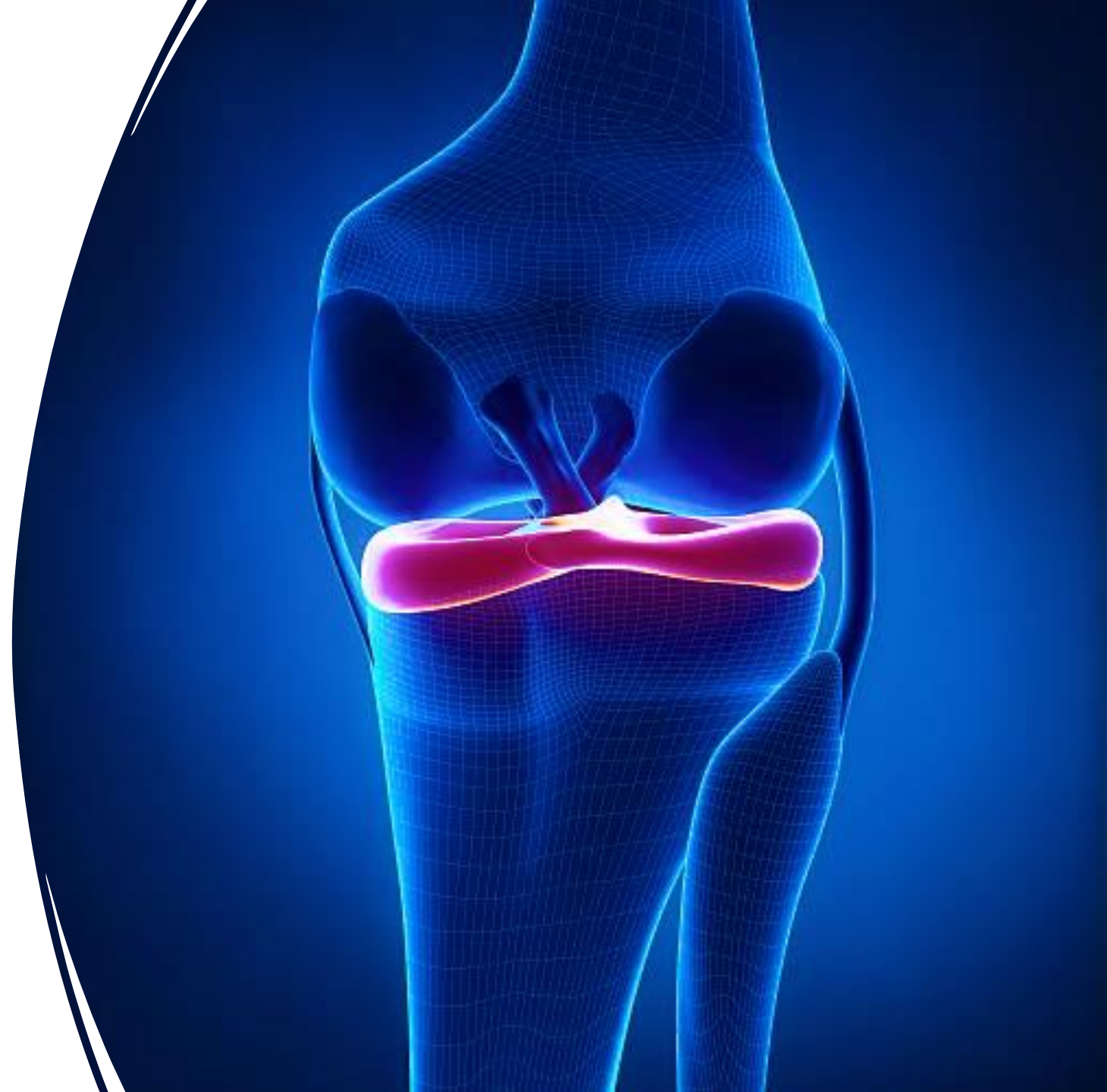
Tear Location and Management

- Red-Red = Good Healing
- Red-White = Partial Healing
- White-White = Poor Healing

Knee Meniscus



(Twomey-Kozak and Jayasuriya, 2020)



Healing Timeframe

- Inflammatory = 0 - 2 weeks
- Proliferative = 2 - 6 weeks
- Remodeling = 6 weeks - 6 months

(Malinowski et al., 2023)



Forces Applied During Healing

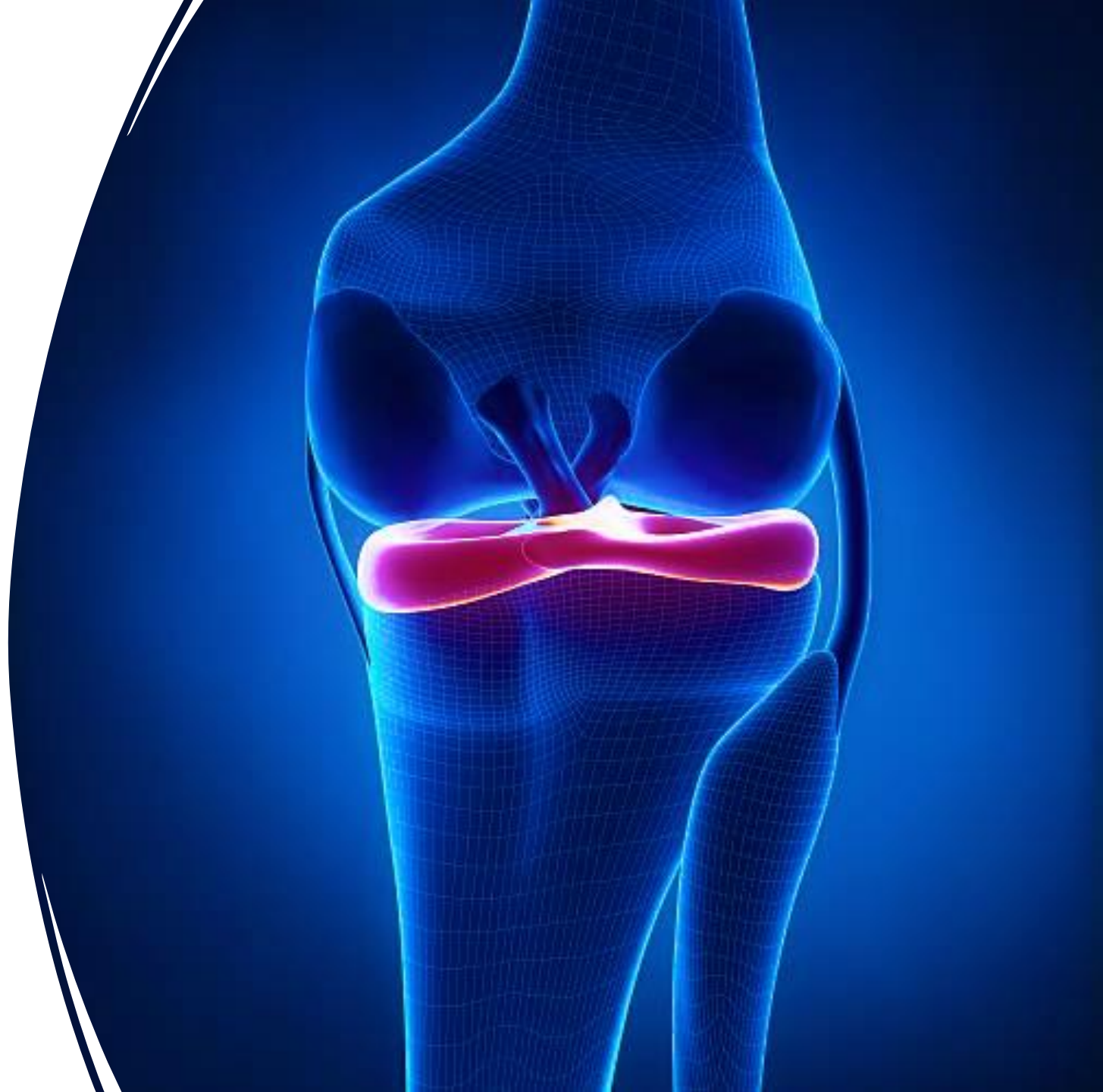
- Early = Compression + Isometrics
- Mid = Controlled Closed-Chain
- Late = Increased Load Tolerance

(Cavanaugh and Killian, 2012)



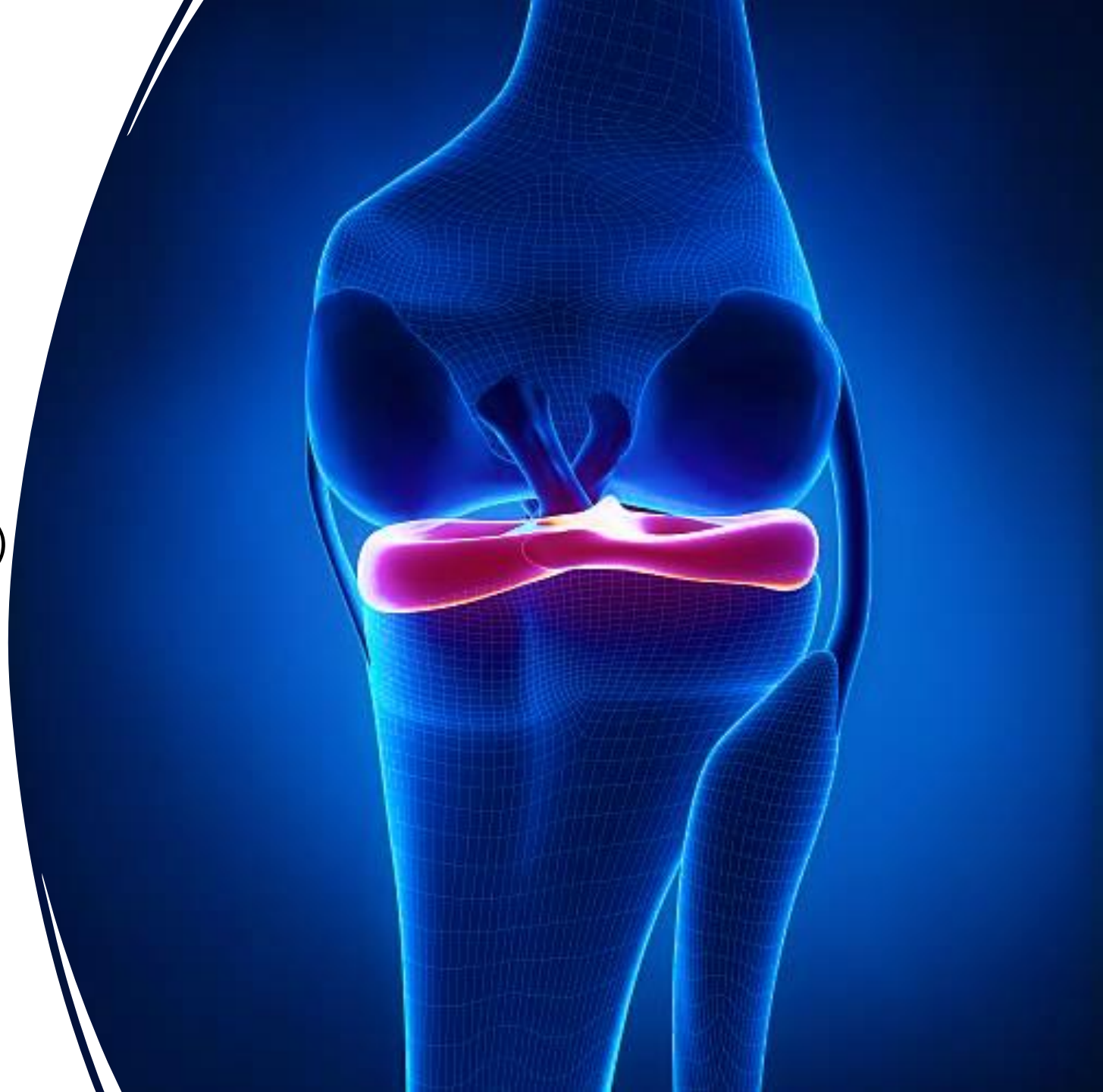
When Can We Progress?

- Pain $< 2/10$
- No Joint Effusion
- Full Knee Extension
- Controlled Movement Quality



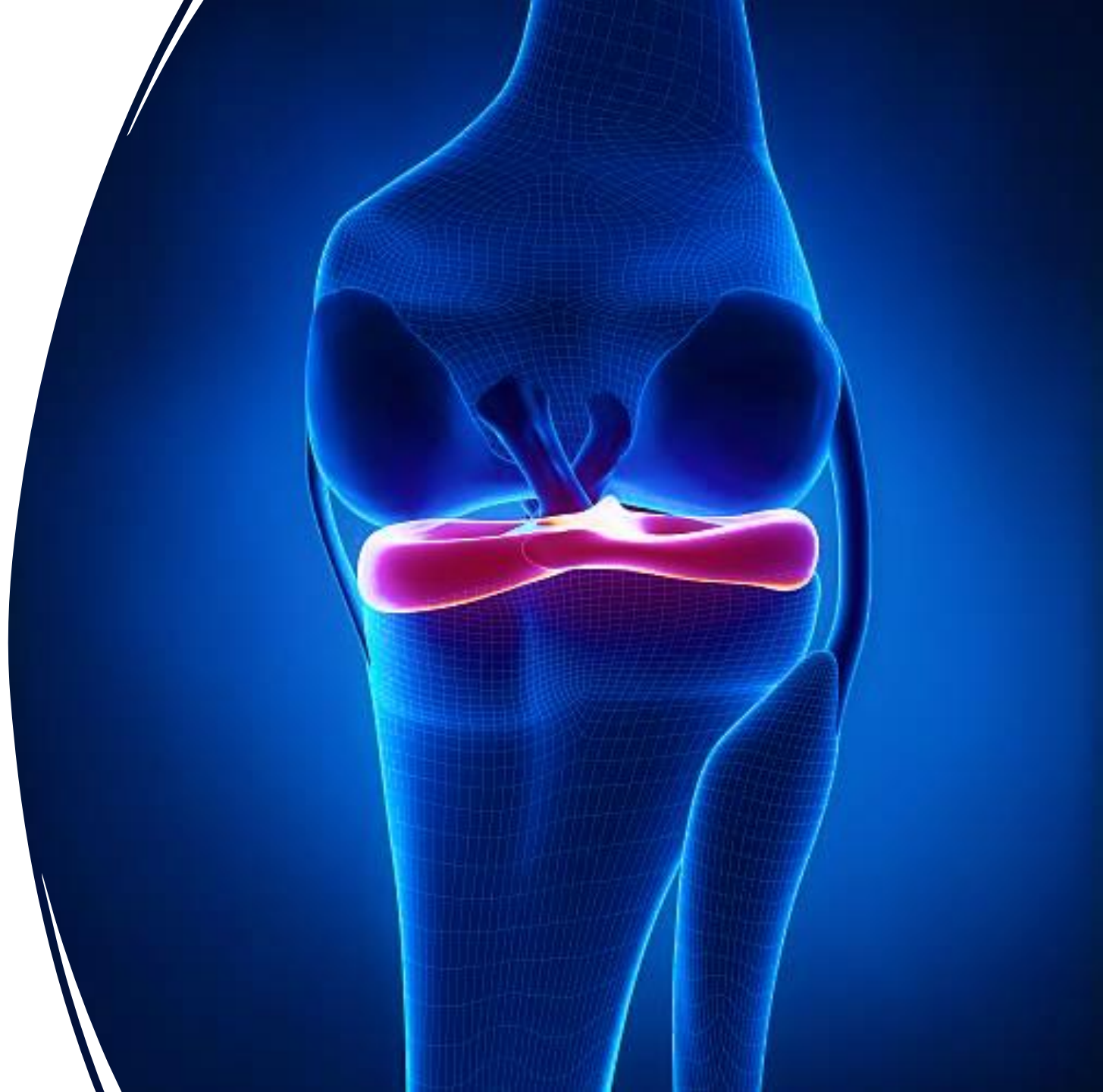
ROM Requirements

- Full Extension Essential (130-140 flexion)
- Flexion Progressed Gradually
- Avoid Deep Flexion Early



Meniscal Injury

- Medial meniscus longitudinal tear
- Conservative Management
- Mechanism = Twisting On Flexed Knee



Quad Isometric

- Stage = Inflammatory Phase
- Reps = 5x10s holds
- Why = Neural activation, Compression without shear
- Regression = Assisted contraction
- Progression = Multi angle holds



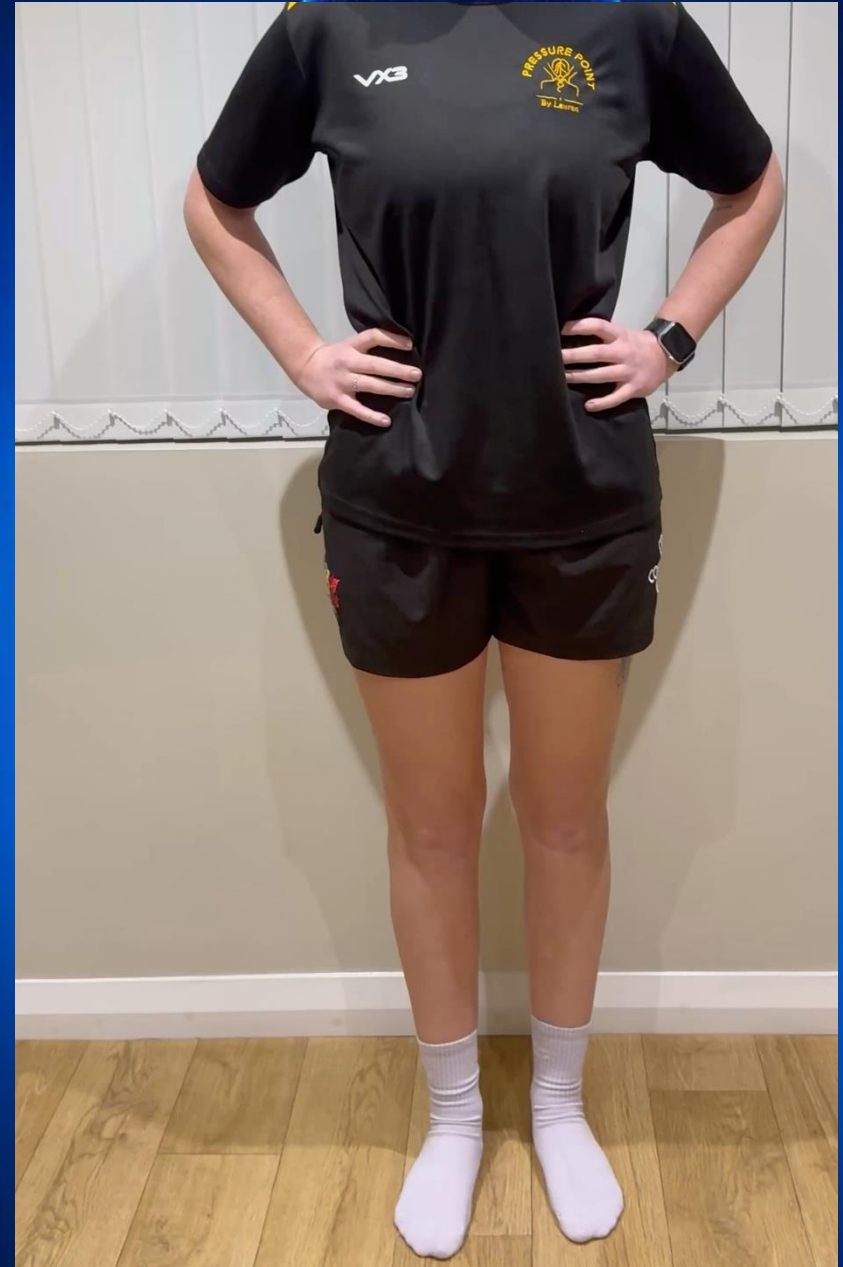
Heel Slides

- Stage = Proliferative Phase
- Reps = 3x12
- Why = Restores ROM without high load
- Regression = Passive assisted
- Progression = Active end-range hold



Single Leg Balance

- Stage = Proliferative Phase
- Reps = 3x30s
- Why = Proprioception
- Regression = Double leg
- Progression = Close eyes or add an activity.



Step Down

- Stage = Proliferative Phase
- Reps = 2x10
- Why = Strength & control
- Regression = Reduced height
- Progression = Slower eccentric



Sit To Stand

- Stage = later stages of proliferative phase
- Reps = 3x10
- Why = Closed-chain compression
- Regression = Raised seat
- Progression = Slower Tempo



Split Squat

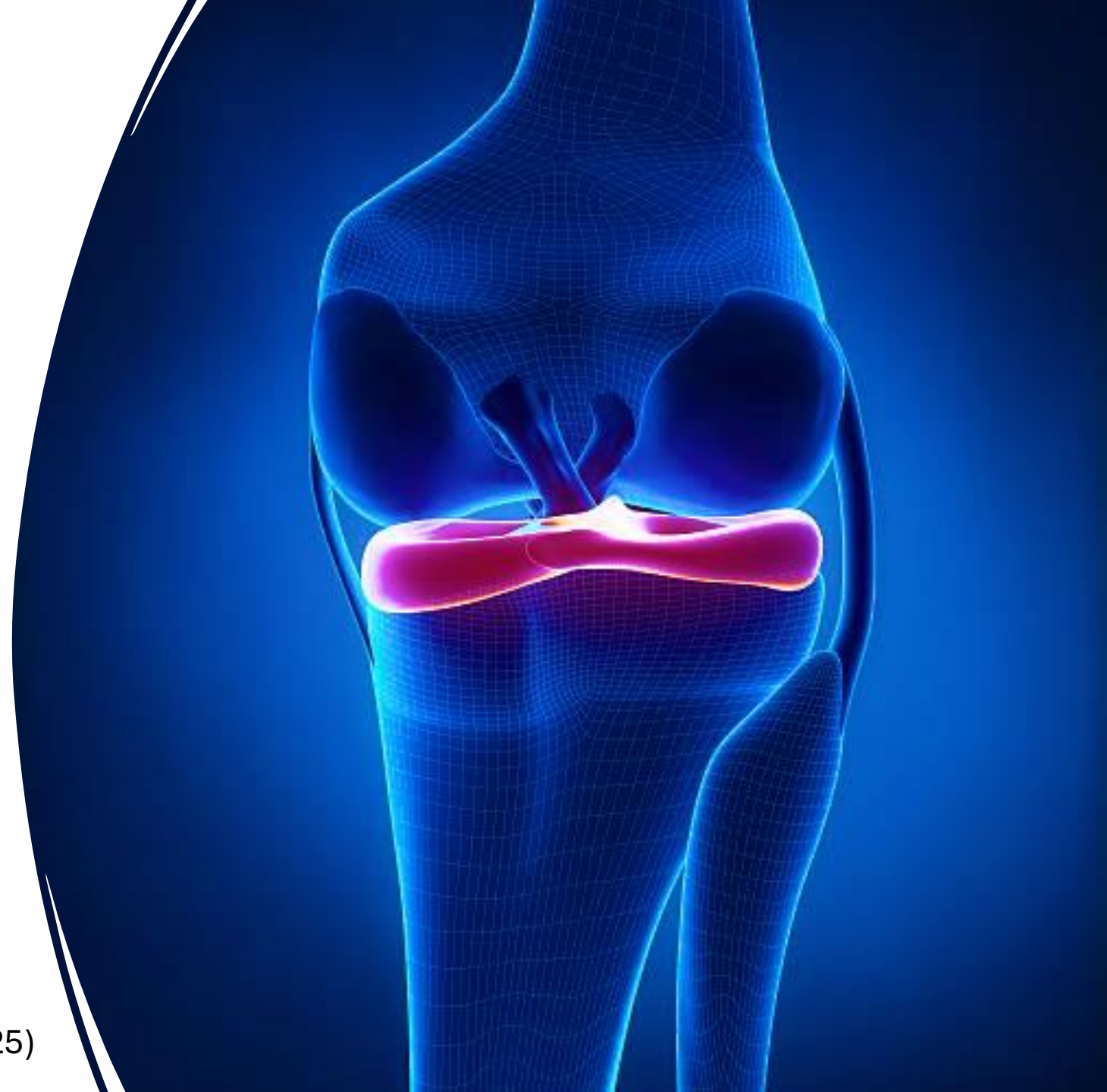
- Stage = Remodeling Phase
- Reps = 4x8
- Why = Sagittal loading
- Regression = Static lunge
- Progression = Increase depth



Programming & Management

- Rehab days alternate with recovery
- Load increased gradually
- Weight-bearing progressed as tolerated

(Pujol et al., 2025)



Surgical & Conservative Options

- Surgical - Meniscal Repairs
 - Partial
- Meniscectomy
- Conservative - Load management
 - Strength & neuromuscular rehab

(Islam et al., 2024)



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Incomplete meniscal healing in early second-look arthroscopy does not necessarily indicate long-term failure: Assessment of phases of meniscal healing. *International Orthopaedics*, 47(10), pp. 2401–2410.