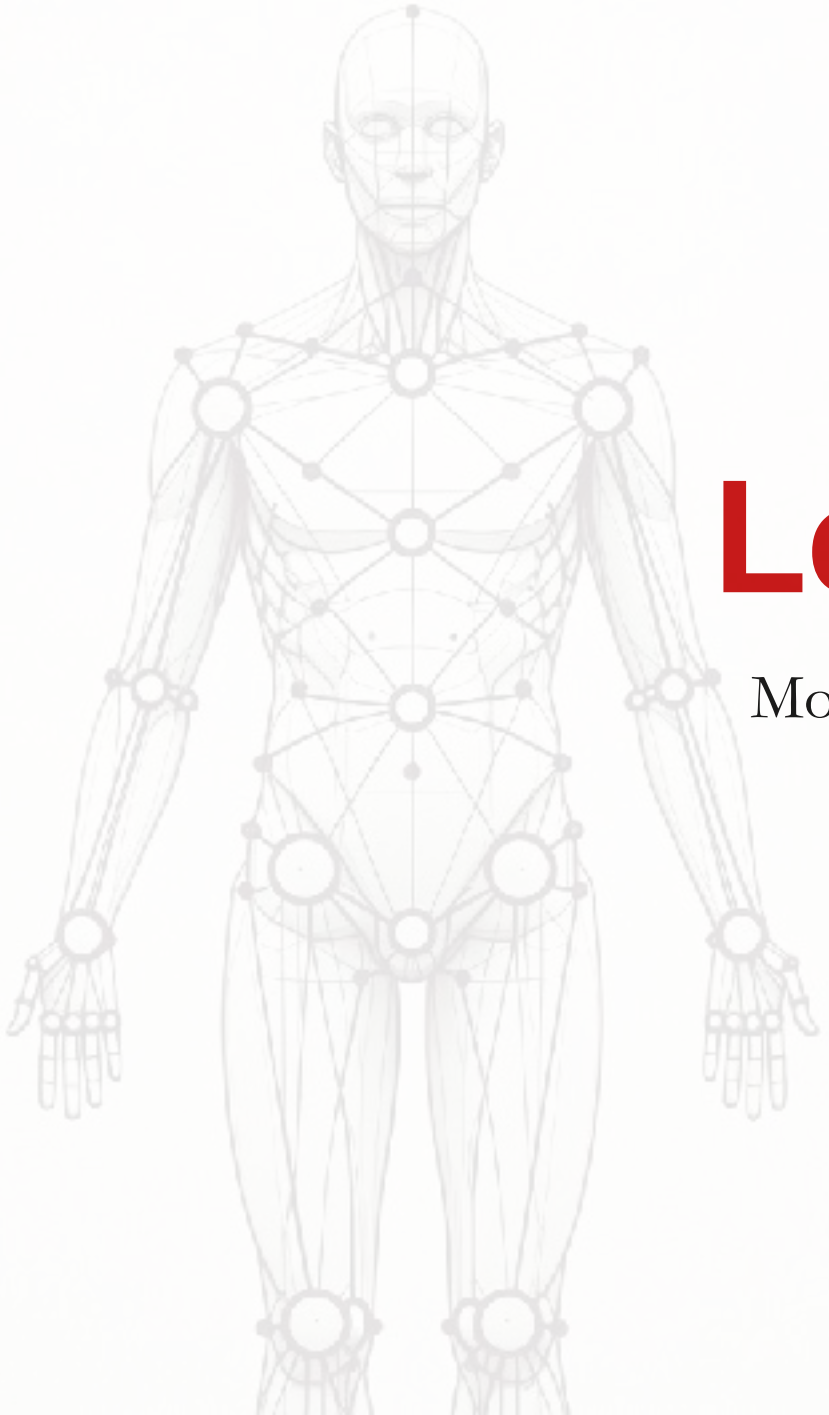
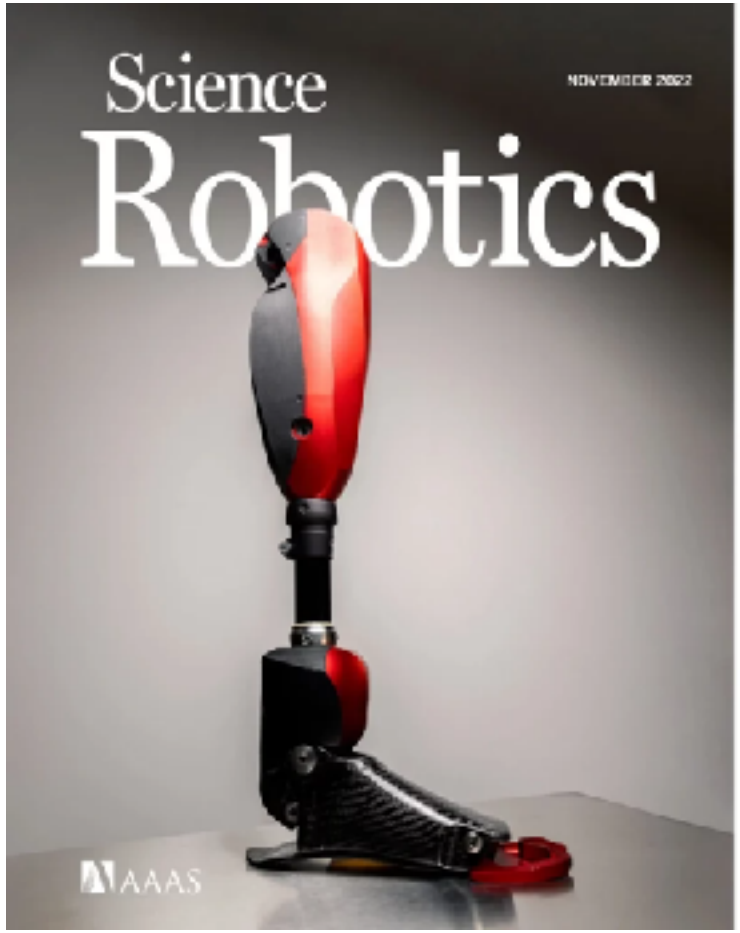
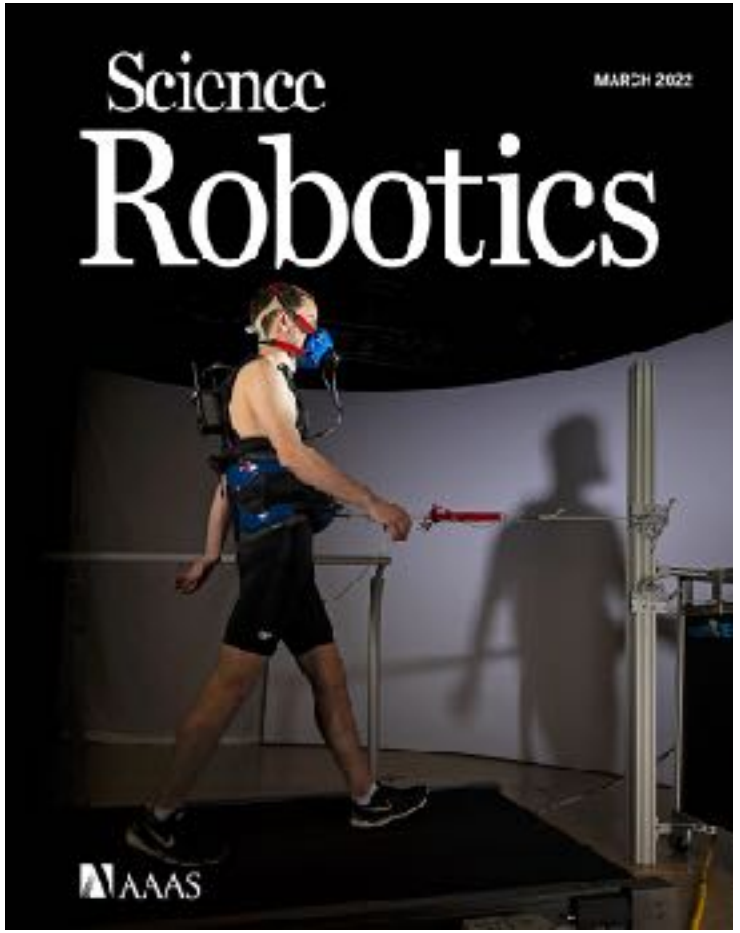


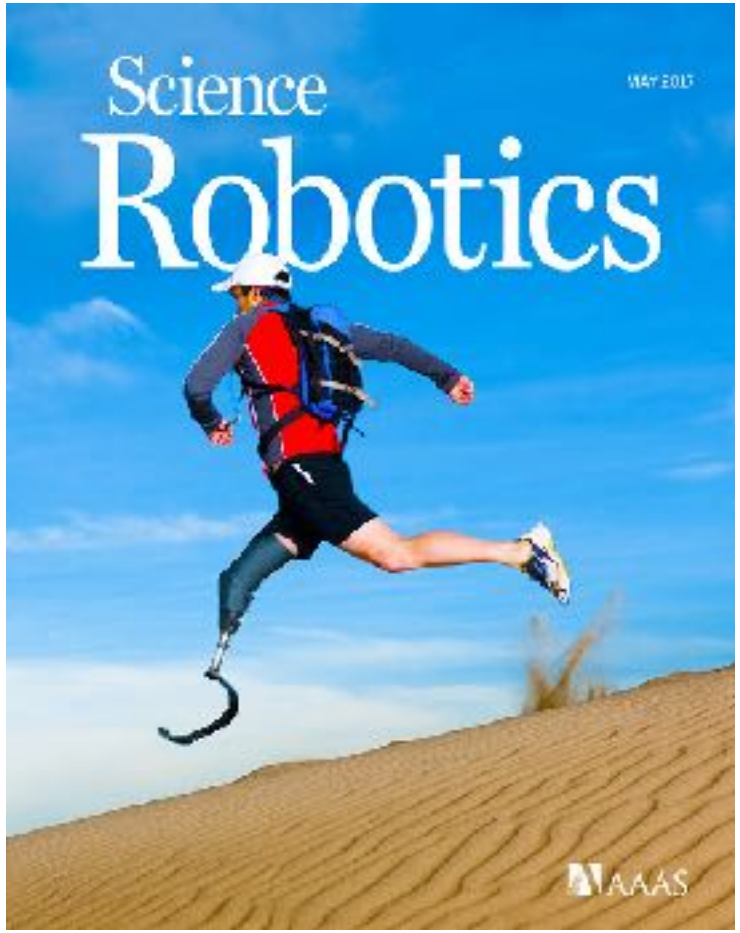
Lecture 1

Monday January 8th 2024

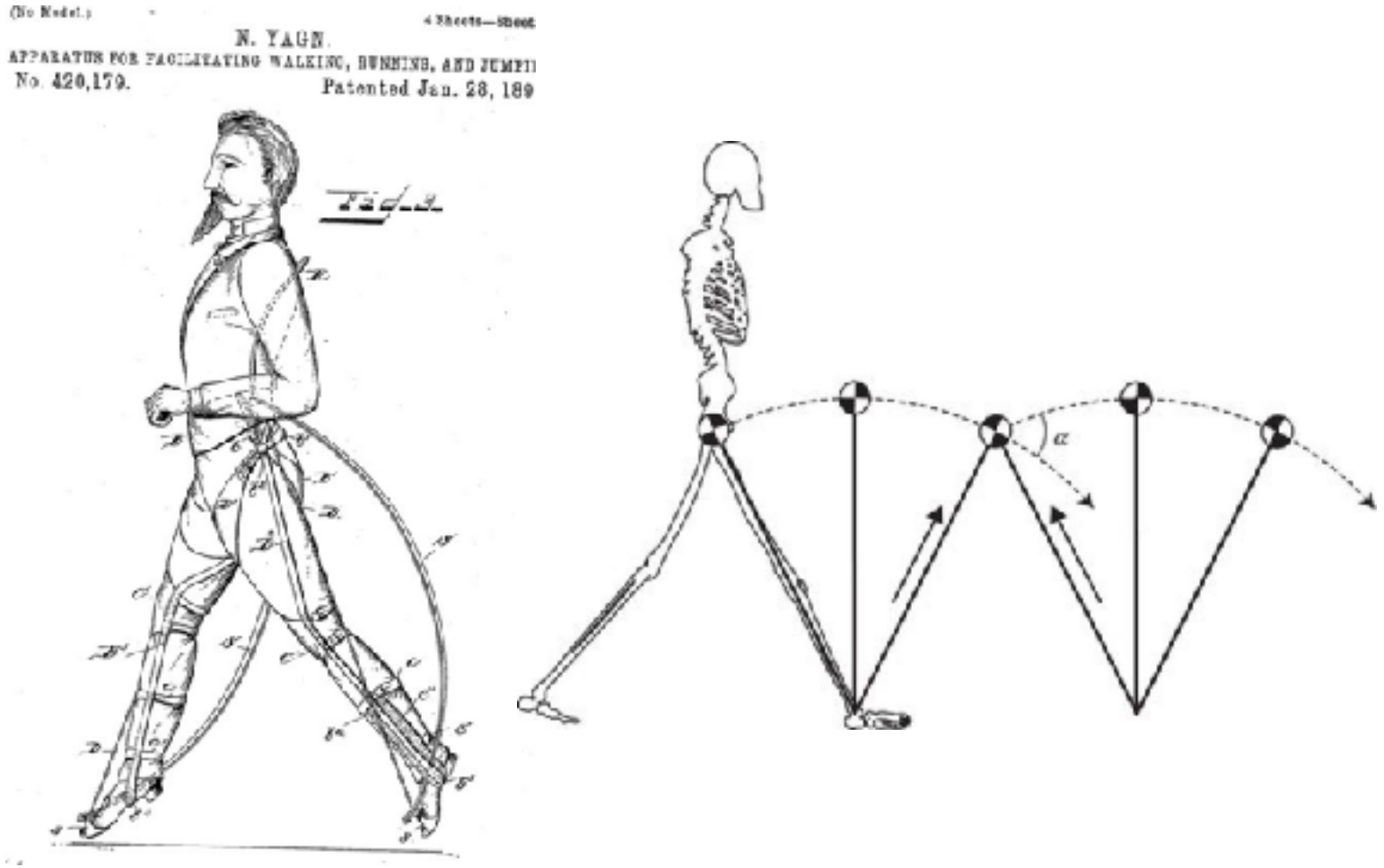
Welcome to BMEG 330 | Biomechanics II





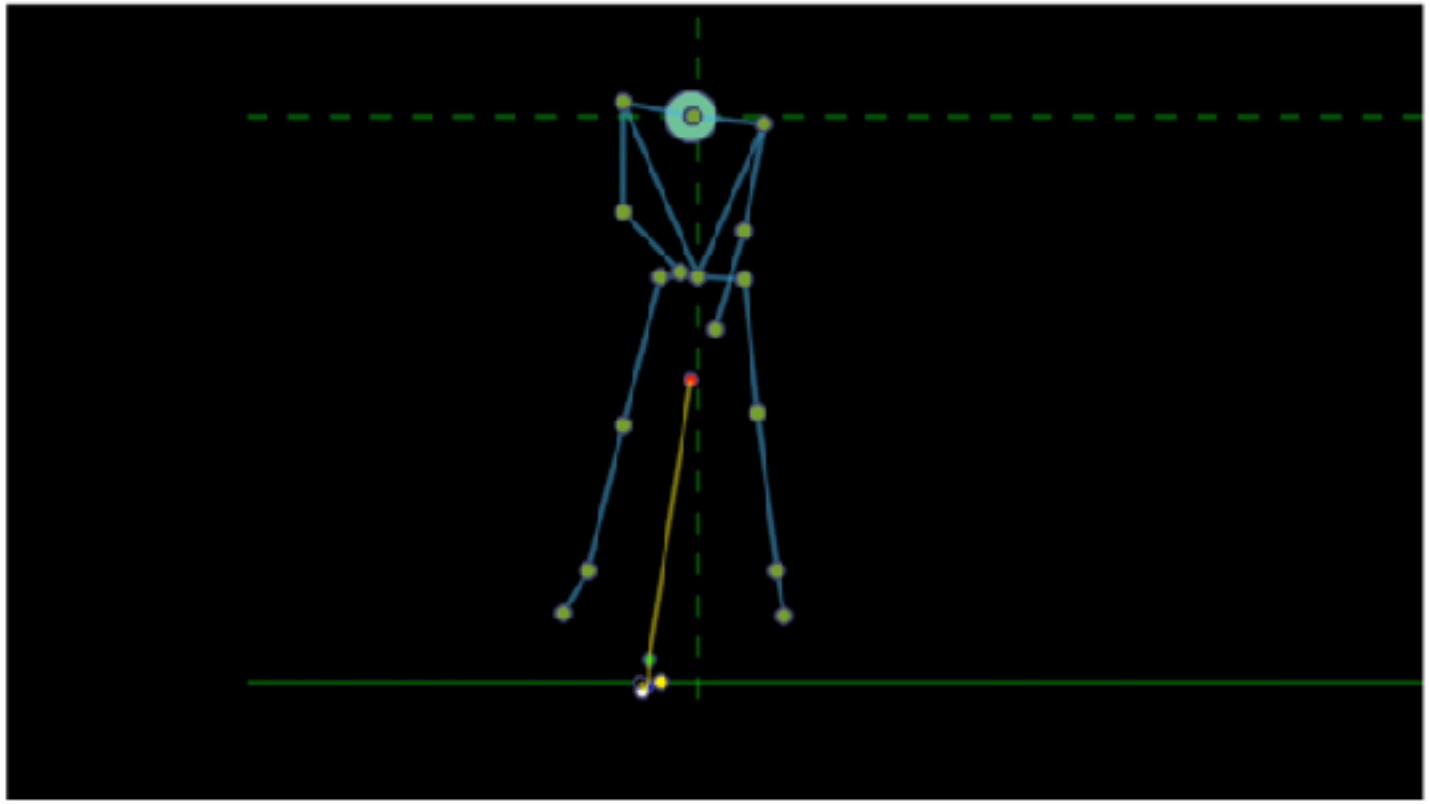


Why I love biomechanics



Why I love biomechanics

Why I love biomechanics



Careers in Biomechanics

1.Wearables Engineer
2.Researcher in Biomechanics
3.Orthopedic Product Designer
4.Sports Equipment Designer
5.Clinical Biomechanist
6.Prosthetics and Orthotics Specialist
7.Ergonomics Consultant
8.Biomechanical Testing Engineer
9.Human Factors Engineer
10.Biomechanics Consultant
11.Sports Biomechanist
12.Gait Analyst
13.Biomechanical Modeling Specialist
14.Medical Device Engineer (with a focus on biomechanical devices)
15.Rehabilitation Engineer
16.Biomechanics Professor or Educator
17.Medicine
18.Programming


Bionic
Power


BROOKS


WEARTECH
LABS


WHOOP


PUMA


FORM


lab


QUALISYS
Motion Capture Systems


The
Moonshot
Factory


plantiga

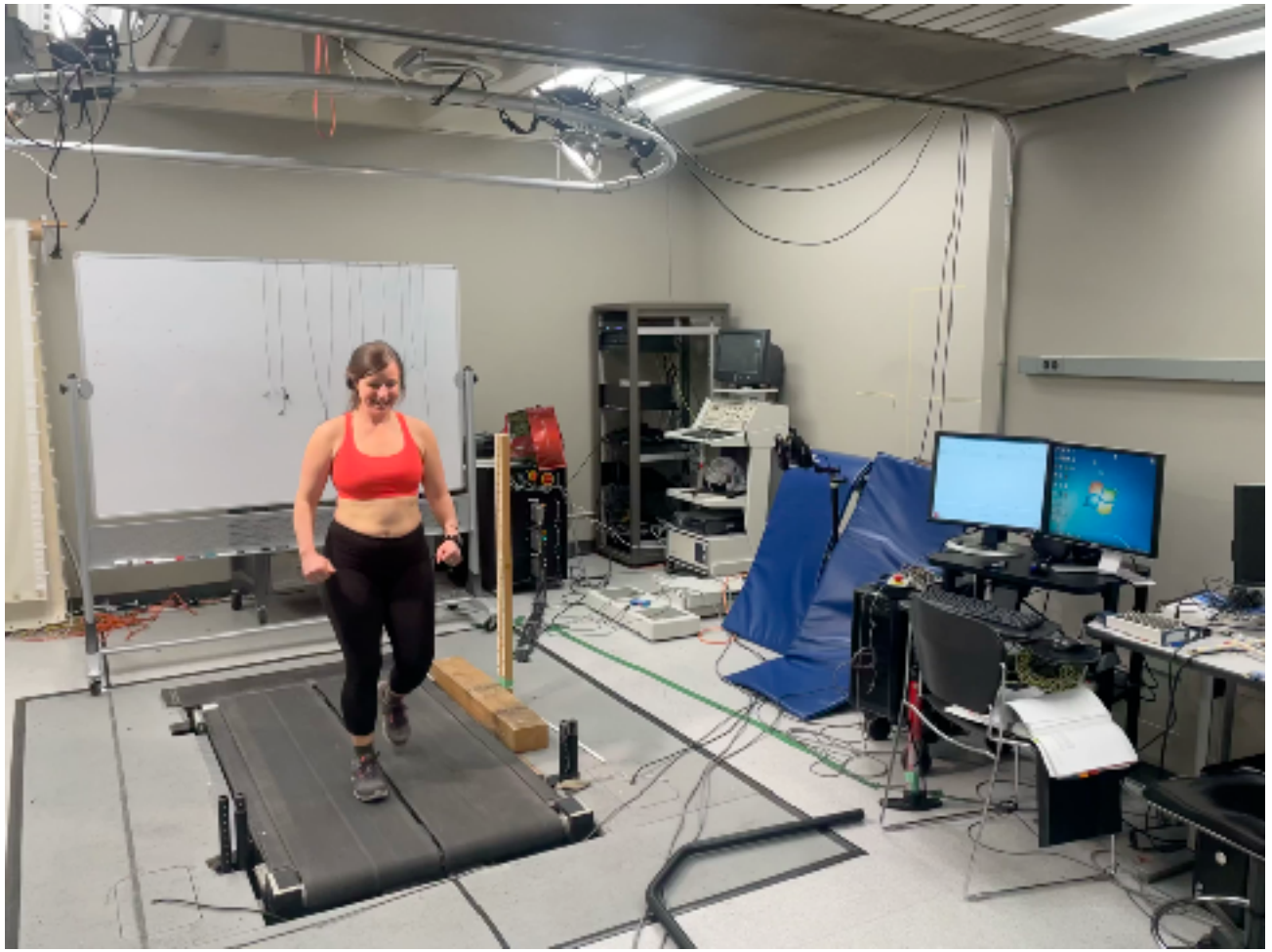

FACEBOOK
REALITY LABS


DELSYS


THEIA
Markerless

How I will strive to serve you..

1. Develop great content to motivate you to learn and think beyond
2. Encourage first principles thinking
3. Navigating a biomechanics lab
4. Give you a skillset that well prepares you for for the world of biomechanics and bio-mech-engineering
5. Inspire you to push outside your comfort zone!
6. Hands on material.



Get organized it takes time

- Summer internships (industry or academic) start looking now
- Talk to people like me
- Email people
- Get a LinkedIn profile
- If wanting to start a company start getting organized and look for summer programs that actually pay you to to this!
- Follow your dreams and enjoy life along the way

Course Breakdown

1. Balancing between individual and group evaluations.

2. Team work is part of any engineering endeavor so working in group is a skill

3. Everyone is here to succeed and learn. Lets support each other on this journey so we can all reach for our goals.

Evaluation Method	Percentage of Final Grade
Pilot Project | *Group*	**20%+1% bonus**
Assignments x3 *Individual*	**10%**
Hands on Labs *Group*	**20%**
In Class Activities	**5%**
Biomechanics Journal Club *Group*	**5%**
Midterm Exam *Individual*	**15%**
Final Exam *Individual*	**25%**
TOTAL	**101%**

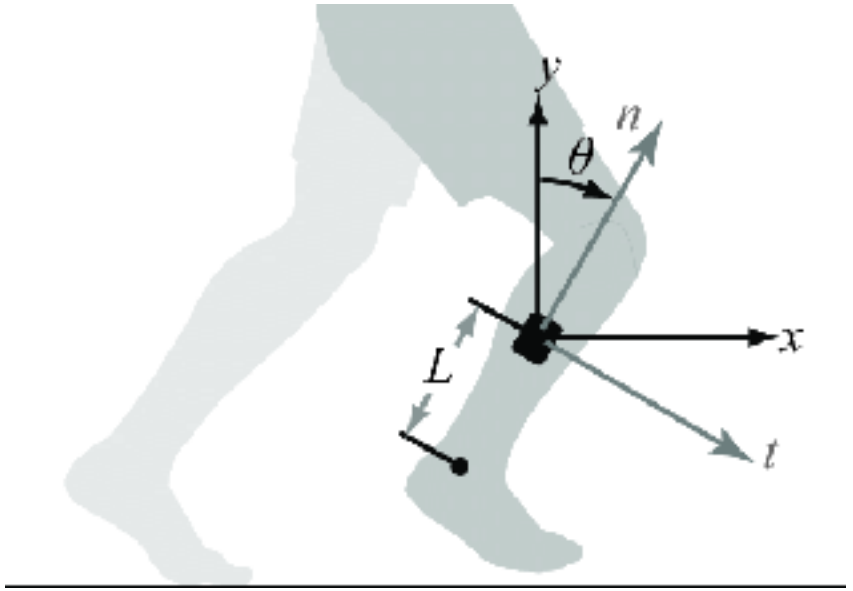
First 6 weeks look roughly like this

		Monday's | Wesbrook Lab 10-12pm	Monday Lecture 1-2pm	Wednesday Lecture 1-2pm	Friday Lecture 1-2pm
Week	Week Start	Labs/Tutorial	Lecture	Lecture	Lecture
1	8-Jan-24	----	Intro / Programming / Writing		Review of External Forces and Kinematics
2	15-Jan-24	Lab 1 # Balance Lab	Centre of Pressure / Balance Control		2D Kinematics Review
3	22-Jan-24	OPEN LAB MATLAB | PROJECT ASSIGNEMENT | WORK HOURS	Gait Cycles | Intro to 3D kinematics		
4	29-Jan-24	Lab # 2 Kinematics Lab	Hip Joint	3D Kinematics	3D Kinematics
5	5 Feb 24	OPEN LAB MATLAB | PROJECT ASSIGNEMENT | WORK HOURS	3D Kinematics	Knee Joint	Guest : Emily Bliven PhD Candidate
6	12-Feb-24	Lab #3 Gait Lab	Journal Club | Attendance Required | Wesbrook	3D Kinematics	Ankle Joint
7	19 Feb 24	Reading Week			

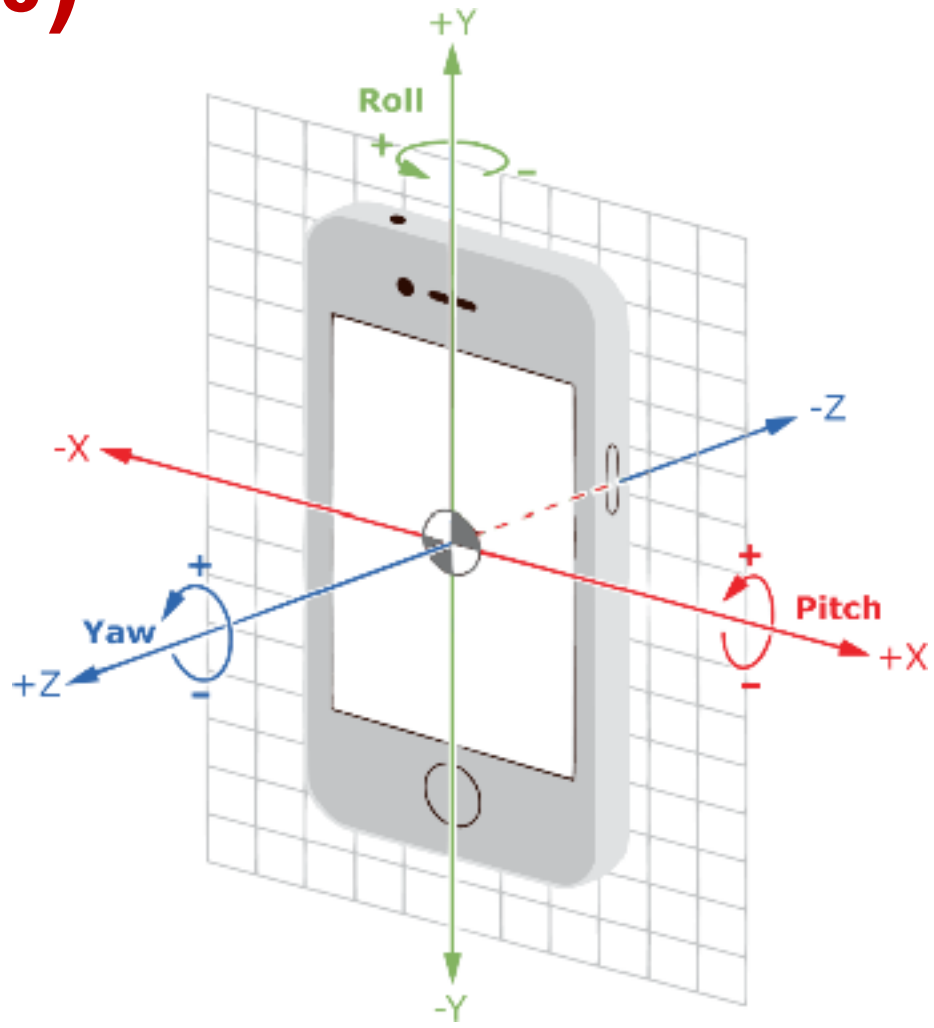
Project (20%)

In this pilot project, you'll work in a team and use your smartphones to study and understand how people move. You'll pick a movement or activity, record data with your phone, and then analyze the data to make biomechanical conclusions. After you analyze the data, you'll share your work with the class.

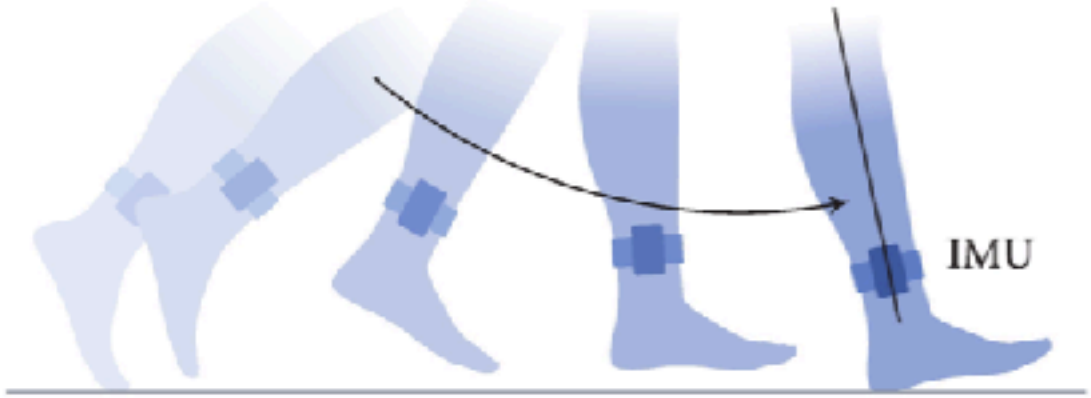
You'll use what you learned to conceptualize sensors that can track movements for biomechanics. This is your chance to come up with ideas and think outside the box.



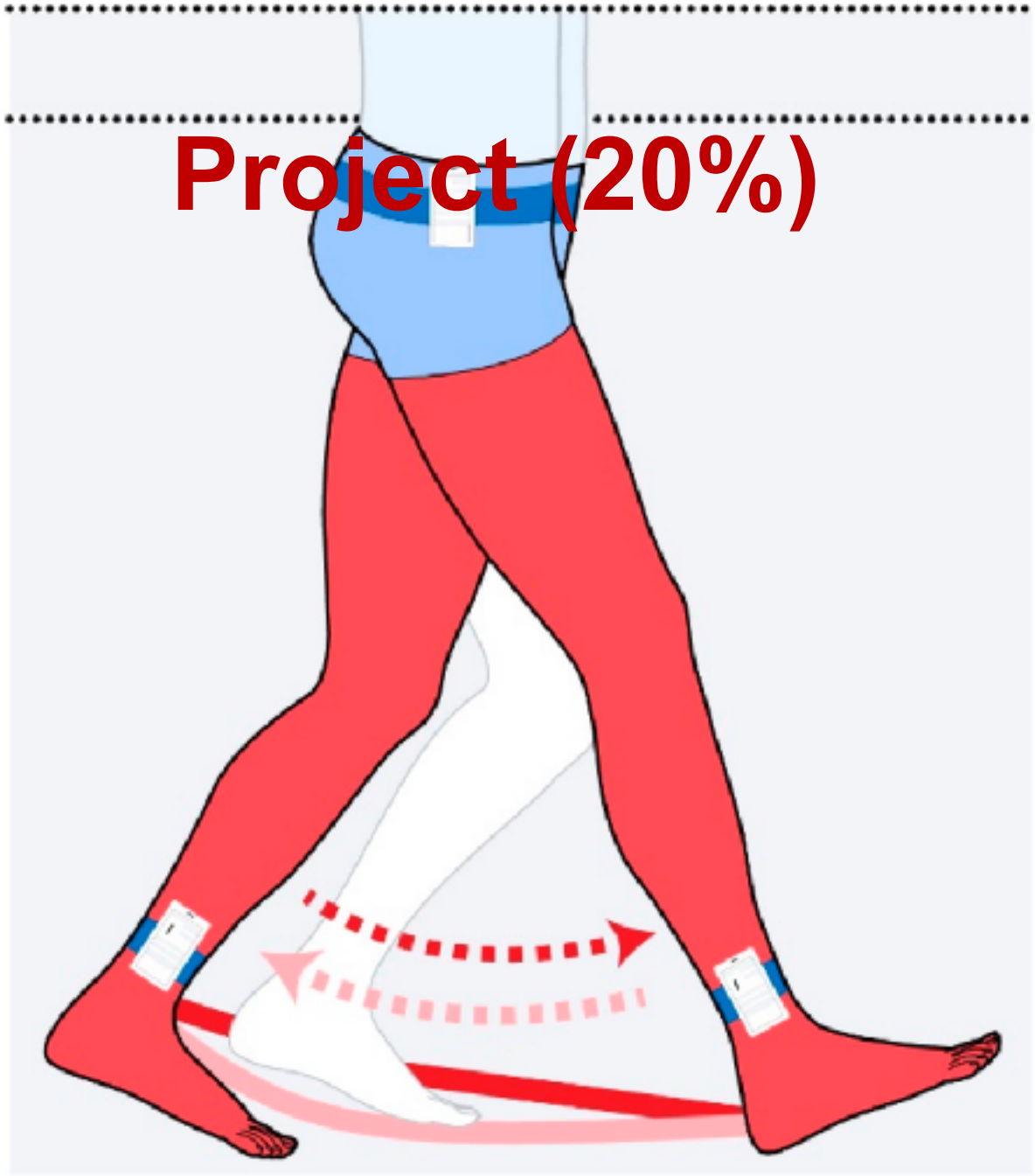
Project (20%)

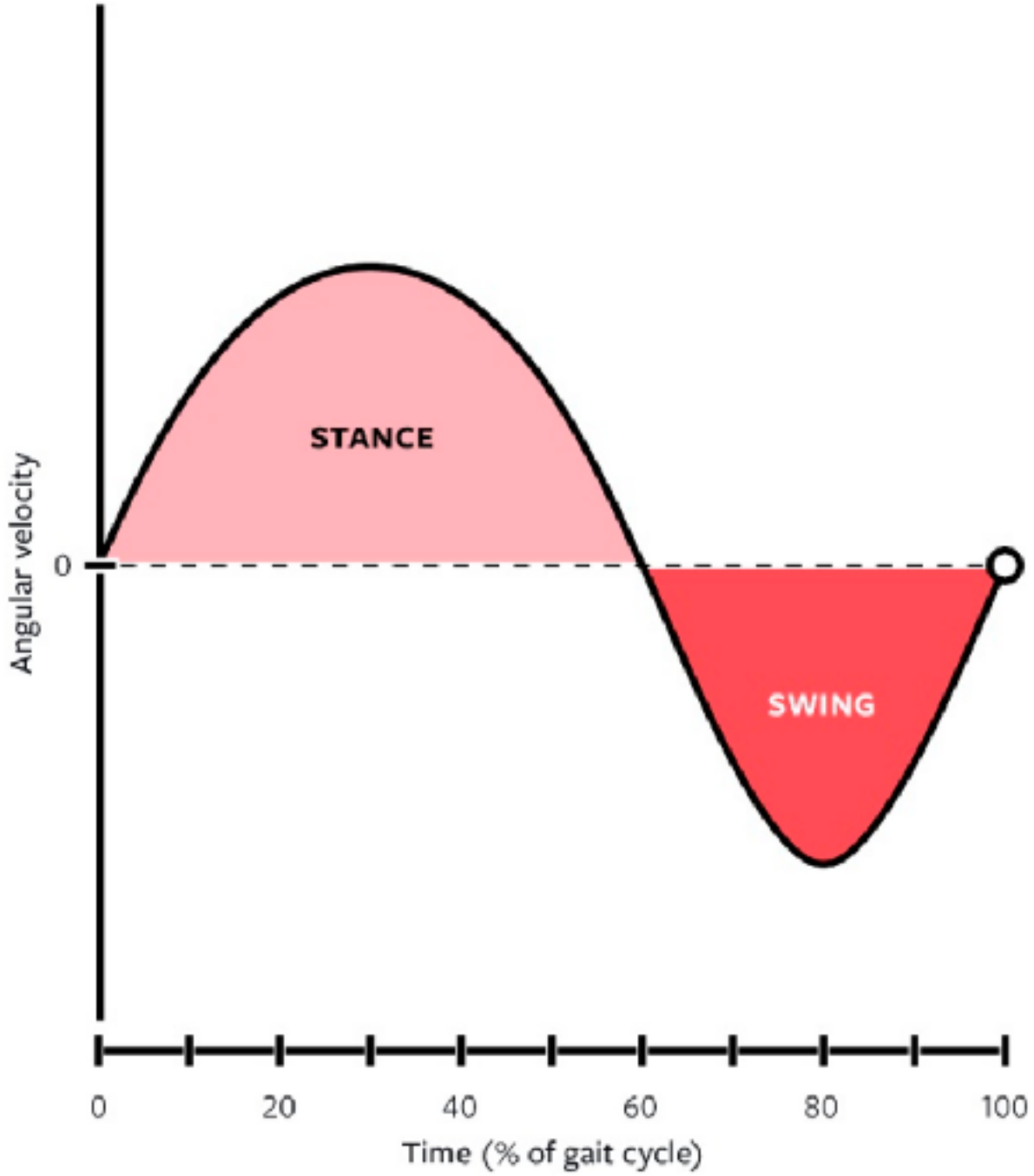


Project (20%)

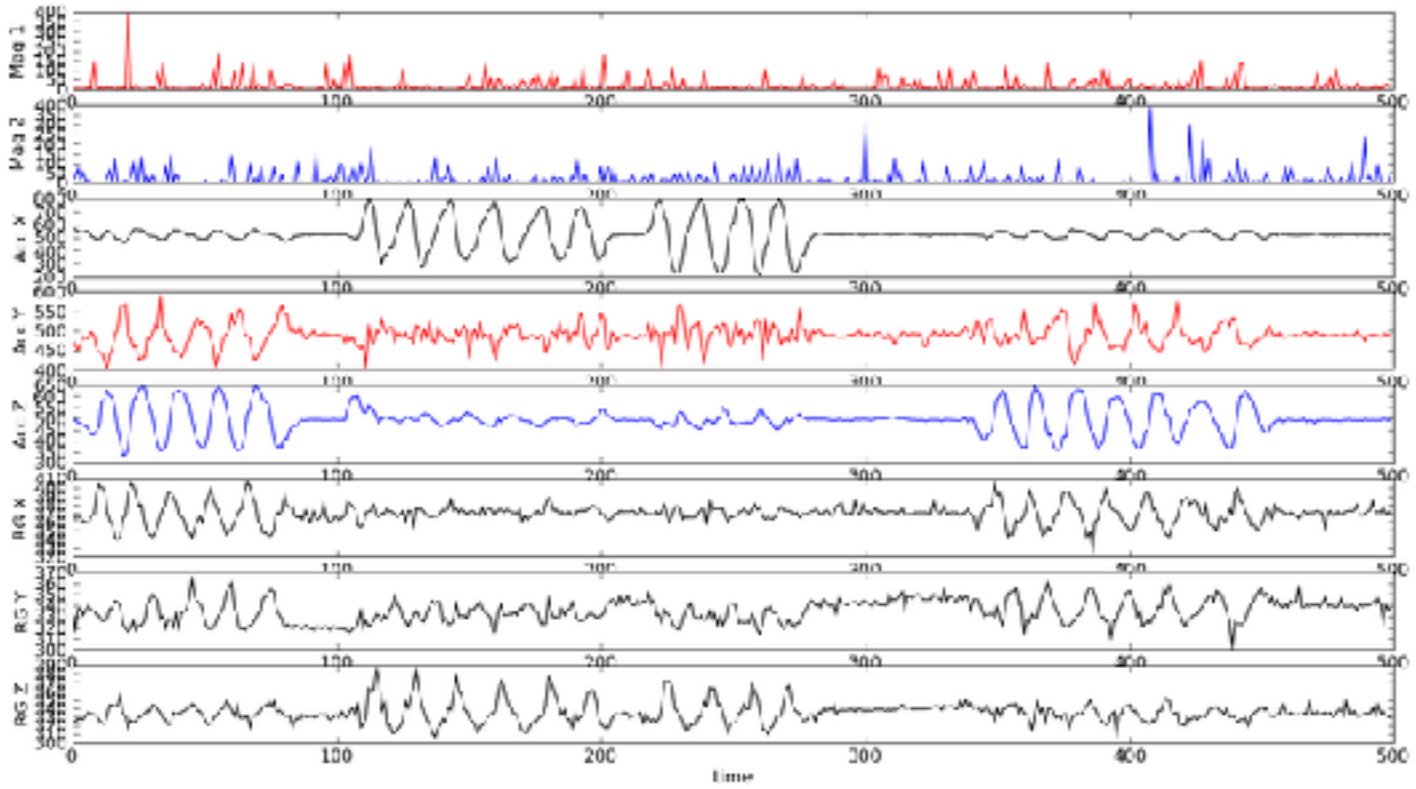


Project (20%)




STANCE
SWING
Angular velocity
0
0
20
40
60
80
100
Time (% of gait cycle)

Project (20%)



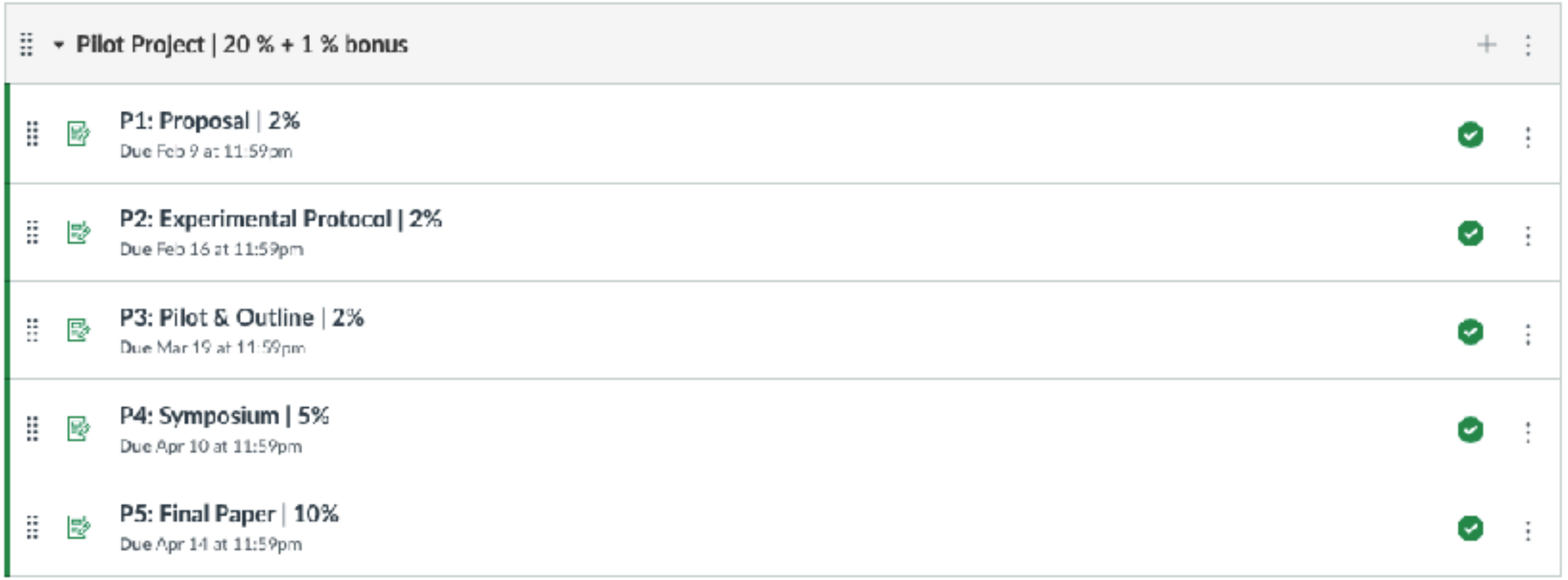
Project (20%)

You can sign up and choose your own group to work with for this project.

I will sent the sign up sheet this week via an announcement shortly.

Project will be done in teams of 2-3 individuals.

Project (20%)


Pilot Project | 20 % + 1 % bonus
P1: Proposal | 2%
Due Feb 9 at 11:59pm
P2: Experimental Protocol | 2%
Due Feb 16 at 11:59pm
P3: Pilot & Outline | 2%
Due Mar 19 at 11:59pm
P4: Symposium | 5%
Due Apr 10 at 11:59pm
P5: Final Paper | 10%
Due Apr 14 at 11:59pm

Journal Club (5%)

4 in total throughout the semester . You will present in ¼. Attendance will be required to all of these though. Peer evaluated

Week 6	Lecture Slot	50 min
Week 10	Tutorial Slot	~70 min
Week 11	Lecture Slot	50 min
Week 3	Tutorial Slot	~70 min

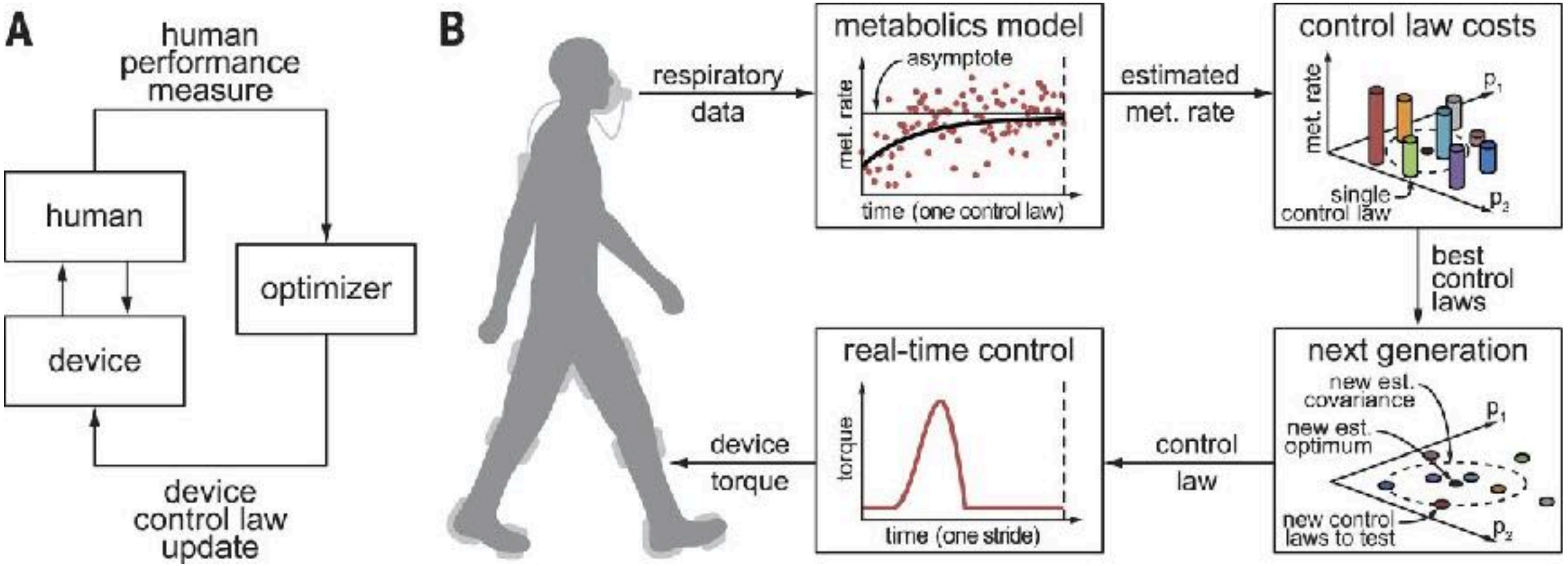
Each JC will have a high level theme. We will discuss a few papers during each JC where you will lead the discussions and presentations of the papers.

Journal Club (5%)

*Tentative themes include (but may change as we progress and specific interests emerge)

1. Augmentation of biological movement
2. Human in the loop experimentation
3. The importance of modelling
4. In the wild data collections and the future of biomechanics

Journal Club (5%)



Labs (20%)

4 hands on experiment based labs
*groups will be randomly generated for each lab to encourage working with new people

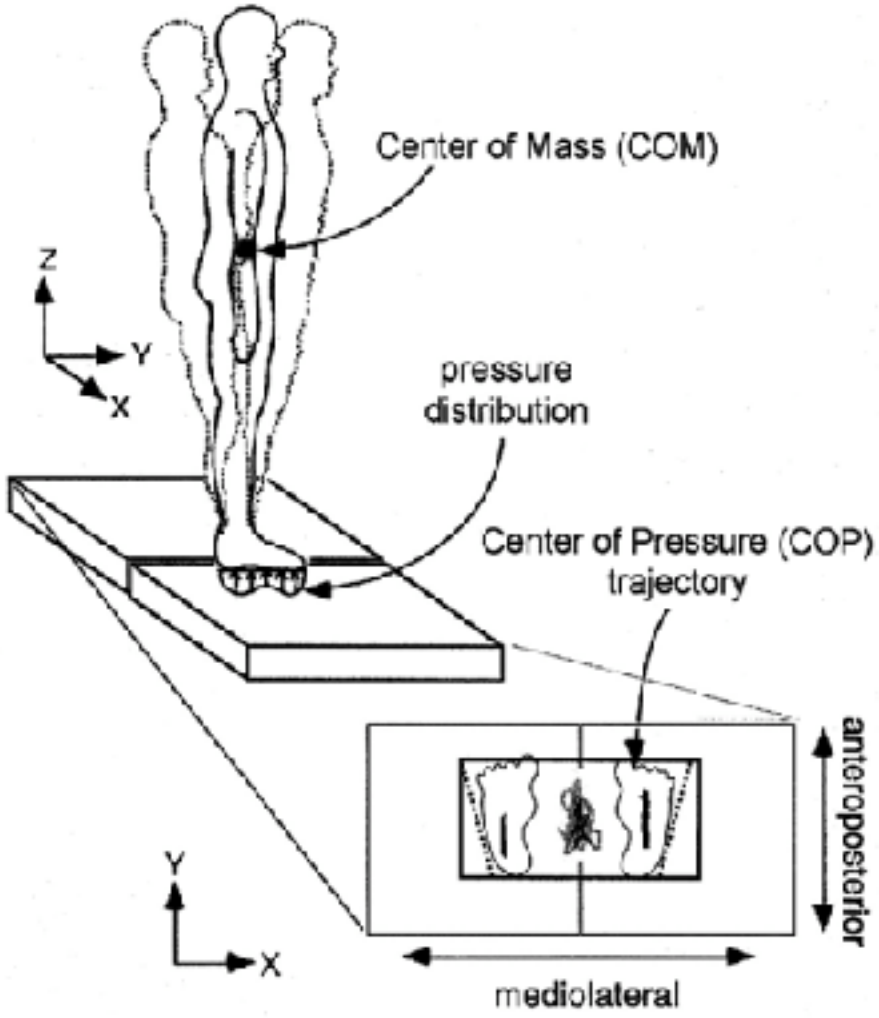
Lab 1 | Week 2 | Jan 15th | Balance Control | ~**Due Feb 2nd**

Lab 2 | Week 4 | Jan 29th | 3D Kinematics | ~**Due Feb 19th**

Lab 3 | Week 6 | Feb 12th | Gait Mechanics | ~**Due March 13th**

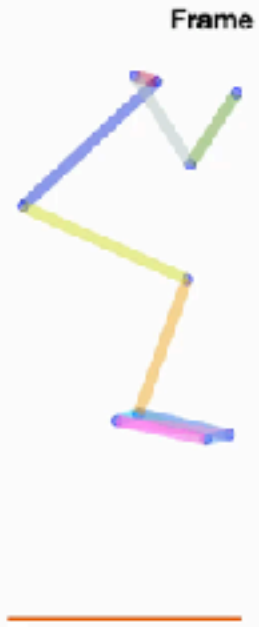
Lab 4 | Week 11 | March 18th | Muscle Modelling | ~**Due April 5th**

Lab #1 Balance Control Lab



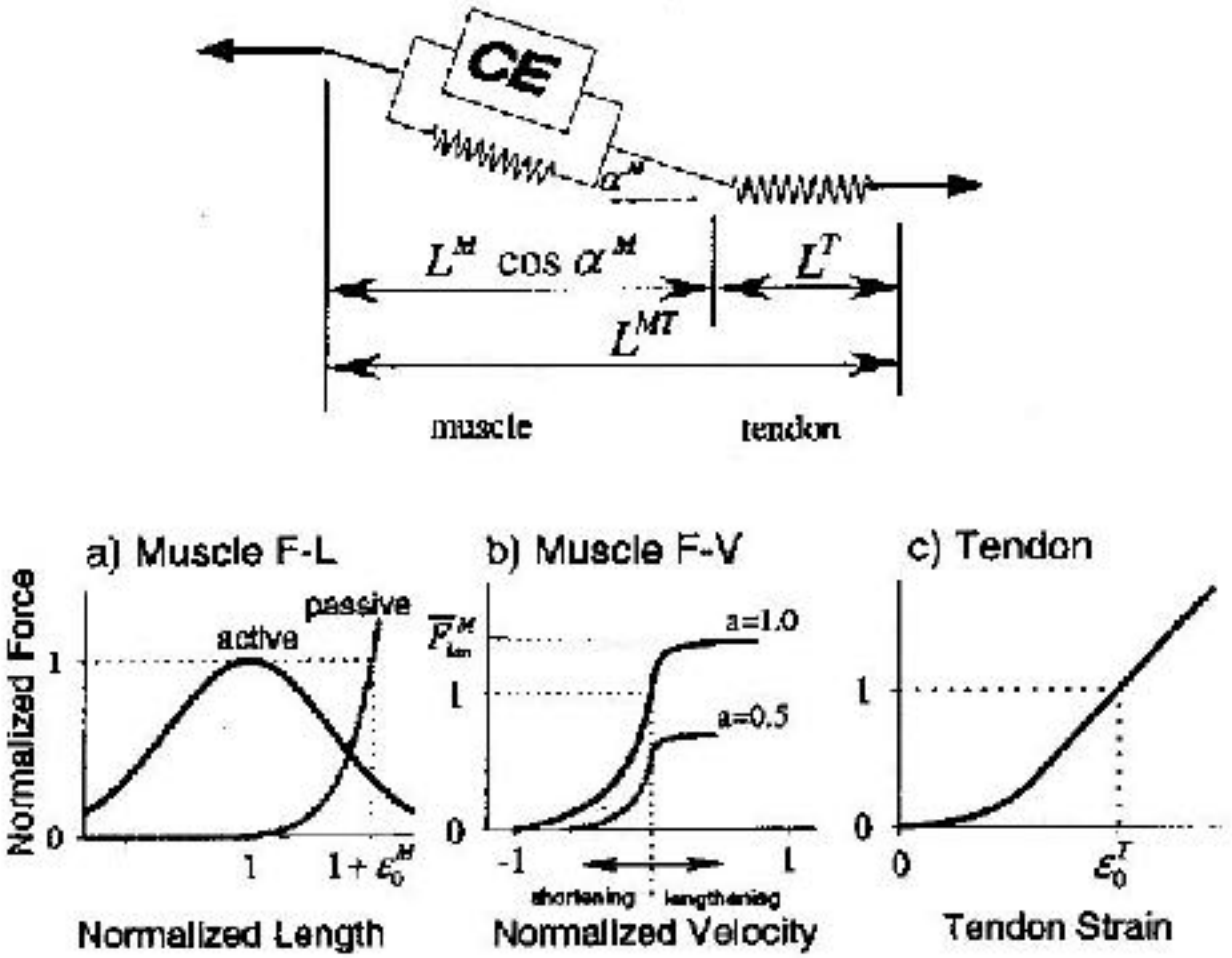
Lab #2 3D Kinematics Lab*

* Will likely be a cycling related lab TBD

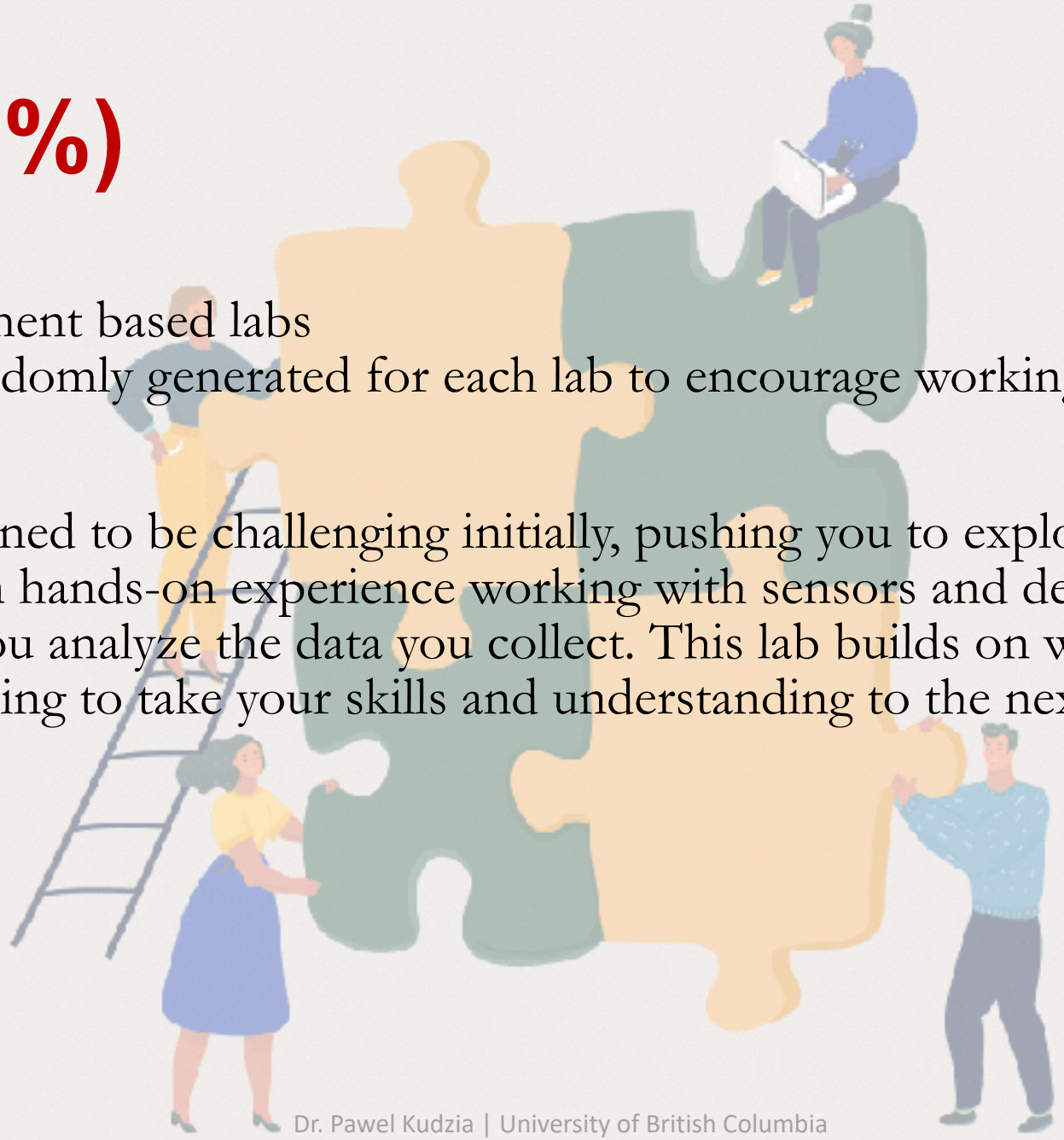


Lab #3 Gait Lab

Lab #4 Muscle Mechanics **



Labs (20%)

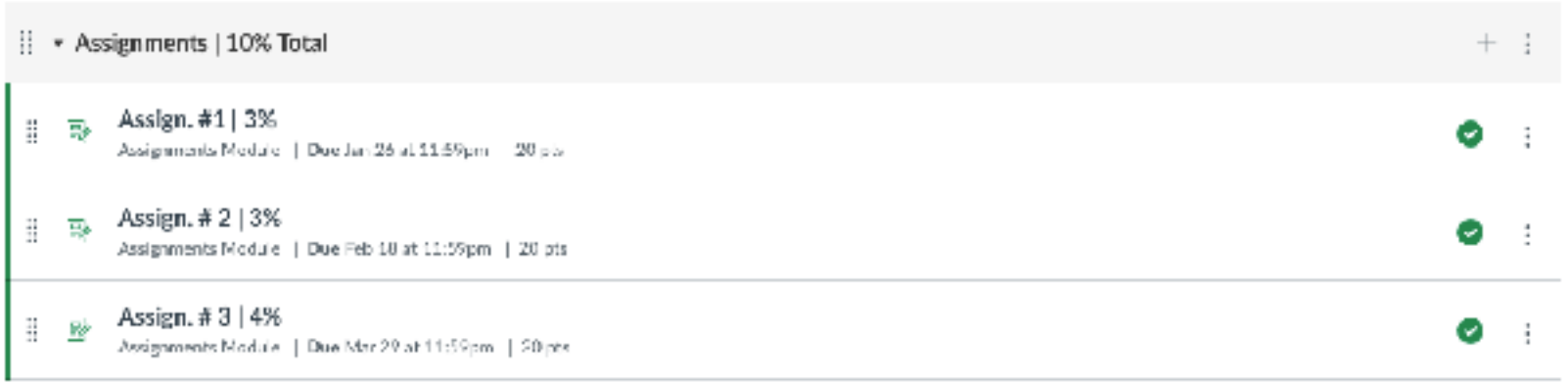


4 hands on experiment based labs
*groups will be randomly generated for each lab to encourage working with new people

These lab are designed to be challenging initially, pushing you to explore and problem-solve. You will gain hands-on experience working with sensors and develop critical thinking skills as you analyze the data you collect. This lab builds on what you've learned in BMEG 230, aiming to take your skills and understanding to the next level.

Assignments (10%)

Meant to challenge you and reinforce the ideas and concepts. Will be data oriented requiring some programming in some capacity.

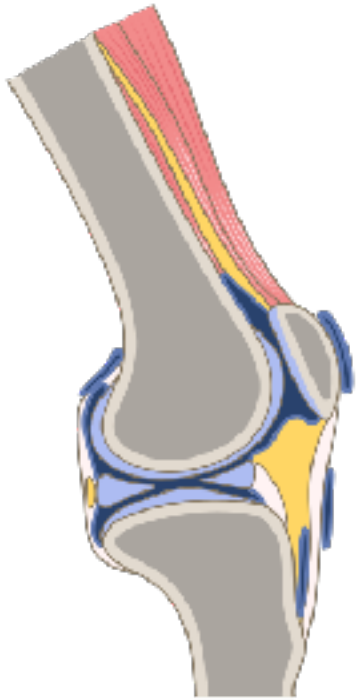


Assignments (10%)

Meant to challenge you and reinforce the ideas and concepts. Will be data oriented requiring some programming in some capacity.

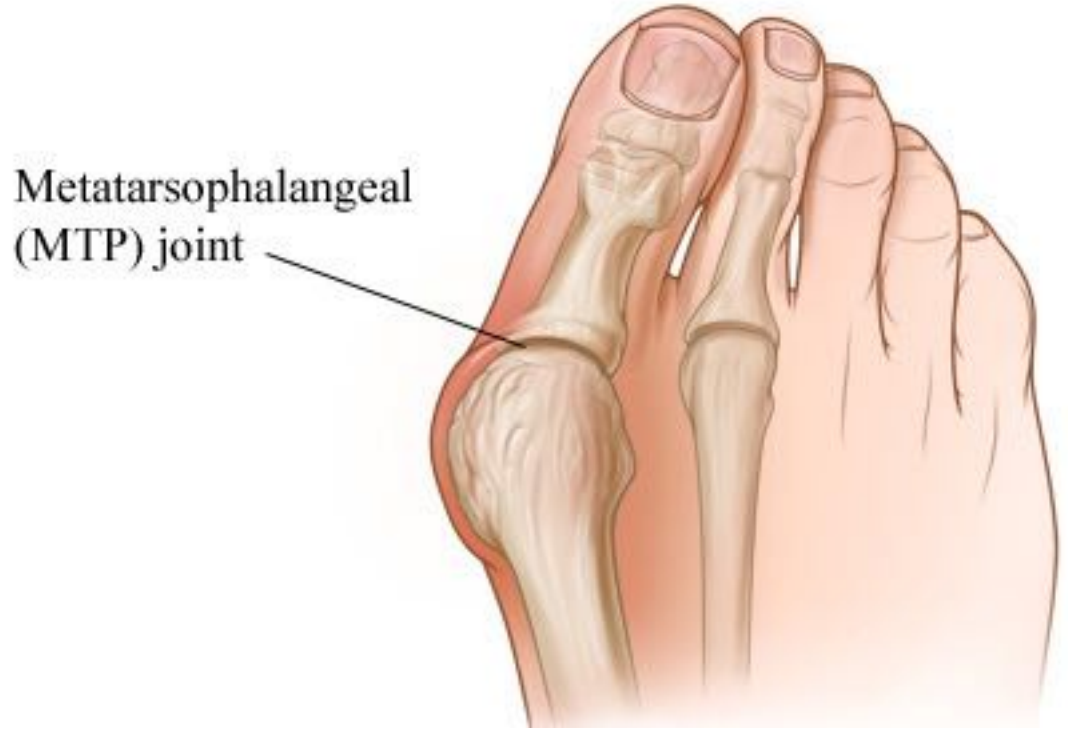
Anatomy of a Joint (Class Activities)

The structures and functions of the lower limb are very diverse and highly specialized. A firm knowledge of anatomy and physiology of the lower limb, and how these structures work together to facilitate motion is essential for any biomedical engineer/ bio-mechanist.



Anatomy of Joint (5%)

- Hip
- Knee
- Ankle
- MTP
- Glenohumeral



Anatomy of Joint (5%)

- In teams you will present a 10 minute presentation on the structure and function of the joint you have chosen. Teams will be formed based on interest in a specific joint.
- Each joint will have two teams working on presenting different aspects of the joint.

  Deliverables will be:
  - Group presentation during lecture slot (3%)
  - A hand out for the class that will be used as a study guide for midterm/exam (2%)

For example hip joint

Team 1 l Mechanics

Bone anatomy review: Begin with a thorough review of the bone anatomy involved in the hip joint, including the pelvis and femur, highlighting key anatomical landmarks at the hip.
3D range of motion: Research and present a detailed 3D range of motion (ROM) analysis during a typical full walking gait cycle. This should include not just the movements (flexion, extension, abduction, adduction, and rotation) but also quantify the degree of each motion. Include a detailed table in your handout for clear reference
Biomechanics: Overview the axes of rotation and rotation centers of this joint
Influencing factors: Discuss factors influencing hip joint mechanics, such as femur orientation, pelvic tilt, and acetabular depth. Explain how these factors contribute to stability and movement.
Age-Related Changes: Present a brief yet insightful overview of how movement mechanics in the hip joint change with age, focusing on common age-related conditions like osteoarthritis.

For example hip joint

Team 2 I Tissues

•**Ligaments**: Focus on the Acetabular Labrum and major ligaments (iliofemoral, pubofemoral, ischiofemoral). Try to find and present detailed information on their lengths, mechanical properties, and attachment points. Include visuals for better understanding.
•**Muscles :** Present any major muscles involved in the moment of the hip. Explain how activation of these muscles enable each specific movement (e.x. flexion extension , abduction adduction, rotation).
•**Moment arms:** Research and present detailed information on the moment arms of major hip muscles (such as the gluteus maximus and iliopsoas) during various 3D movements. Explain how these moment arms change with different hip positions. Focus on walking.
•**Articular Cartilage Analysis:** Provide an in-depth look at the mechanical properties of the acetabular cartilage, discussing its role in shock absorption and joint congruity.

Age-Related Changes: Briefly explore how hip tissues change with age, including common degenerative changes and a life time of wear.

Anatomy of Joint (5%)

Week 4 | Monday's lecture | Hip

Week 5 | Wednesday's lecture | Knee

Week 6 | Friday's lecture | Ankle

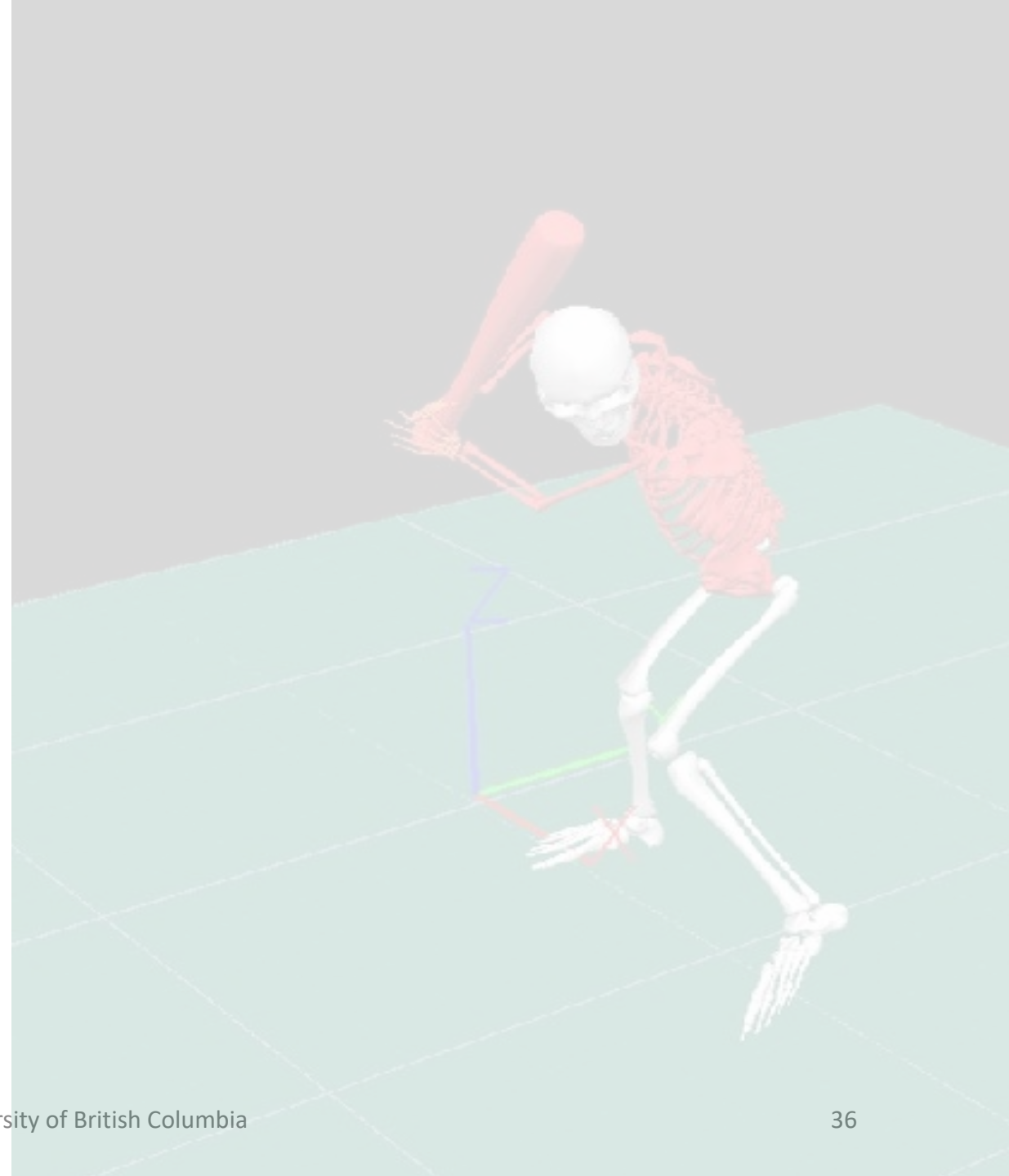
Week 10 | Friday's lecture | MTP

Week 6 | Friday's lecture | Glenohumeral

Midterm and Exam

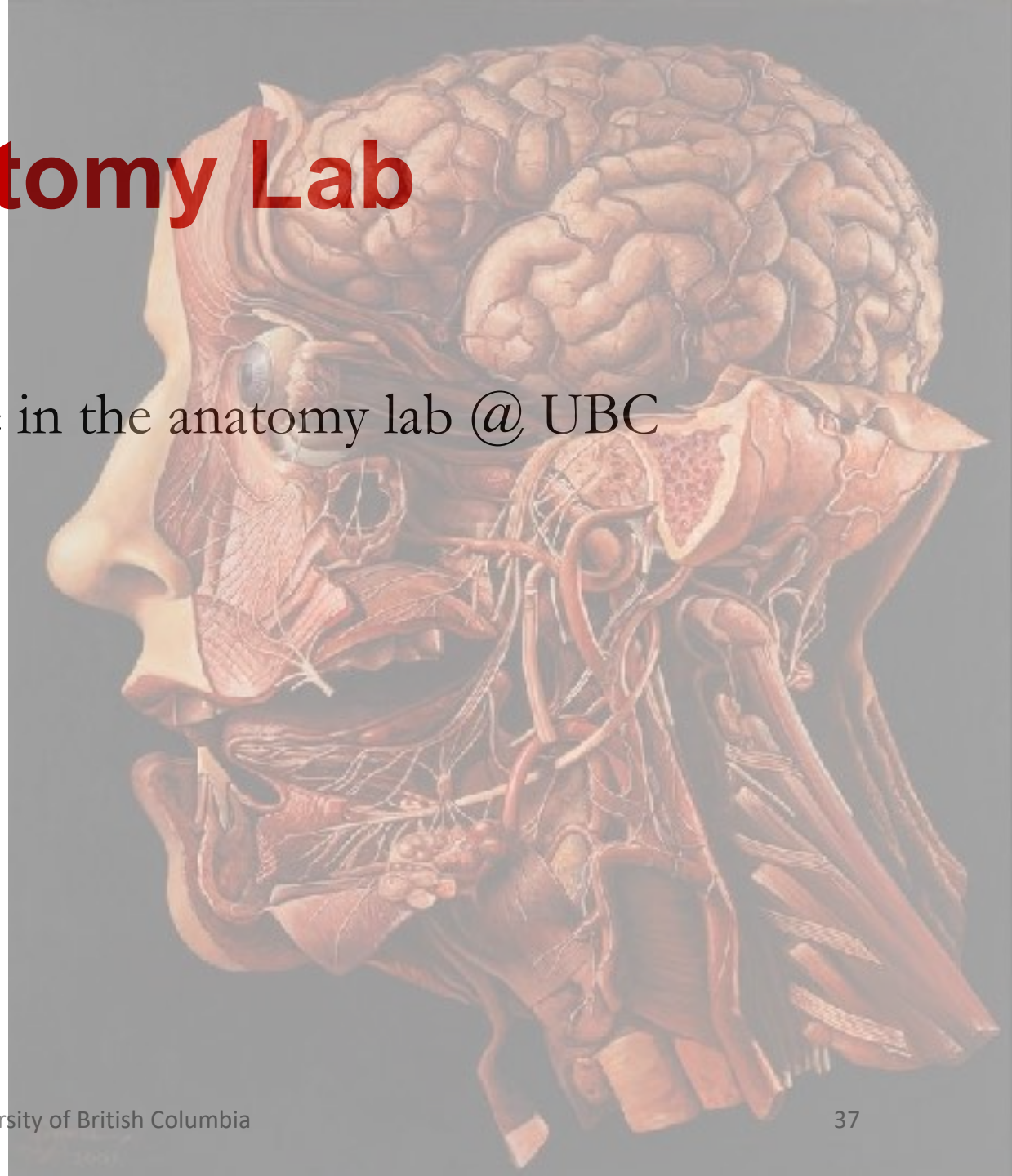
- Midterm (15%) Week 8 | Feb 26th during Monday's tutorial slot . Will cover what we did in course week 1-6.

- Exam (25%) TBD | Ill let you know as soon as I know the date promise!



Field Trip to the Anatomy Lab

- Save the date |Week 9 |
  Mondays tutorial on March 4th will be in the anatomy lab @ UBC

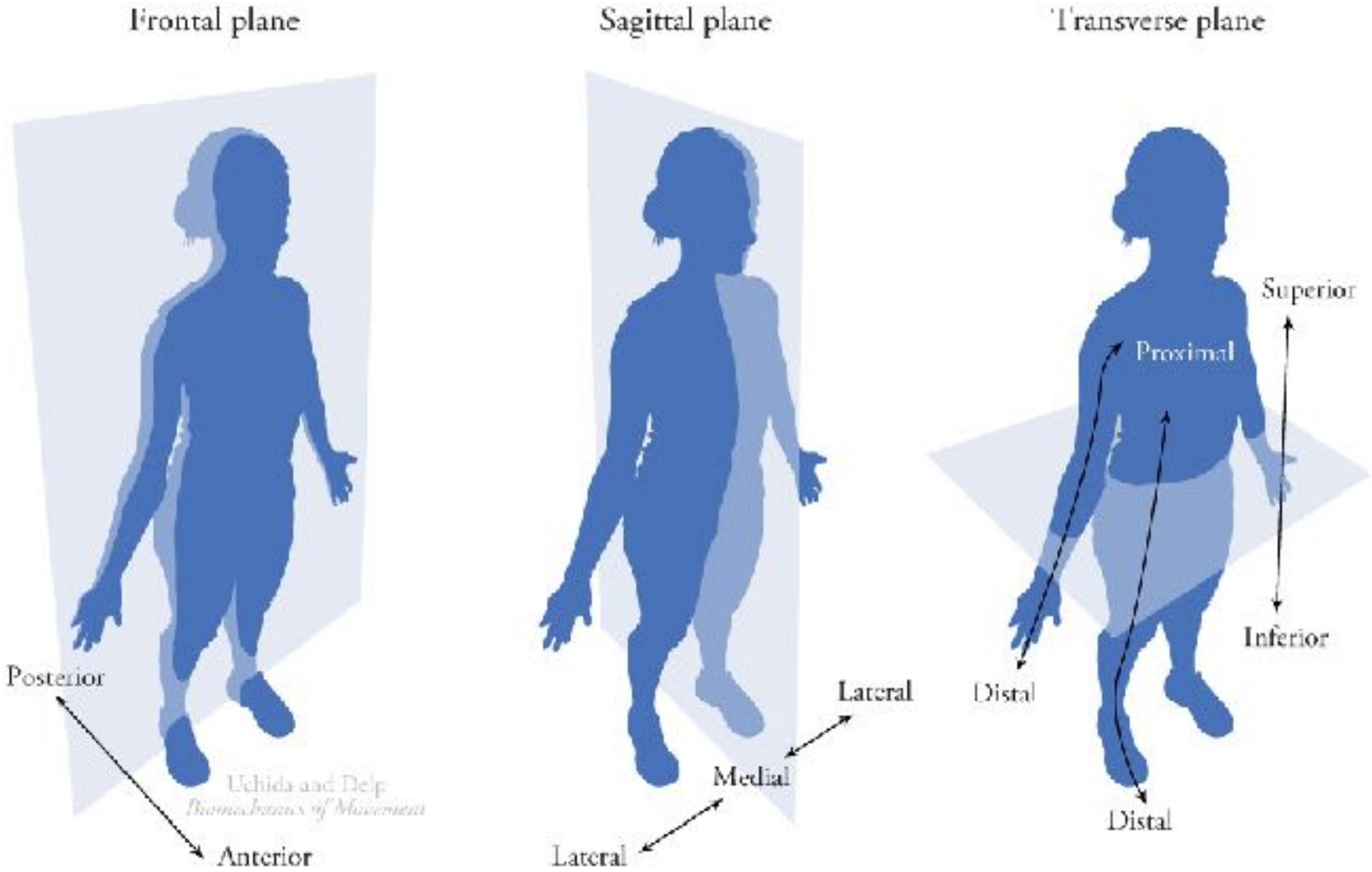


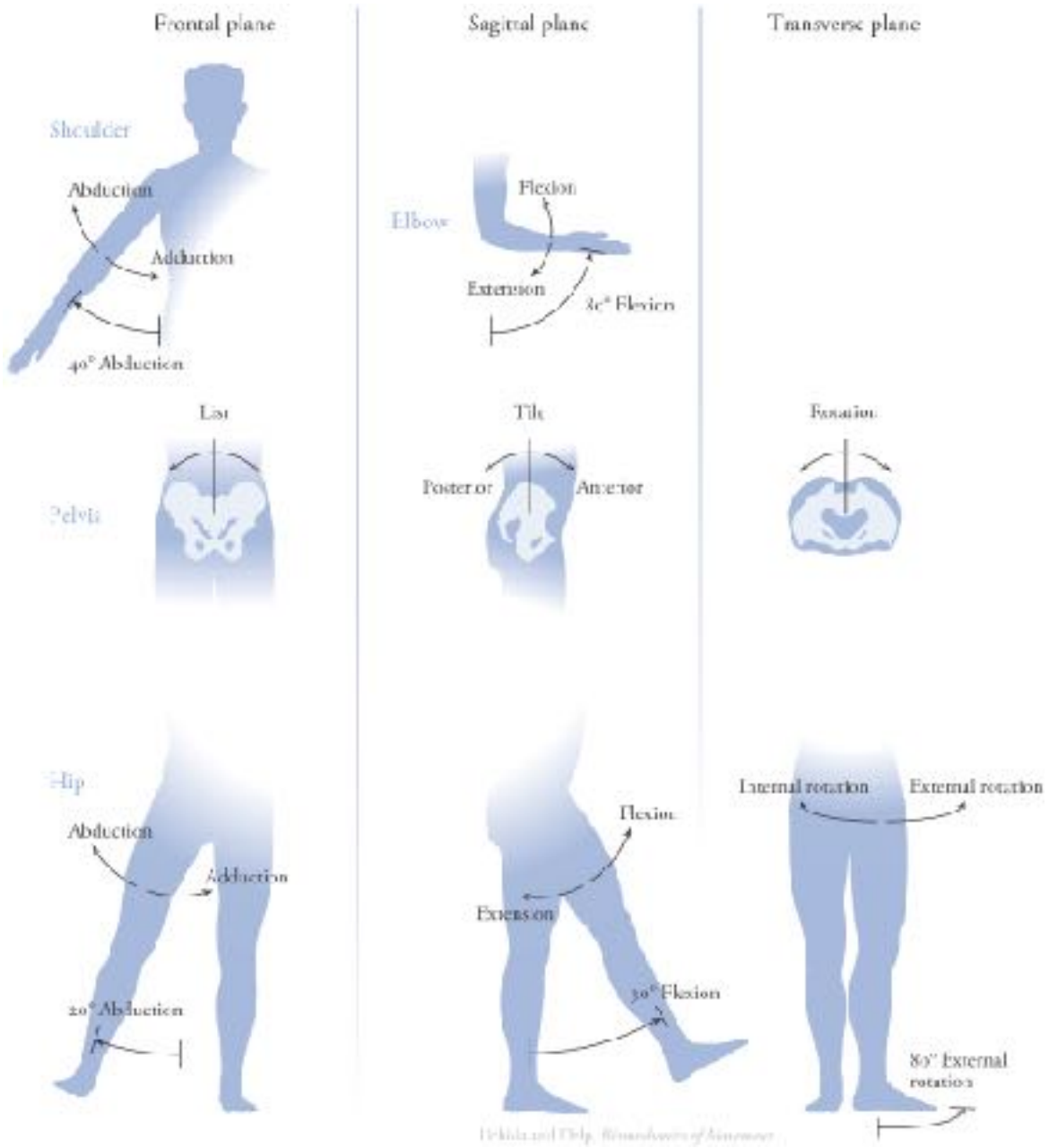
How to succeed in BMEG 330

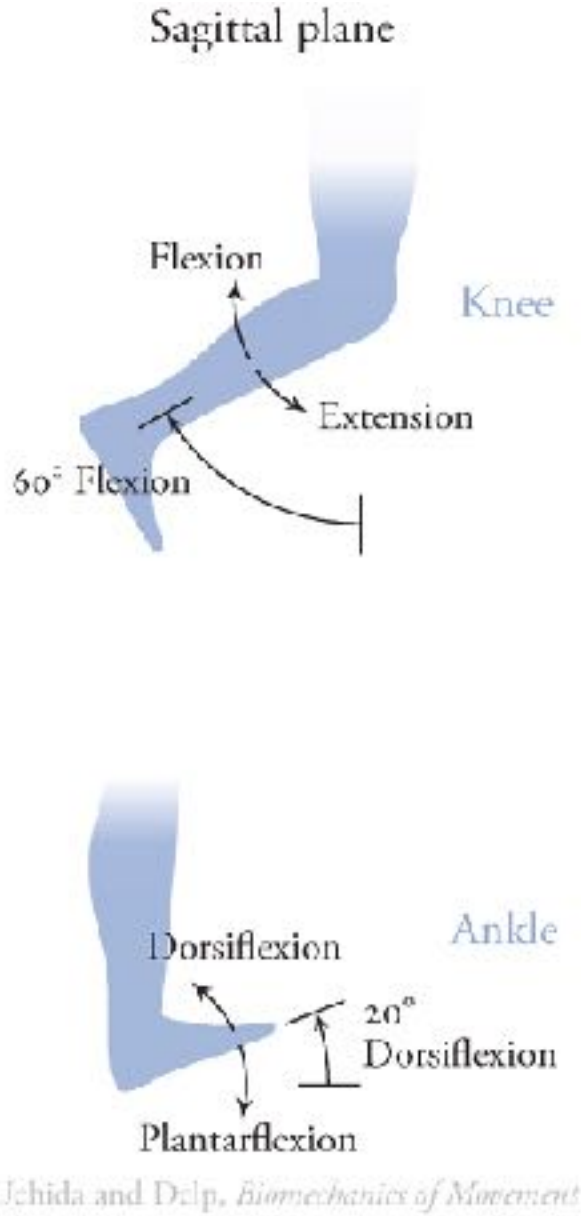
Beyond just a good grade.

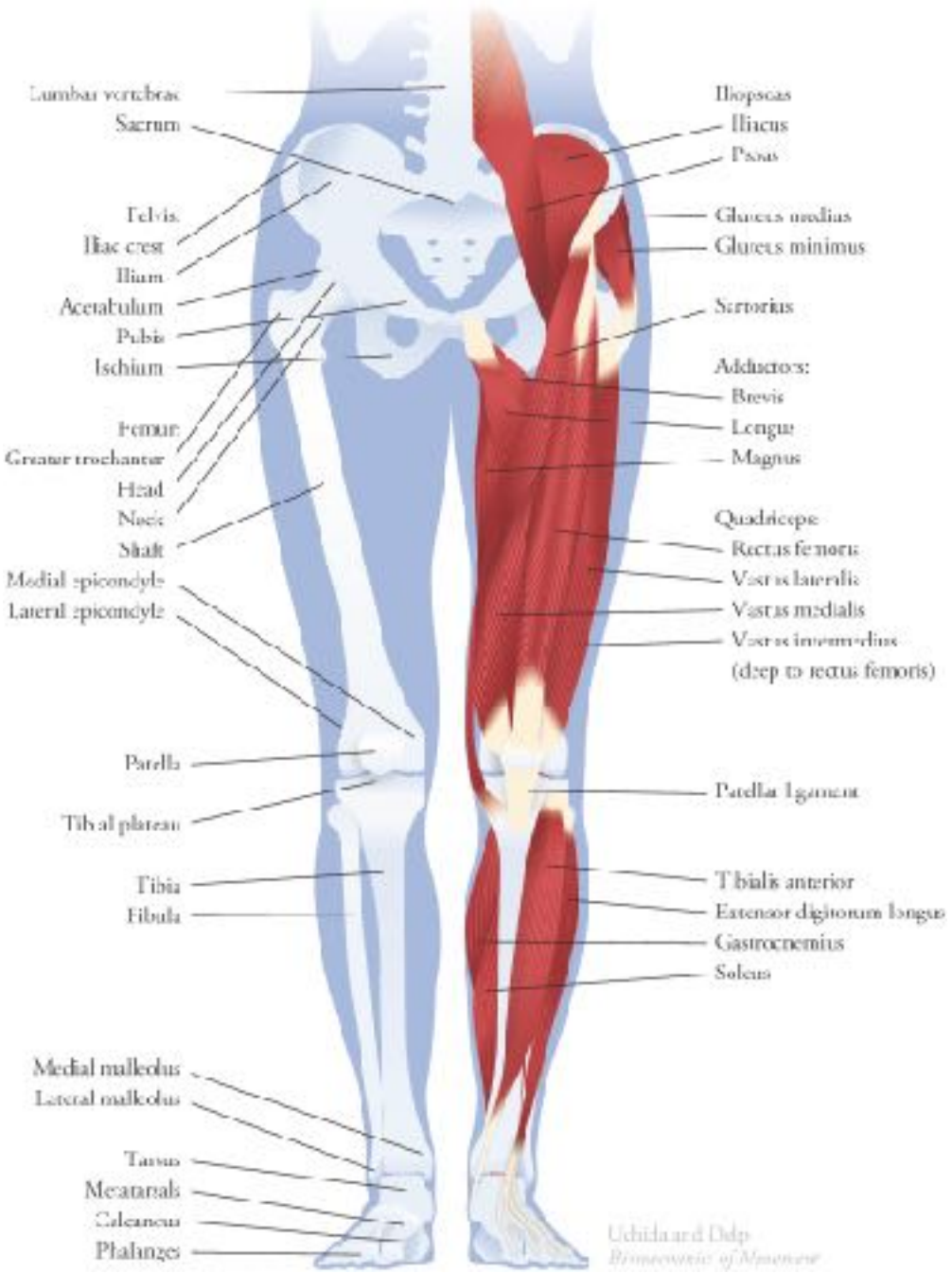
Come to class and open labs.
Ask questions both to me and your peers.
Research things that may not go into as much detail as you wish.
Spend some mastering the basics of programming . Long term investment.
Challenge me and challenge yourself.
Keep your peers accountable.

Review | Planes and Terms

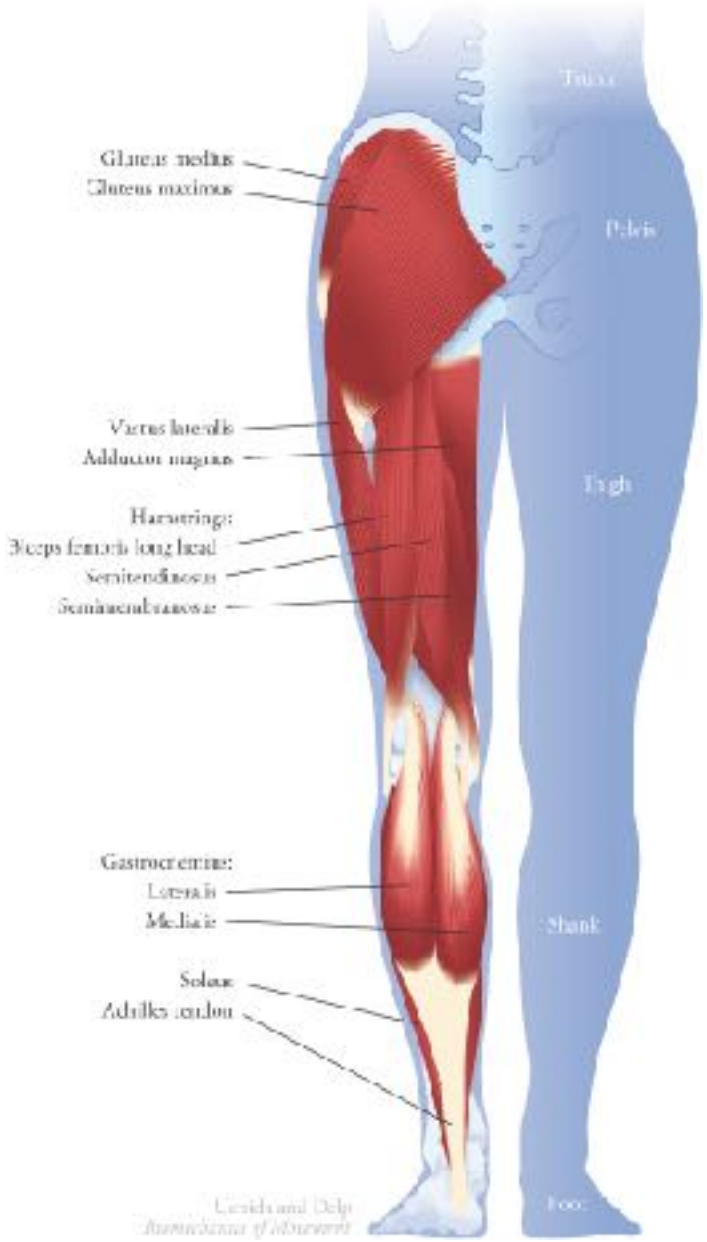

Frontal plane
Sagittal plane
Transverse plane
Posterior
Anterior
Uchida and Delp
Biomechanics of Movement
Lateral
Medial
Lateral
Superior
Proximal
Inferior
Distal
Distal


Frontal plane
Sagittal plane
Transverse plane
Shoulder
Abduction
Adduction
40° Abduction
Elbow
Flexion
Extension
Pelvis
Tilt
Posterior
Anterior
Rotation
Hip
Abduction
Adduction
20° Abduction
Flexion
Extension
30° Flexion
Internal rotation
External rotation
External rotation


Sagittal plane
Flexion
Knee
Extension
60° Flexion
Ankle
Dorsiflexion
20°
Dorsiflexion
Plantarflexion
Uchida and Delp, Biomechanics of Movement



*** Don't need to memorize minor muscle names but knowledge of lower limb major muscles and bones is required and expected at this level**



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