



# HK\*4610 Health and Injury Biomechanics

Fall 2019

Section(s): C01

Department of Human Health and Nutritional Sciences

Credit Weight: 0.50

Version 1.00 - August 08, 2019

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## 1 Course Details

### 1.1 Calendar Description

This course presents an overview of bone and joint function from a biomechanics perspective, within the framework of health and injury. Particular emphasis is placed on the influence of biomechanical signals on the regulation of bone and joint structure and function. Individual diseases, such as osteoarthritis, will be considered as they impact the various tissues of the joint (cartilage, ligament and bone) and the neuromuscular system. The laboratory will provide supplementary material illustrating particular aspects of musculoskeletal function including in vivo and in vitro biomechanical testing.

**Pre-Requisites:** ENGG\*3150 or HK\*2270

### 1.2 Course Description

This course presents an overview of neuromuscular tissue function in health, injury and disease from a biomechanics perspective. Particular emphasis is placed on understanding and applying biomechanical principles to the characterization of soft tissue, bone and joint structure and function, in health and injury. The impact of individual diseases, such as osteoarthritis and osteoporosis, will be studied in the context of their effect on the various tissues (cartilage, ligament, muscle and bone) comprising the neuromuscular system. Clinical applications of these biomechanical principles will be emphasized in the second half of the course to address the diagnosis, assessment, treatment and clinical management of conditions affecting the neuromuscular system, in health and disease. The laboratory component will expose the student to practical and clinical skills relevant to the assessment of the neuromuscular system, interpretation of clinical tests and formulation of clinical impression/diagnosis in the physical assessment of the patient in health and disease.

### 1.3 Timetable

Lectures: Monday, Wednesday, Friday from 10:30am-11:20am. Lectures are held at Landscape Architecture (LA), 204

Labs: Monday, Wednesday and Friday, 12:30-2:20pm. A total of three (3) labs will be conducted - TBA. Labs will be held in JTP 208

## 1.4 Final Exam

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# 2 Instructional Support

## 2.1 Instructional Support Team

<b>Instructor:</b>	John Srbely DC PhD
<b>Email:</b>	jsrbely@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x52058
<b>Office:</b>	HHNS Annex 281
<b>Office Hours:</b>	By appointment

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# 3 Learning Resources

There is no required textbook for this course.

## 3.1 Required Resources

### **Courselink (website) (Website)**

All course material, news, announcements, online quizzes and grades will be administered and/or regularly updated on the HK\*4610 Courselink site.

Study materials including lecture and lab notes, and supplementary readings will be added to the site on an ongoing basis.

**You are responsible for checking the site regularly to keep up to date on all course activities.**

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# 4 Learning Outcomes

## 4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Characterize mechanisms of tissue injury in bone, tendon, ligament, cartilage and muscle tissues using basic principles of biomechanics, tissue and fluid mechanics.
  2. Learn to perform a clinical history and orthopedic/neurologic physical examination/assessment.
  3. Interpret the findings of a clinical history and physical examination to confer a clinical opinion/impression/diagnosis.
  4. Learn how to communicate clinical findings with other health professionals, including how to record SOAP notes.
  5. Understand the key clinical features of musculoskeletal injuries and disease, and applying these to clinical assessment and diagnosis of a patient.
  6. Understand physiologic mechanisms of acute and chronic pain and how to clinically assess patients with chronic pain.
  7. Understand and apply principles of evidence-based rehabilitation and injury management principles to the clinical management of musculoskeletal injury and disease.
  8. Appreciate and understand the role and contribution of the Certified Kinesiologist in the Canadian health delivery system
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## 5 Teaching and Learning Activities

### Course topics

- Clinical Biomechanics review
- Tissue mechanics, structure and function of:
  - bone
  - tendon
  - ligament
  - cartilage
  - muscle
  - joints
- injury and healing
- clinical epidemiology

- acute and chronic pain
- injury prevention
- clinical applications of biomechanics
  - diagnosis and assessment of injury
  - management of musculoskeletal injury and disease

## 5.1 Lecture

### Week 1

**Topics:** Lecture 1-REVIEW OF BIOMECHANICAL PRINCIPLES  
RELEVANT TO THE STUDY OF INJURY

Kinetics v Kinematics

Energy: Relationship of Energy to Injury, Total Mechanical Energy and Injury, Energy dissipation and injury prevention, Impulse-momentum and implications to injury and prevention, Friction

Forces and Moments: Muscle force and joint moments, Clinical applications including: Coxa vara, coxa valga, Low back pain, Q-angle, Rotator cuff strain, Joint Stability, Stabilizing vs destabilizing joint forces and their role in injury

### Week 2

**Topics:** Lecture 2-CONNECTIVE TISSUES, HEALING AND TISSUE  
REPAIR, PRINCIPLES OF REHABILITATION

Histology and classification of connective tissue, Collagen Types, Mechanical properties. Comparison of connective tissues including:

1. Tendon and ligament,
2. Cartilage
3. Bone

Inflammation

Tissue Repair and regeneration

1. Tissue remodeling
2. RICE
3. Therapeutic modalities and their role in injury management

Therapeutic Exercise Programming

### **Week 3**

**Topics:** Lecture 3-MATERIAL MECHANICS AND VISCOELASTIC TISSUES

Structural v material properties of tissues: Stress-strain, Load-deformation

Bending moment of inertia and impact on injury

Tissue loading

Biomechanical principles of injury and tissue failure

Properties of viscoelastic tissues and how they relate to injury

1. Stress-relaxation
2. Creep

### **Week 4**

**Topics:** Lecture 4-TISSUE MECHANICS-BONE  
Bone development and related injury considerations

1. Peak height velocity (PHV)
2. Bone mineral density (BMD)
3. Bone strength
4. Stress-strain properties of bone
5. Effect of bone mineralization and collagen
6. Bone Density
7. Porosity and Mineralization

Effect of clinical conditions on bone strength and material properties

1. Osteoporosis
2. Osteoclastic bone disease (cancer, metabolic)

Determinants of bone strength and how to optimize this through therapeutics and lifestyle management

Bone adaptation and remodeling: Therapeutic implications, Vibration, Exercise, Medication and pharmacotherapeutics, Nutrition and prevention

Bone injury

### **Week 5**

**Topics:** Lecture 4-TISSUE MECHANICS-CARTILAGE  
Cartilage structure and function: Cartilage matrix structure, Cartilage mechanics,  
Cartilage growth and repair, Cartilage adaptation and aging

1. Clinical implications: Cartilage injury, Disc injury/pathology, Meniscus, Arthritis
2. Prevention of cartilage injury and degeneration

Therapeutics

Cartilage structure and function: Cartilage matrix structure, Cartilage mechanics, Cartilage growth and repair, Cartilage adaptation and aging

Clinical implications: Cartilage injury, Disc injury/pathology, Meniscus, Arthritis

Prevention of cartilage injury and degeneration

Therapeutic management of cartilage injury and disease

## **Week 6**

**Topics:** Lecture 6-TISSUE MECHANICS-TENDON AND LIGAMENT  
Structure of ligaments and tendons: Anisotropy and clinical implications

Tendon injury

Ligament injury

Structural Properties of tendon/ligament: Stress-strain, Cross-sectional area, Length

Factors influencing mechanical properties of tendon and ligament: Exercise, Tension, Age, Use v Disuse, Therapeutic implications

Biomechanical principles relevant to muscle injury: Anatomy, Muscle architecture, Fusiform v penniform, Force-length, Force-velocity, Power-velocity, Efficiency of muscle contraction

Muscle Injury: Strain, Sprain, Contusion, Muscle cramp, DOMS

Pathophysiology and Clinical Considerations for nerve injury: Peripheral nerve, Central Nervous System

## **Week 7**

**Topics:** Lecture 7-CLINICAL HISTORY TAKING AND PATIENT ASSESSMENT

How to perform a thorough clinical history and physical examination

Legal and Ethical Considerations of Patient Assessment and Management

Posture Assessment: Techniques, Types of curvatures

Cranial Nerve Examination

## **Week 8**

**Topics:** Lecture 8-PAIN AND INFLAMMATION

Classification of pain: Definition, Models and dimensions of pain, Pain vs nociception, Referred pain

Inflammation: chronic vs acute

Cardinal/clinical signs of inflammation

Management of Inflammation and Pain: Phases of healing, RICE

Central sensitization: mechanisms and clinical manifestation

Pain Management: Clinical evaluation, Pain assessment techniques

Therapeutic options for pain management

Pain and aging

Pain and Disability: Disability vs impairment

Assessment of disability: McGill Pain Questionnaire, Oswestry, Roland Morris

## **Week 9**

**Topics:** Lecture 9-CLINICAL CONSIDERATIONS AND INJURY  
MANAGEMENT OF UPPER LIMB

Function Anatomy-Shoulder

1. Kinematics and Kinetics
2. Definition, mechanism of injury, signs and symptoms and management for:  
Sprains, Strains, Dislocation, Fracture, Rotator cuff, Strain, Tear, Impingement,  
Acromioclavicular Joint, Bursitis, Biceps Tendonitis

Functional Anatomy-Elbow, wrist and hand, Kinematics and Kinetics

1. Kinematics and Kinetics
2. Definition, mechanism of injury, signs and symptoms and management for:  
Bursitis, Sprains and dislocations, Strains, Medial and lateral epicondylitis,

Carpal tunnel syndrome

**Week 10**

**Topics:** Lecture 10-CLINICAL CONSIDERATIONS AND INJURY  
MANAGEMENT OF LOWER LIMB

Functional Anatomy-Hip and Pelvis: Kinetics and kinematics

1. Definition, mechanism of injury, signs and symptoms and management for:  
Osteitis pubis, Sacroiliac joint, Hip pointer, Adductor strain, Iliopsoas strain,  
Bursitis
2. Functional Anatomy-Thigh and Knee: Kinematics and kinetics
3. Definition, mechanism of injury, signs and symptoms and management for:  
Hamstring strain, Bursitis, Iliotibial band syndrome, Knee, Meniscal injury,  
Patellofemoral stress syndrome, Chondromalacia patellae, Osgood-Schlatter  
Disease, Patellar tendinosis, Knee ligament injury (Anterior Cruciate, Posterior  
Cruciate, Medial Collateral, Lateral Collateral), Myositis ossificans, Contusion,  
Femoral fracture
4. Functional Anatomy-Leg, Ankle and Foot: Kinematics and Kinetics

Definition, mechanism of injury, signs and symptoms and management for:

1. Shin splints
2. Sprains
3. Achilles tendonitis
4. Compartment syndrome
5. Medial tibial stress syndrome
6. Plantar fasciitis
7. Morton's foot
8. Arch problems

**Week 11**

**Topics:** Lecture 11-CLINICAL CONSIDERATIONS AND INJURY  
MANAGEMENT OF THE SPINE

Functional Anatomy-Spine:

Kinematics and Kinetics

Anatomy of the Spine



Injury Prevention in everyday activities

Assessing spinal posture: Spinal curvatures that predispose to injury

Definition, mechanism of injury, signs and symptoms and management:

Whiplash, Sprain and strain, Suboccipital region,

Clinical implications: Cervicogenic headache, Disequilibrium and vertigo

Low Back Pain: Acute low back pain, Chronic low back pain, Mechanical vs discogenic low back pain

Spinal stenosis

Dowager's Hump

Degenerative Disc Disease: Pathophysiologic mechanisms, Disc loading and it's contribution to DDD, Stages of discopathy

Sciatica and herniated disc:

Spondylolysis and spondylolisthesis

Arthritis

Osteoarthritis: Primary vs secondary, Diagnostic criteria of OA, Radiographic, Clinical

Seropositive Arthritis: Rheumatoid Arthritis

Seronegative Arthritis: Ankylosing Spondylitis: Enteropathic, Psoriatic

**Wed, Sep 5 - Sat, Dec 1**

**Topics:**

**Tentative Lecture Schedule Fall 2019**

September	4	10:30-11:20 am	RICH 2529 Introduction
September	6	10:30-11:20 am	RICH 2529 Review of Clinical Applications of Biomechanics
September	9	10:30-11:20 am	RICH 2529 Classification of Biological Tissues
September	11	10:30-11:20 am	RICH 2529 Clinical Biomechanics and Energy
September	13	10:30-11:20	RICH 2529 Clinical Biomechanics and Energy

		am	
September	16	10:30-11:20 am	RICH 2529 Joint Mechanics
September	18	10:30-11:20 am	RICH 2529 Material Mechanics
September	20	10:30-11:20 am	RICH 2529 Viscoelastic Tissues
September	23	10:30-11:20 am	RICH 2529 Tissue Loading
September	25	10:30-11:20 am	RICH 2529 Bone Structure and Formation
September	27	10:30-11:20 am	RICH 2529 Bone Structure and Formation
September	30	10:30-11:20 am	RICH 2529 Biomechanics of Bone
October	2	10:30-11:20 am	RICH 2529 Bone Adaptation and Remodeling
October	4	10:30-11:20 am	RICH 2529 Ligament and Tendon Structure
October	7	10:30-11:20 am	RICH 2529 Ligament and Tendon Biomechanics
October	9	10:30-11:20 am	RICH 2529 Cartilage
October	11	10:30-11:20 am	RICH 2529 Cartilage
<b>October</b>	<b>14-18</b>		<b>FALL READING WEEK</b>
October	21	10:30-11:20 am	RICH 2529 MID TERM EXAM
October	23	10:30-11:20 am	RICH 2529 Clinical History Taking
October	25	10:30-11:20 am	RICH 2529 Posture
October	28	10:30-11:20 am	RICH 2529 Posture
October	30	10:30-11:20	RICH 2529 Inflammation and Tissue Healing

		am	
November	1	10:30-11:20 am	RICH 2529 Pain
November	4	10:30-11:20 am	RICH 2529 Pain
November	6	10:30-11:20 am	Guest Lecture: Ortho Physical Assessment of RICH 2529 Shoulder (Long)
November	8	10:30-11:20 am	RICH 2529 Upper Extremity
November	11	10:30-11:20 am	RICH 2529 Upper Extremity
November	13	10:30-11:20 am	RICH 2529 Lower Extremity
November	15	10:30-11:20 am	RICH 2529 Lower Extremity
November	18	10:30-11:20 am	RICH 2529 Head Neck and Spine
November	20	10:30-11:20 am	RICH 2529 Head Neck and Spine
November	22	10:30-11:20 am	RICH 2529 Head Neck and Spine
November	25	10:30-11:20 am	RICH 2529 Guest Lecture: Exercise Prescription (Bucciarelli)
November	27	10:30-11:20 am	RICH 2529 Guest Lecture: Exercise Prescription (Bucciarelli)
November	29	10:30-11:20 am	Guest Lecture: Musculoskeletal Epidemiology RICH 2529 (Nolet)
December	2	10:30-11:20 am	RICH 2529 Review Lecture

## 5.2 Lab

TBA

**Topics:** Lab 1 - Physical Examination of the Upper Limb and Cranial Nerves

Aims of the Clinical Assessment: History, Physical Examination

Cervical Spine: ROM - assessment of both active and passive ranges

Physical assessment of the Atlanto-Occipital Region

Testing for cervical myotomes

Special Tests for Cervical Spine: Kemp's, Formainal Compression, Cervical Distraction, Valsalva, L'Hermitte

Thoracic Outlet Syndrome: pathophysiology and physical examination; Adson's Test

Reflex Testing: C5-C7

Assessment of the Shoulder: Glenohumeral, Acromioclavicular and Scapulothoracic Joints

1. Range of Motion
2. Apley's Scratch Test
3. Impingement Sign
4. Supraspinatus and Biceps test
5. Shoulder apprehension test

Elbow: Range of Motion, tests for ligamentous instability, Tinel's sign, strength testing

Carpal Tunnel Syndrome: diagnosis and assessment

## **TBA**

### **Topics:**

Lab 2 - Physical Assessment of Spine and Lower Limb

Postural Assessment

Scoliosis: Assessment and Management

Assessment of the Lumbar Spine

1. motion palpation of the lumbar spine and pelvis
2. Lasegue's Straight Leg Raise Test
3. Deyelle-May Test
4. Nerve Root Testing: L4 and L5
5. Reflex Testing
6. Dermatomal testing

Assessment of the Hip

1. Range of Motion
2. Compression Test

#### Assessment of the Knee

1. Range of Motion
2. Palpation of knee landmarks
3. Drawer Sign for ACL
4. Medial/Lateral Gap test for collaterals
5. Meniscal tests (Apley's compression, McMurray)
6. Patellar Compression for Chondromalacia Patellae

#### Assessment of Foot and Ankle

1. Range of Motion
2. Achilles tendon
3. Medial and lateral malleoli
4. Tarsal bones
5. Talofibular ligament
6. Deltoid ligament

#### Cranial Nerve Examination

### **TBA**

**Topics:** Lab 3- Core: Scapular and Lumbo-Pelvic Assessment  
Assessment of Scapular Stability and Function

1. Scapular Anatomy: muscles and ligaments
2. Scapular dyskinesis
3. Scapulo-humeral rhythm
4. Scapular repositioning tests

#### Rehabilitation of "Core" Scapular Exercises

#### Impingement Syndromes

#### Lumbo-Pelvic Core

1. Assessment of lumbar stability
2. Anatomy of the pelvis: muscle and ligament
3. Assessment of the pelvic function
4. Sorensen's Test
5. Prone double straight leg raise test
6. active straight leg raise test

Exercise and Rehabilitation of the Low Back Pain patient

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## 6 Assessments

### 6.1 Assessment Details

#### Midterm Exam (25%)

**Date:** October 21, 2019

**Learning Outcome:** 2, 3

Mid-Term will be held in lecture hall within the regularly scheduled lecture timeslot (10:30-11:20 am in RICH 2529).

Learning Outcomes # 2 and 3.

#### Online Quizzes (40%)

**Date:** TBA

**Learning Outcome:** 2, 3, 4, 5, 6, 7, 8, 9

A total of 4 online quizzes will be offered. Each quiz is worth 10%.

The dates of the online quizzes will be scheduled on a TBA basis, as material is covered in class.

Learning outcomes # 2-9.

#### Final Exam (35%)

**Date:** TBA

**Learning Outcome:** 2, 3, 4, 5, 6, 7, 8, 9

Date and Location TBA

Learning outcomes # 2-9

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## 7 Department of Human Health and Nutritional Sciences Statements

### 7.1 Academic Advisors

If you are concerned about any aspect of your academic program:

- Make an appointment with a program counsellor in your degree program. [B.Sc. Academic Advising](#) or [Program Counsellors](#)

### 7.2 Academic Support

If you are struggling to succeed academically:

- Learning Commons: There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist. <http://www.learningcommons.uoguelph.ca/>
- Science Commons: Located in the library, the Science Commons provides support for physics, mathematic/statistics, and chemistry. Details on their hours of operations can be found at: <http://www.lib.uoguelph.ca/get-assistance/studying/chemistry-physics-help> and <http://www.lib.uoguelph.ca/get-assistance/studying/math-stats-help>

### 7.3 Wellness

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance. <https://www.uoguelph.ca/counselling/>
- Student Health Services is located on campus and is available to provide medical attention. <https://www.uoguelph.ca/studenthealthservices/clinic>
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations.

<http://www.selfregulationskills.ca/>

## 8 University Statements

### 8.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

### 8.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

### 8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

### 8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.



## 8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

More information can be found on the SAS website  
<https://www.uoguelph.ca/sas>

## 8.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct  
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct  
<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 8.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless

further permission is granted.

## **8.8 Resources**

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

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