Musculoskeletal Biomechanics

BIOEN 520 | ME 527

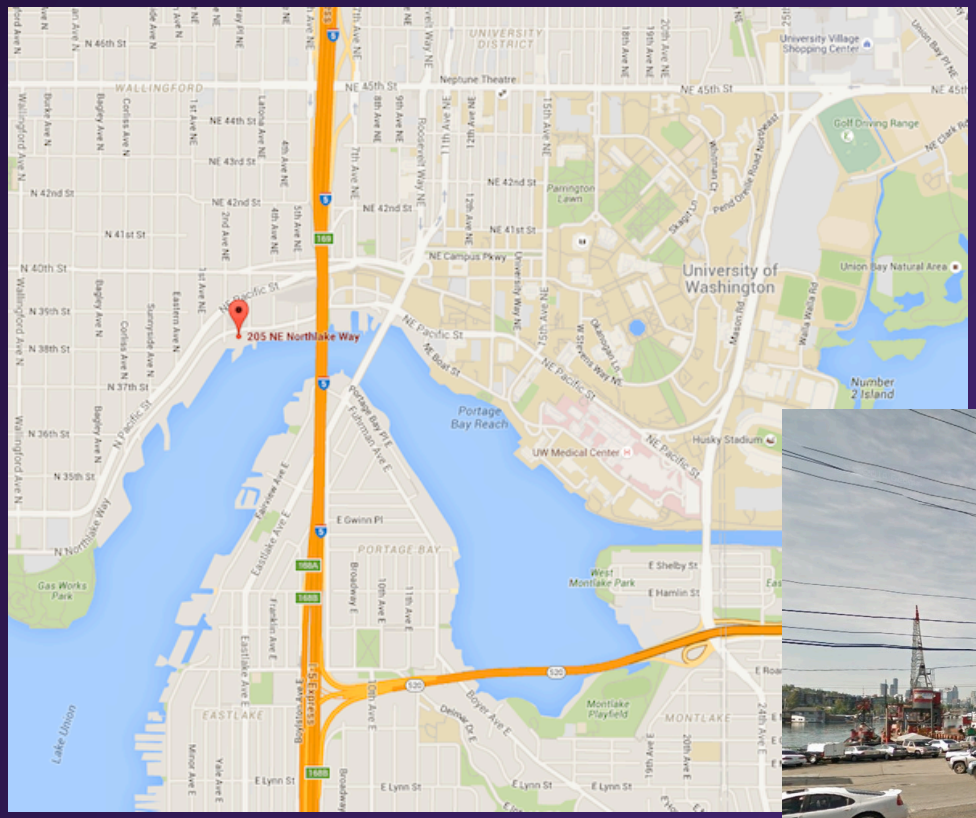
Winter 2016

Instructors: Profs. Randy Ching & Bil Ledoux

Office hours: by appointment

Website: http://courses.washington.edu/bioen520/

Background…


205 NE Northlake Way
University of Washington
Portage Bay Reach
Husky Stadium
UW Medical Center
Gas Works Park
Lake Union
EASTLAKE
PORTAGE BAY
MONTLAKE
Montlake Playfield
West Montlake Park
Number 2 Island
Union Bay Natural Area
Golf Driving Range
Neptune Theatre
University Village Shopping Center
Parrington Lawn
NE Campus Pkwy
NE Pacific St
NE 45th St
NE 42nd St
NE 41st St
Portage Bay Pl E
Fuhrman Ave E
Eastlake Ave E
Fairview Ave E
E Gwinn Pl
E Shelby St
E Hamlin St
E Lynn St
Boyer Ave E
Delmar Dr E
Montlake Blvd
I-5 Express
Roosevelt Way NE
15th Ave NE
University Way NE
Pend Oreille Road Northwest
Mountain Ct
Skagit Ln
Okanogan Ln
W Stevens Way NE
Wahkiakum Ln
Mason Rd
Walla Walla Rd
Broadway E
10th Ave E
11th Ave E
20th Ave E
24th Ave E
Yale Ave E
Minor Ave E
Franklin Ave E
Bagley Ave N
Corliss Ave N
Sunnyside Ave N
Eastern Ave N
Wallingford Ave N
Dayton Ave N
Burke Ave N
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WALLINGFORD
UNIVERSITY DISTRICT


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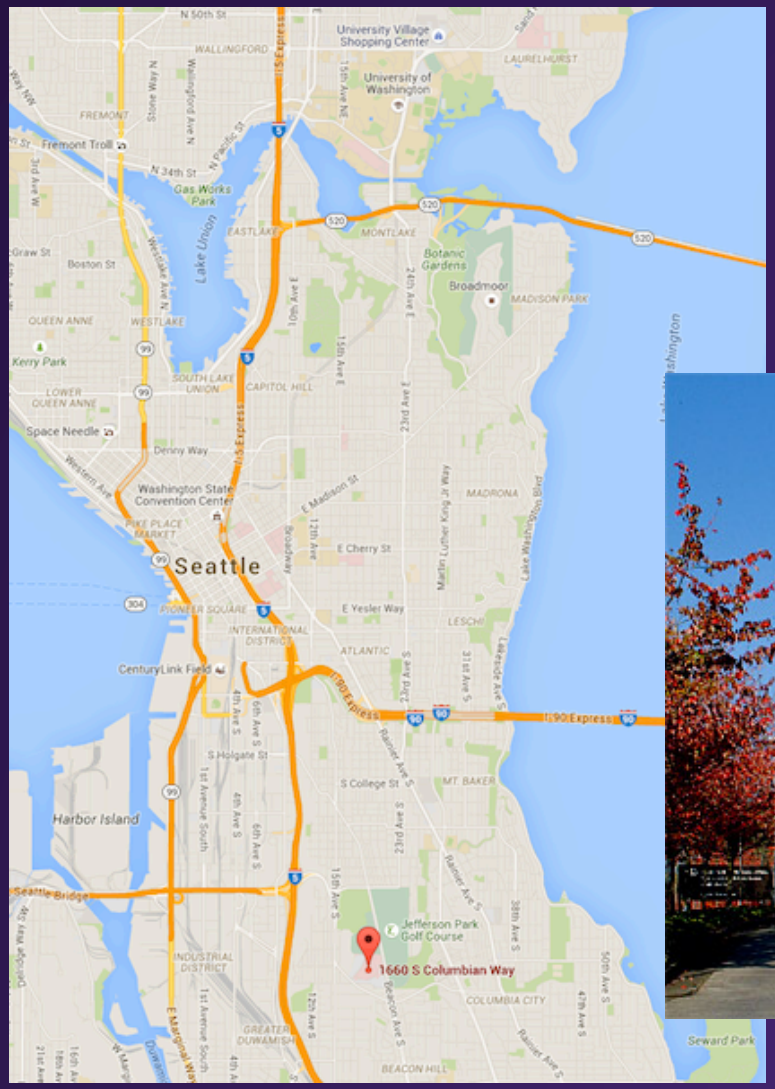
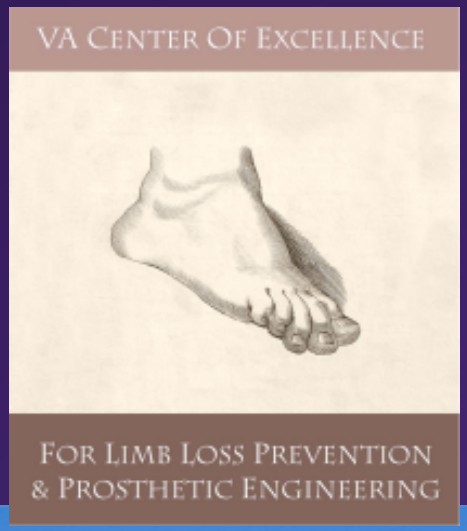
STOP

Background…


University Village Shopping Center
University of Washington
Fremont Troll
Gas Works Park
Lake Union
Botanic Gardens
Broadmoor
Kerry Park
Space Needle
Washington State Convention Center
Seattle
CenturyLink Field
Harbor Island
Seattle Bridge
Jefferson Park Golf Course
1660 S Columbian Way
Seward Park


VA Center Of Excellence
For Limb Loss Prevention
& Prosthetic Engineering

Course Organization...

- Research Study Framework...
- Important dates...
- Assignments...
- Exams...
- Grading...

BIOEN 520 | ME 527 Syllabus
MUSCULOSKELETAL BIOMECHANICS
[Winter 2016, MEB 248, TuTh 8:30-10:20 am]

Session	Date	Topic	Assignments
1A	01/05/16 (Tu)	***Introduction:*** Course Admin/History & Current Topics	
1B		***Mini-Lab 1:*** Basic Anatomy	
2A	01/07/16 (Th)	***Background:*** Basic Mechanics & Viscoelasticity	
2B		***Methods:*** Exp. Design (Study Design/Metrics/Models/Test Envir)	
3A	01/12/16 (Tu)	***Methods:*** Tools of the Trade 1 (Force/Displacement/DAQ)	
3B		***Methods:*** Tools of the Trade 2 (MoCap/Force Plates/Pressure)	
4A	01/14/16 (Th)	***Methods:*** Kinematics & Kinetics	HW 1 (out)
4B		***Mini-Lab 2:*** Grant Writing/Intro Final Project	Final Proj (out)
5A	01/19/16 (Tu)	***Methods:*** Imaging in Biomechanics	
5B		***Methods:*** Histology/Biochemistry	
6A	01/21/16 (Th)	***Methods:*** ABL Tour	
6B		***Lab I:*** Chewing Kinematics	Lab I (out)

Course Objectives...

- Become aware of scope and practice of the field of biomechanics…
- Understand basic experimental tools and techniques…
- Grasp the structure-function-property relationships for musculoskeletal tissues...
- Explore the implementation of these biomechanical tools and techniques...
- Demonstrate proficiency in developing a musculoskeletal biomechanics research project…

Course Instruction…

- Two instructors; two different "styles"…
- "Cody and Joe" → "Randy and Bil"

Today's Discussion Questions...

[Q1]: What is biomechanics?

[Q2]: Why study biomechanics?

[Q3]: Why are YOU interested in biomechanics?

[Q4]: Who were some important historical biomechanists?

[Q5]: Why is it important to know what others have done in the past?

[Q6]: How can we know if a field is growing?

[Q7]: What are some current "hot" research areas in biomechanics?

Biomechanics…

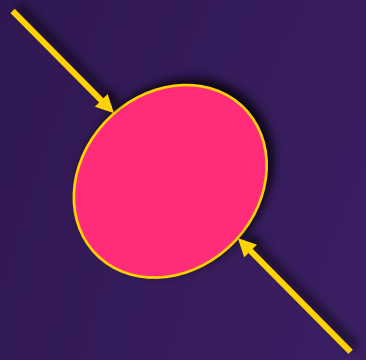
[Q1]: What is biomechanics?

"…Mechanics applied to biology"

[Y.C. Fung, 1981]

Biomechanics...

[Q]: If *biomechanics* is mechanics applied to biology, what is *mechanics*?



"...the study of motion and the deformation of objects in response to forces acting upon them..."

Biomechanics…

[Q2]: Why study biomechanics? (i.e., what benefits can be gained?)

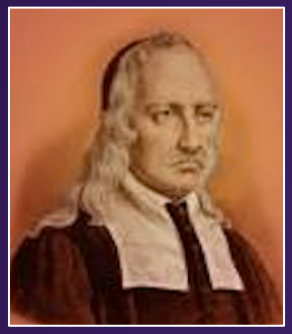
- Sport biomechanics — Enhance performance
- Ergonomics — Prevent injuries
- Injury biomechanics — Prevent injuries
- Clinical biomechanics (ortho, rehab, sports medicine) — Improve healthcare
- Prosthetic engineering — Improve healthcare

Biomechanics...

[Q3]: Why are YOU interested in biomechanics? (…what do you hope to take away from this course?)

Biomechanics...

[Q4]: Who were some of the important historical figures who contributed to the field of biomechanics?




History of Biomechanics... Who am I?

In addition to his important contributions to physics and astronomy (e.g., the definition of momentum and the first observations of the heavens using a telescope), his mechanical analysis of the movement of animals together with his study of bone mechanics has led some to consider him to be the “Father of Biomechanics"…

Who was Galileo Galilei? (1564 - 1642)

History of Biomechanics... Who am I?

This Italian physiologist and physicist was the first to calculate the human center of gravity and the forces required for equilibrium in various joints of the human body (well before Newton published the laws of motion). The highest honor bestowed by the American Society of Biomechanics is awarded in his name.

Who was Giovanni Borelli? (1608-1679)

History of Biomechanics... Who am I?

He was the first to coin the name "cell" to describe basic biological organisms he observed through his early work with microscopes, and he also developed the fundamental law of elasticity based on his work with springs.

Who was Robert Hooke? (1635- 1703)

History of Biomechanics... Who am I?

This English physician and physicist developed the wave theory of light and came up with a solution to the problem of astigmatism in lenses. He also studied the formation of the human voice, identified it as vibrations, and connected it with the elasticity of materials giving us a well known modulus bearing his name.

Who was Thomas Young? (1773 - 1829)

History of Biomechanics...

Other Contributors to Biomechanics

- Leonardo da Vinci (1452 - 1519) [Anatomy and mechanics]
- William Harvey (1578 - 1657) [Circulation of blood]
- Eadweard Muybridge (1830 - 1904) [Locomotion photos]
- Julius Wolff (1836 - 1902) [Bone adaptation]
- Etienne Marey (1838 - 1904) [Cinematography & gait analysis]
- A.V. Hill (1886 - 1977) [Muscle mechanics]

History of Biomechanics...

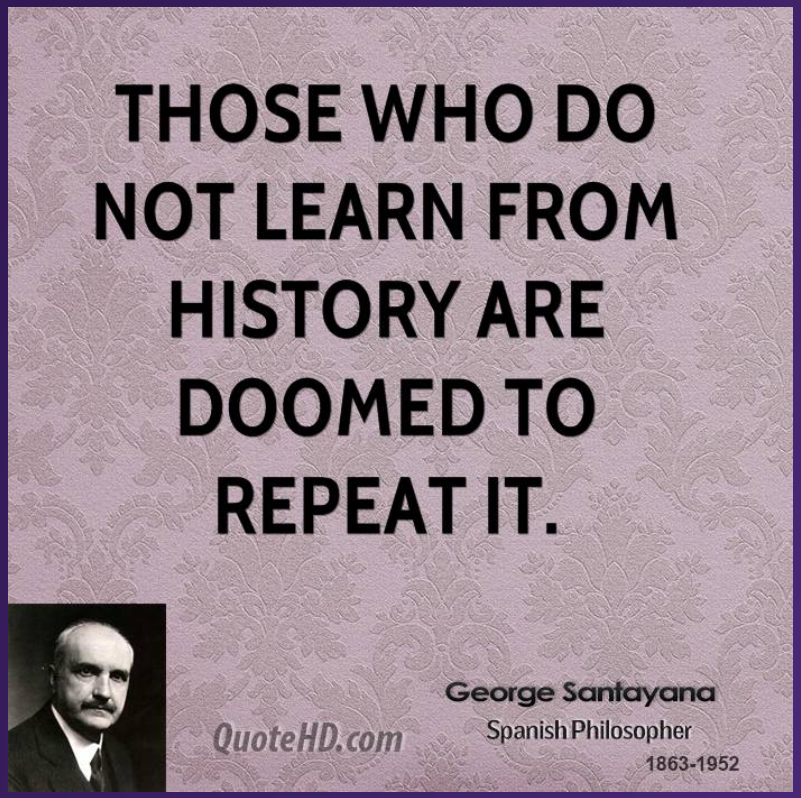
[Q5]: Why should we care about these historical figures and their contributions?

"…If I have seen a little further it is by standing on the shoulders of giants."

Sir Isaac Newton, in a letter to Robert Hooke, 1676

History of Biomechanics...

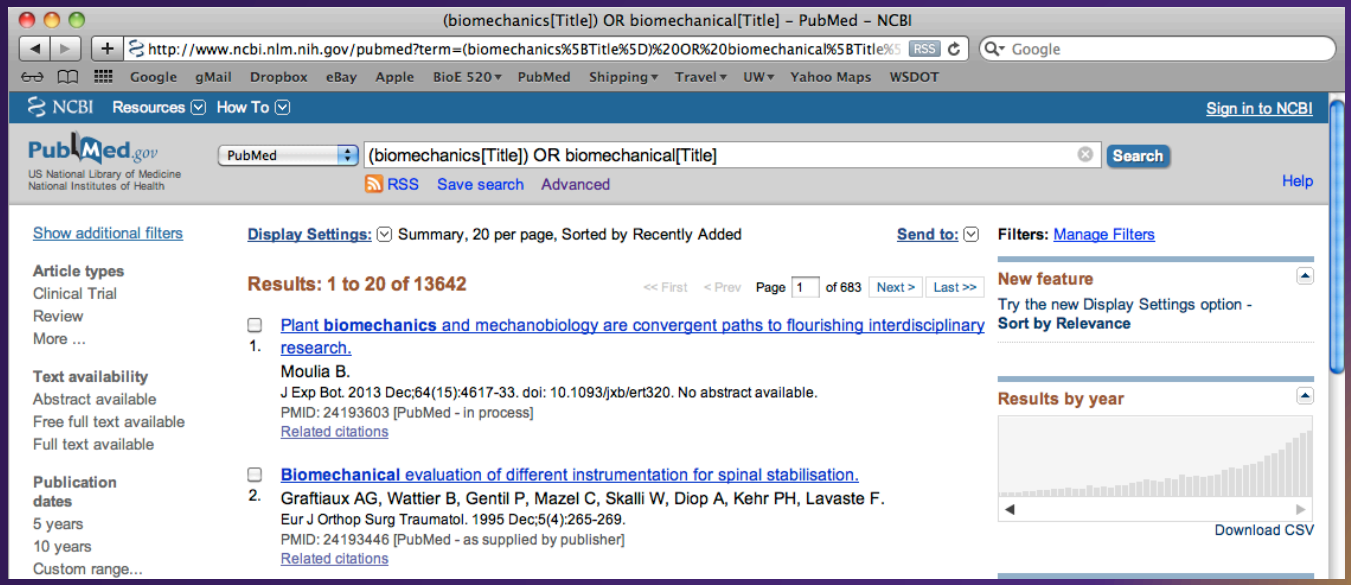
[Q5]: Why should we care about these historical figures and their contributions?



Current Topics…

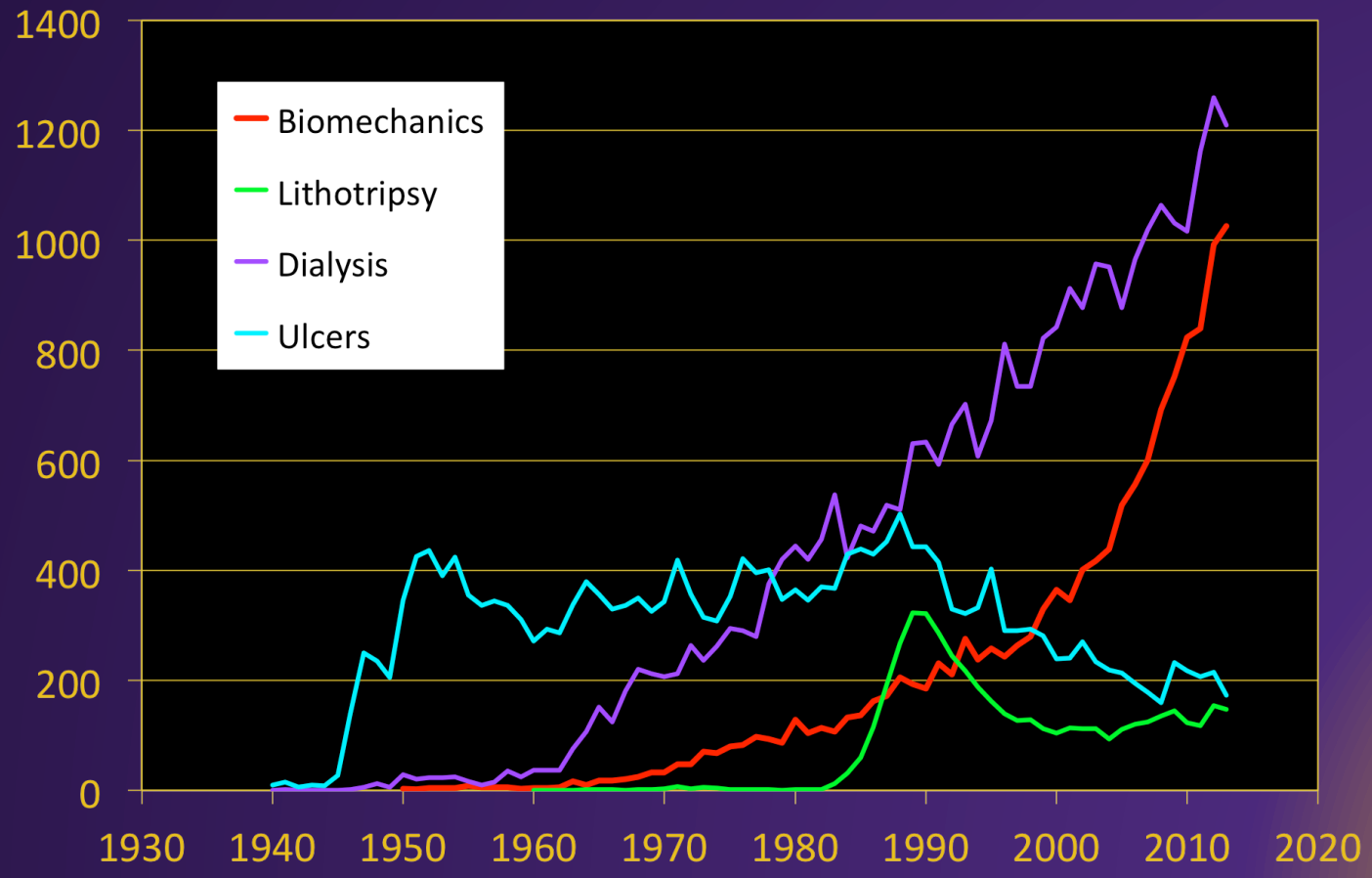
[Q6]: How can we determine whether a field of study is growing or in decline?

Track the research publications being produced…



Current Topics…

Indexed journal articles each year…



Current Topics…

- Research societies…
  - International Society of Biomechanics (ISB)
    - Journal of Biomechanics / Clinical Biomechanics
  - Am/Eur Society of Biomechanics (ASB/ESB)
    - Journal of Biomechanics
  - American Society of Mechanical Engineers (ASME)
    - Journal of Biomechanical Engineering
  - Biomedical Engineering Society (BMES)
    - Annuals of Biomedical Engineering

Current Topics…

- Biomechanics (engineering) programs…
  (ISB website: 86 departments in U.S. colleges/univ.)

Current Topics...

[Q7]: What are some current "hot" research areas in biomechanics research?

- Tissue engineering...
- Custom (patient-specific) implants...
- Computer-aided surgery...
- Synthetic bone & ligament replacement...
- Bioresorbable fixation devices...
- Others?

“Brain Teaser”…

[Q]: Was Galileo correct? *[He hypothesized that the cross-sectional geometry of long bones would have to increase more quickly than length to support the increased weight of larger animals.]*

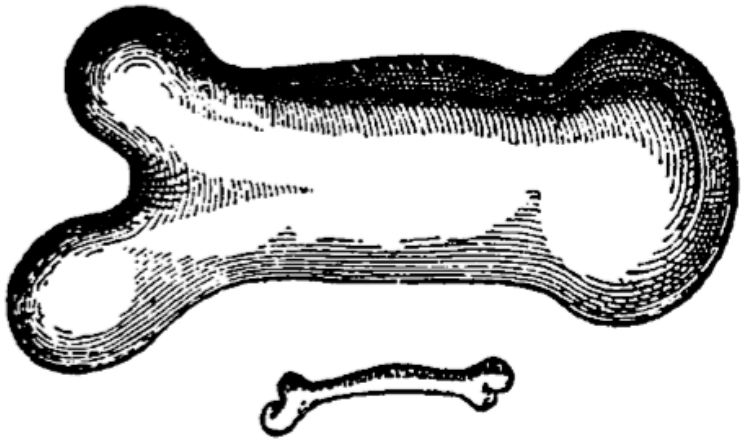


Figure 1.2.3 Galileo's comparison of a normal femur with the femur needed to support an animal three times the size (from Singer, 1959, with permission of Oxford University Press).