University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Course Specification of Biomechanics

Course Code (BE243)

I. Course Identification and General Information:

1	**Course Title:**	Biomechanics				
2	**Course Code & Number:**	BE324				
3	**Credit hours:**	C.H				TOTAL
		Th.	Seminar	Pr	Tr.	
		2	--	--	2	3
4	**Study level/ semester at which this course is offered:**	3th Level / 2nd Semester				
5	**Pre –requisite (if any):**	Mechanics				
6	**Co –requisite (if any):**	None				
7	**Program (s) in which the course is offered:**	Biomedical Engineering Program				
8	**Language of teaching the course:**	English				
9	**Location of Teaching the Course:**	Faculty of Engineering				
10	**Prepared by:**	Dr. Mushtaq Ali Alazazi				
11	**Reviewed by:**					
12	**Date of Approval:**					

II. Course Description:

Biomechanics is one of the most important supporting subjects for the principles and practices of health technology. This course will provide an introduction to the mechanical behavior of biological tissues and systems. The purpose of this course is to introduce students to concepts of mechanics as they apply to human movement.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)		**Referenced PILOs** (Only write code number of referenced Program Intended learning outcomes)
Knowledge and Understanding: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
a1	Describe the essential concepts of biomechanics and their impacts on the behavior of physical bodies subject to forces or displacements.	A1 Describe and explain the underlying mathematical methods and theories; life scientific-principles; and engineering core concepts related to the Biomedical Engineering context.
a2	Identify the mechanical engineering problems in biomaterials and biomedical devices, explain the problems with critical thinking generated from mechanics concepts, and solve the problems with mechanics theory.	A2 Clarify the design principles and techniques and the engineering materials characteristics and how these are relevant to the developments and technologies in a biomedical systems context.
B. Cognitive/ Intellectual Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
b1	Illustrate how basic physical principles apply to human motion and the mechanical properties of musculoskeletal tissues.	B1 Apply engineering principles; basic of life-science; mathematical theories; and modern tools professionally in modeling, analyzing, designing, and constructing physical digital systems; devices and/or processes relevant to Biomedical Engineering fields.
b2	Analyze the optimization of human performance through application of biomechanical principles.	B2 Identify, formulate and solve the Complex problems related to the Biomedical Engineering fields in a Creative and innovative manner by using

		A systematic and analytical thinking methods.
b3	Propose the use of biomechanical analysis in the design of implantable artificial prostheses and in the engineering of living tissues.	B3 Design the biomedical systems or Processes within realistic constraints Such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
C. Professional and Practical Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
c1	Apply life science and engineering concepts in the process of evaluating and understanding normal and abnormal movements to theoretically develop processes for the production of biomedical physiotherapy devices and artificial limbs .	C1 Apply integrally knowledge of mathematics, life science, IT, design, business context and engineering practice to solve problems and to design systems/processes relevant to Biomedical Engineering.
C2	Use standards testing procedures to evaluate joint motion at the hip, knee and ankle during a walking and running gait cycle.	C3 Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, collect, analyze and interpret data and present results in the biomedical systems practice.
D. Transferable Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
d1	Engage in life-long self-learning to	D3 Recognize the needs for ,and engage in

	overcome challenges and further development in biomechanics and rehabilitation medicine.	life-long self-learning.

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1. Describe the essential concepts of biomechanics and their impacts on the behavior of physical bodies subject to forces or displacements.	• Interactive lectures & examples, • Tutorials • Presentation/seminar, • Interactive class discussions, • Case studies • Exercises and home works, • Directed self- study.	• Written tests (mid and final terms and quizzes), • Home works and assignments, • Presentations.
a2. Identify the mechanical engineering problems in biomaterials and biomedical devices, explain the problems with critical thinking generated from mechanics concepts, and solve the problems with mechanics theory.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Directed self- study.	• Written tests (mid and final terms and quizzes), • Home works and assignments, • Presentations.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Illustrate how basic physical principles apply to human motion and the mechanical properties of musculoskeletal tissues	• Interactive lectures & examples, • Interactive class discussions, • Tutorial • Directed self- study, • Exercises and home works, • Case studies • Mini/major project.	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments, • Presentations.
b2. Analyze and explain the optimization of human performance through application of biomechanical principles.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Tutorials, • Exercises and home works, • Directed self- study,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments, • Presentations.
b3. Propose the use of biomechanical analysis in the design of implantable artificial prostheses and in the engineering of living tissues.	• Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Case studies,	• Written tests (mid and final terms and quizzes), • Home works and assignments, • Presentations.

	• Directed self- study, • Team work (cooperative	

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1. Apply life science and engineering concepts in the process of evaluating and understanding normal and abnormal movements to theoretically develop processes for the production of biomedical physiotherapy devices and artificial limbs .	• Interactive lectures & examples, • Tutorials, • Presentation/seminar, • Interactive class discussions, • Case studies • Exercises and home • works, • Directed self- study,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments, • Presentations.
C2. Use standards testing procedures to evaluate joint motion at the hip, knee and ankle during a walking and running gait cycle.	• Interactive lectures & examples, • Tutorials • Presentation/seminar, • Interactive class discussions, • Directed self- study, • Case studies • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments, • Presentations.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1. Engage in life-long self-learning to overcome challenges and further	• Interactive lectures & examples, • Tutorials • Presentation/seminar, • Interactive class discussions, • Case studies • Exercises and home works, • Directed self- study, • Problem basedlearning,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments, • Presentations.

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	contact hours	Learning Outcomes
1	**Introduction**	– Introduction to the course. – Course outlines. – The importance of biomechanics – Biomechanics applications and examples – A brief history of biomechanics	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1
2	**Introduction to Cell**	– Introduction to cellular architecture	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1

		– A Framework (the cytoskeleton) – Engines (the mitochondria) – The cells energy system - Adenosine triphosphate (ATP).			
3	**Muscles and movement**	– Types of Muscle – Skeletal muscles – Smooth muscle – Cardiac Muscle - The two basic ATP production strategies. - Skeletal muscle characteristics - Overview of skeletal muscle structure. - Sliding Filament Model - Myosin cross-bridges - Isometric and Isotonic contraction. - Muscle constitutive modelling - Load–length relationship for skeletal muscle. - Load–velocity relationship	2	4	a1,a2, b1,b2,b3,c1 ,c2,d1
4	**Three element model for muscle**	- Continuum mechanic - Constitutive equation - Constitutive models of linear viscoelasticity - The elastic components - The viscous components - Maxwell model - Kelvin–Voigt model - Three element model for muscle	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1

5	**Whole muscle mechanics**	- Muscle Mechanics - Parallel versus pinnate muscle types - Parallel Arrangement - The force generated by Parallel muscle, - Pinnate Arrangement - the force generated by bipinnate muscle.	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1
6	**Muscle/bone interactions**	- Foreleg motion - Flexion of the elbow - The muscles responsible for elbow flexion - The physiological cross-sectional area (PCSA)	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1
7	**Biomechanics of the knee**	- Introduction to biomechanics of the knee - Bones involved in the knee joint - Cruciate ligaments - Patellar ligament - Quadriceps - Meniscus - knee flexion - Femoro-patellar contact loads - Diagram of forces acting in and on the knee during flexion - Femoro-patellar contact loads during walking	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1
8	**Skeletal biomechanics**	- The skeletal system - Introduction to bone	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1

		- Functions of bone - Distribution of bones - Composition and structure of bone - How bone replaced - Composition of bone - Types of bone cells - Bone tissue - Cortical and trabecular bone - Density of bone tissue - Cortical properties - Trabecular import ants - Trabecular 3D			
9	**Mechanics of materials**	- Principal objective of mechanics - Normal stress and strain - Solid mechanics - Deformation - Modulus of elasticity - Length scale - A fiber-reinforced composite (FRC) - Young's modulus - Poisson's ratio - Tensile strength - Compressive strength - Yield strength - Strain rate - Relative density - Linear elasticity	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1

10	**Biomechanical properties of cortical and trabecular bone**	- Introduction - Cortical bone mechanics - Mechanical properties of cortical bone - Trabecular bone mechanics - Properties of human trabecular - Stress–strain curve - Compressive stress–strain curve - Density dependence - Relationship between relative density and Young's modulus of trabecular bone. - Relationship between relative density and compressive strength of trabecular bone. -	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1
11	**Unit cell models**	- Unit cell models - Model of the cytoskeleton - Tensegrity - Prestressed structure - The actin cytoskeleton - Idealized models for the microstructure of trabecular bone	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1
12	**Functional adaptation and mechanobiology**	- Introduction - Functional adaptation - Wolff's law - Functional adaptation that intrigue researchers	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1

		- Structural optimization - Study by Jones. - Geom. changes to mechanical properties of the humerus			
13	**The design of bone**	– Introduction. - Requirements of design for bone - Incidence of fracture of various bones - Observation from the fracture incidence data	1	2	a1,a2, b1,b2,b3,c1 ,c2,d1
Number of Weeks /and Units Per Semester			**14**	**28**	

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	These will cover similar material to the lectures.	14	28	a1, a2,b1, b2, c1, c2
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Tutorials
- Presentation/seminar,
- Interactive class discussions,
- Case studies
- Exercises and home works,
- Directed self- study,

V. Teaching Strategies of the Course:

- Problem based learning,
- Interactive lectures & examples,
- Interactive class discussions,
- Tutorial
- Directed self- study,
- Exercises and home works,
- Case studies Mini/major project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Coursework activities assessment,
- Home works and assignments,
- Presentations.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Tutorials:#15	a1,a2, b1,b2,b3,c1,c2,d3	Weekly	30
Total				30

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Assignments	Weekly	30	20%	a1,a2, b1,b2,b3,c1,c2,d3
2	Quiz 1	4	10	6.67%	a1,a2, b1,b2,b3,c1,c2,d3
3	Midterm Exam	8	30	20%	a1,a2, b1,b2,b3,c1,c2,d3
4	Quiz 2	12	10	6.67%	a1,a2, b1,b2,b3,c1,c2,d3
5	Final Exam	16	70	46.67%	a1,a2, b1,b2,b3,c1,c2,d3
Total			150	100%	

IX. Learning Resources:

1- Required Textbook(s) (maximum two).

1. C. Ross Ethier, Craig A. Simmons , 2007 **"Introductory Biomechanics - From Cells to Organisms"** , Cambridge University Press
2. Cees Oomens, Marcel Brekelmans, Frank Baaijens , 2009 **"Biomechanics Concepts and Computation"** Cambridge University Press

2- Essential References.

1. Joseph Hamill, Kathleen M., Timothy R., 2015, **"Biomechanical Basis of Human Movement",** 4th Ed. USA , University of Massachusetts at Amherst Amherst, Massachusetts.

2. Susan J. Hall,2015 **" Basic Biomechanics",** 7th Ed. College of Health Sciences University of Delaware.
3. Duane Knudson ,2007 **"Fundamentals of Biomechanics",** Springer Science +Business Media, LLC

3- Electronic Materials and Web Sites *etc*.

Websites:

1- The American Society of Biomechanics (ASB) was founded in October 1977 by a group of 53 scientists and clinicians. The mission of the ASB is to foster the advancement, communication, and application of biomechanics to benefit society.
https://asbweb.org/

2- The International Society of Biomechanics in Sports is composed of members from all over the world with a common desire to study and understand human movement, especially as it relates to applied sports biomechanics.
https://isbs.org/

Journals:

1- Journal of Applied Biomechanics
https://journals.humankinetics.com/configurable/content/journal

2- Russian Journal of Biomechanics
http://vestnik.pstu.ru/biomech/about/inf/?lang=eng

X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university

	Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects**: In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating**: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies**: - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.

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Template for Course Plan (Syllabus)

Biomechanics
BE324

I. Course Identification and General Information:					
1	**Course Title:**	Biomechanics			
2	**Course Code & Number:**	BE243			
3	**Credit Hours:**	**Credit Hours**	**Theory Hours**		**Lab. Hours**
			Lecture	**Exercise**	
		3	2	2	--
4	**Study Level/ Semester at which this Course is offered:**	3^{th} Level / 2^{nd} Semester			
5	**Pre –Requisite (if any):**	Mechanics			
6	**Co –Requisite (if any):**	None			
7	**Program (s) in which the Course is Offered:**	Bachelor of Biomedical Engineering			
8	**Language of Teaching the Course:**	English			
9	**Location of Teaching the Course:**	Faculty of Engineering			
10	**Prepared by:**	Dr. Mushtaq Alazazi			
11	**Reviewed by:**				
12	**Date of Approval:**				

II. Course Description:

Biomechanics is one of the most important supporting subjects for the principles and practices of health technology. This course will provide an introduction to the mechanical behavior of biological tissues and systems. The purpose of this course is to introduce students to concepts of mechanics as they apply to human movement.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)

A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:	
a1	Describe the essential concepts of biomechanics and their impacts on the behavior of physical bodies subject to forces or displacements.
a2	Identify the mechanical engineering problems in biomaterials and biomedical devices, explain the problems with critical thinking generated from mechanics concepts, and solve the problems with mechanics theory.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Illustrate how basic physical principles apply to human motion and the mechanical properties of musculoskeletal tissues.
b2	Analyze the optimization of human performance through application of biomechanical principles.
b3	Propose the use of biomechanical analysis in the design of implantable artificial prostheses and in the engineering of living tissues.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	
c1	Apply life science and engineering concepts in the process of evaluating and understanding normal and abnormal movements to theoretically develop processes for the production of biomedical physiotherapy devices and artificial limbs .
c2	Use standards testing procedures to evaluate joint motion at the hip, knee and ankle during a walking and running gait cycle.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)	
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	Engage in life-long self-learning to overcome challenges and further development in biomechanics and rehabilitation medicine.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction**	– Introduction to the course. – Course outlines. – The importance of biomechanics – Biomechanics applications and examples – A brief history of biomechanics	W1	2
2	**Introduction to Cell**	– Introduction to cellular architecture – A Framework (the cytoskeleton) – Engines (the mitochondria) – The cells energy system – Adenosine triphosphate (ATP).	W2	2
3	**Muscles and movement**	– Types of Muscle – Skeletal muscles – Smooth muscle – Cardiac Muscle – The two basic ATP production strategies. – Skeletal muscle characteristics – Overview of skeletal muscle structure.	W3-W4	4

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		– Sliding Filament Model – Myosin cross-bridges – Isometric and Isotonic contraction. – Muscle constitutive modelling – Load–length relationship for skeletal muscle. – Load–velocity relationship		
4	**Three element model for muscle**	– – Continuum mechanic – Constitutive equation – Constitutive models of linear viscoelasticity – The elastic components – The viscous components – Maxwell model – Kelvin–Voigt model – Three element model for muscle	W5	2
5	**Whole muscle mechanics**	– Muscle Mechanics – Parallel versus pinnate muscle types – Parallel Arrangement – The force generated by Parallel muscle, – Pinnate Arrangement – the force generated by bipinnate muscle.	W6	2
6	**Muscle/bone interactions**	– Foreleg motion	W7	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		– Flexion of the elbow – The muscles responsible for elbow flexion – The physiological cross-sectional area (PCSA)		
7	**Mid-Term Theoretical Exam**	All Preceding Lectures	W8	2
8	**Biomechanics of the knee**	– Introduction to biomechanics of the knee – Bones involved in the knee joint – Cruciate ligaments – Patellar ligament – Quadriceps – Meniscus – knee flexion – Femoro-patellar contact loads – Diagram of forces acting in and on the knee during flexion – Femoro-patellar contact loads during walking	W9	2
9	**Skeletal biomechanics**	– The skeletal system – Introduction to bone – Functions of bone – Distribution of bones – Composition and structure of bone – How bone replaced	W10	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		– Composition of bone – Types of bone cells – Bone tissue – Cortical and trabecular bone – Density of bone tissue – Cortical properties – Trabecular import ants – Trabecular 3D		
10	**Mechanics of materials**	– – Principal objective of mechanics – Normal stress and strain – Solid mechanics – Deformation – Modulus of elasticity – Length scale – A fiber-reinforced composite (FRC) – Young's modulus – Poisson's ratio – Tensile strength – Compressive strength – Yield strength – Strain rate – Relative density – Linear elasticity	W11	2
11	**Biomechanical properties of Cortical and**	– Introduction – Cortical bone mechanics – Mechanical properties of cortical bone	W12	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
	trabecular bone	– Trabecular bone mechanics – Properties of human trabecular – Stress–strain curve – Compressive stress–strain curve – Density dependence – Relationship between relative density and Young's modulus of trabecular bone. – Relationship between relative density and compressive strength of trabecular bone.		
12	**Unit cell models**	– Unit cell models – Model of the cytoskeleton – Tensegrity – Prestressed structure – The actin cytoskeleton – Idealized models for the microstructure of trabecular bone	W13	2
13	**Functional adaptation and mechanobiology**	– Introduction – Functional adaptation – Wolff's law – Functional adaptation that intrigue researchers – Structural optimization – Study by Jones. – Geom. changes to mechanical properties of the humerus	W14	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
14	**The design of bone**	– Introduction – Requirements of design for bone – Incidence of fracture of various bones – Observation from the fracture incidence data	W15	2
15	**Final Theoretical Exam**	All topics.	W16	2
Number of Weeks /and Units Per Semester			**16**	**32**

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours
1	These will cover similar material to the lectures.	15	30
Number of Weeks /and Units Per Semester		**15**	**30**

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Tutorials
- Presentation/seminar,
- Exercises and home works,
- Case studies
- Directed self- study,

V. Teaching Strategies of the Course:

- Team work (cooperative learning),
- Problem based learning,

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Coursework activities assessment,
- Home works and assignments,
- Presentations.

VII. Assignments:

No.	Assignments	Week Due	Mark
1	**Tutorials:#15**	weekly	**30**
Total			**30**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	**Assignments**	weekly	30	20%
2	**Quiz 1**	4	10	6.67%
3	**Midterm Exam**	8	30	20%
4	**Quiz 2**	12	10	6.67%
5	**Final Exam**	16	70	46.67%
Total			**150**	**100%**

IX. Learning Resources:

1- Required Textbook(s) (maximum two).

1. C. Ross Ethier, Craig A. Simmons **"Introductory Biomechanics - From Cells to Organisms "**2007 Cambridge University Press
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Journals:

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2- Russian Journal of Biomechanics
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