

BIOL 4000 / 6000: Quantum Biology (Spring, 2018)

1. Course Information

- Course number and section: BIOL 4000 (A) (CRN #: 21996) / BIOL 6000 (A) (CRN #: 22018)
- Course name: Quantum Biology
- Hours of credit: 3
- Pre-requisites or co-requisites as listed in university catalogue:
BIOL 4000: Prerequisites: BIOL 1107K, BIOL 1108K, BIOL 3200, and 3250.
BIOL 6000: Prerequisite: Admission into the graduate program or permission of the instructor.
- Classroom location and room number: M & W 3:30 pm - 4:45 pm, BC 1202
- Department, College, University: Department of Biology, College of Arts and Sciences, Valdosta State University

2. Instructor Information

- Instructor name: Dr. Jonghoon Kang
- Instructor contact: BC 2217, 229-333-7140, jkang@valdosta.edu
- **Instructor office hours: M & W 2:00 pm - 3:00 pm**

3. Course Description

- Course description as printed in university catalogue: Selected topics in the biological sciences. May be repeated if the topic is different. This course does not include a laboratory.
- Required texts, resources, and materials: ***“Life on the Edge: The Coming of Age of Quantum Biology”*** by Johnjoe McFadden and Jim Al-Khalili from Broadway Books (ISBN-13: 978-0307986825). I will also use articles in class. They will be posted on the Blazeview.
- Required out-of-class activities: In addition to attending the lectures you need to
 - ✓ Read your notebook/ppt materials (very important).
 - ✓ Read the textbook
 - ✓ Complete assignments.
- **Specific Description of Course**
The course focuses on how **quantum mechanics** plays a role in biological and biochemical phenomena. Basic concepts in quantum aspects of nature will be reviewed and their implications in biology will be examined. Traditionally biologists don't need to learn quantum mechanics because most biological phenomena can be explained without knowing the quantum nature of the system. However, with recent development of experimental techniques and theoretical advancement, it is now clear that **the quantum aspect of nature plays a critical role in some biological phenomena including consciousness**. This course is **ambitious and exciting** in that we are going to **explore the interface between biology and the quantum world to learn how the weirdest aspect of the nature manifests itself in biology**. I will teach **biology, mathematics, and physics** relevant to this course. Even though the use of mathematics will be minimized to the level of pre-calculus as this course is mainly targeted for biology students, students should expect to learn some advanced mathematics such as complex numbers, calculus, differential equations, and matrix algebra at least at the conceptual level.

4. Standards, Goals, Objectives, or Outcomes

- outcomes:

The departmental educational outcomes (listed in the university catalogue).

1. Develop and test hypotheses, collect and analyze data, and present the results and conclusions in both written and oral formats used in peer-reviewed journals and at scientific meetings.
3. Demonstrate an understanding of the cellular basis of life.
4. Relate the structure and the function of DNA/RNA to the development of form and function of the organism and to heredity.

Specific Outcomes

- Comprehend basic (quantum) physics
- Acquire basic mathematical skills used in quantum mechanics
- Recognize the necessity of quantum physics in explaining some biological phenomena
- Describe those biological phenomena with quantum mechanics
- Demonstrate literature analysis capability in quantum biology
- Demonstrate competency for the basic quantum physics and chemistry in standard tests such as MFT, GRE, MCAT, and DAT
- Perform a research project in quantum biology assigned by the instructor and present results of the research (Graduate students)

5. Assignments (explicitly aligned with the goals, objectives, or outcomes)

- General description of the assignments: Students are required to read the lecture materials to be covered before and after class. Some additional materials will be posted on the Blazeview and you need to study them before class. There will be three in-class tests, one final test, and two assignments.
- Policies for missed assignments, make-up assignments, late assignments, and/or extra credit: If you miss any assignment due to medical or family-related emergency you can have make-up assignments as long as you prove the valid reason of your absence (doctor's notes). Late assignments will not be accepted. If you miss class more than three times for any reasons, you won't pass this course. So, make sure that you attend all lectures.

6. Assessment or Evaluation Policy

- Explanation of how much each assignment contributes to the overall grade for the class:

**Total Score for Undergraduate =
300 (In Class Exam) + 10 (A1) + 50 (A2) + 200 (Final) = 560**

**Total Score for Graduates =
300 (In Class Exam) + 10 (A1) + 50 (A2) + 50 (Presentation) + 200 (Final) = 610**

- Explanation of how grades are assigned:

| Total score (%) | Grade |
|-----------------|-------|
| $\geq 90\%$ | A |
| $\geq 80\%$ | B |
| $\geq 70\%$ | C |
| $\geq 60\%$ | D |
| $< 60\%$ | F |

7. Schedule of Activities or Assignments, including university -scheduled final exam time (all schedule is tentative and may be subject to change)

| Date | Topic |
|------|---|
| 1/8 | Introduction to Quantum Mechanics. What is It? Quantum Theory - Full Documentary HD by Brian Green https://www.youtube.com/watch?v=CBrsWPCp_rs (YouTube, about 60 min) What are the key words in the presentation? |
| 1/10 | Introduction to Quantum Biology: An Example A Brief History of the Study Consciousness by Stuart Hameroff (YouTube, about 45 min) https://www.youtube.com/watch?v=hKAVgq99o_w What are the key ideas of the presentation? Assignment 1: one paragraph comment to each video (10 pts) (Due: 1/17) |
| 1/15 | <i>MLK HOLIDAY</i> |
| 1/17 | Introduction to Quantum Physics (PDF1 page 1 – page 17) Quantization of Energy; The Photoelectric Effect; Photon Energies; Photon Momentum |
| 1/22 | Introduction to Quantum Physics (PDF1 page 17 – page 34) Particle-Wave Duality; Wave Nature of Matter; Uncertainty Principle |
| 1/24 | Atomic Physics (PDF2 page 1 – page 15) Main topic: Bohr’s Theory of the Hydrogen Atom |
| 1/29 | Atomic Physics (PDF2 page 15 – page 28) X Rays; Atomic Excitation and De-Excitations; Wave Nature of Matter |
| 1/31 | Atomic Physics (PDF2 page 28 – page 40) More Quantization; Quantum Numbers; Pauli Exclusion Principle |
| 2/5 | EXAM 1 (100 pts) |
| 2/7 | Quantum Biology of Reactive Oxygen Species (paper) |
| 2/12 | Quantum Mitochondrion (paper) |
| 2/14 | Minimum Biological Energy Quantum (paper) |
| 2/19 | Mathematics for Quantum Biology I http://www.eng.famu.fsu.edu/~dommelen/quantum/style_a/contents.html |
| 2/21 | Mathematics for Quantum Biology II |
| 2/26 | Mathematics for Quantum Biology III |
| 2/28 | Particle in a Box; Quantum Mechanics on the Color of Carrots |
| 3/5 | EXAM 2 (100 pts) |
| 3/7 | Quantum Interference and Selectivity through Biological Ion Channels (paper) Discussion of A2 |

8. Classroom Policy

Accommodations Statement

Students with disabilities who are experiencing barriers in this course may contact the Access Office for assistance in determining and implementing reasonable accommodations. The access Office is located in Farbar Hall. The phone numbers are 229-245-2498 (V), 229-375-5871. For more information, please visit VSU's Access Office or email: access@valdosta.edu.

Title IX Statement

Valdosta State University (VSU) is committed to creating a diverse and inclusive work and learning environment free from discrimination and harassment. VSU is dedicated to creating an environment where all campus community members feel valued, respected, and included. Valdosta State University prohibits discrimination on the basis of race, color, ethnicity, national origin, sex (including sexual harassment and sexual violence), sexual orientation, gender identity, religion, age, disability, genetic information, or veteran status, in the University's programs and activities as required by applicable laws and regulations such as Title IX. The individual designated with responsibility for coordination of compliance efforts and receipt of inquiries concerning nondiscrimination policies is the University's Title IX Coordinator: the Director of the Office of Social Equity, titleix@valdosta.edu, 1208 N. Patterson St., Valdosta State University, Valdosta, Georgia 31698, 229-333-5463.

- Arrive on time. In the event that a student misses a class with an excuse, s/he should email the instructor within 24 hours of the missed class. It is the instructor's prerogative to accept the excuse or not. Students are still responsible for all class content even if they received an excused absence.
- Cell phones are not allowed to be used in class.
- Email: Please email me only from a VSU email account. I am unable to respond to emails from non-VSU accounts.
- Academic integrity is the responsibility of all VSU faculty and students. Students are responsible for knowing and abiding by the Academic Integrity Policy as set forth in the Student Code of Conduct and the syllabus. All students are expected to do their own work and to uphold a high standard of academic ethics. Cheating (including plagiarism) will not be tolerated. The instructor reserves the right to dismiss you from the course without credit if you are caught cheating. You will be respectful of your instructor and your fellow students at all times, or you will be dismissed from the class and potentially the course.
- No arguments on final grade. You can check any mistake in the calculation of your grade but no any other arguments.

9. Additional Information (at instructor's discretion)

- Strategies used to support learning: Students should take advantage of my office hours. Studying as a group (study group) should be a good idea. However, you have to complete all assignments by yourself. If cheatings are found in your works, all students involved will get a zero point in those assignments.
- ***I will teach you and you will learn a fascinating science, quantum biology. Therefore, your intellectual enhancement from taking this course will depend on both of us.***