BIOL 4560 / 6560: Quantum Biology (Fall, 2020)

1. Course Information
   - Course number and section: BIOL 4560 (A) (CRN #: 84426) / BIOL 6560 (A) (CRN #: 84427)
   - Course name: Quantum Biology
   - Hours of credit: 3
   - Pre-requisites or co-requisites as listed in university catalogue:
     BIOL 4560: Prerequisites: A grade of "C" or better in MATH 2261, BIOL 1107, BIOL 1107L, BIOL 1108, 1108L, BIOL 3200, CHEM 1211, CHEM 1211L, CHEM 1212, CHEM 1212L, and either PHYS 1111K or PHYS 2211K or consent of the instructor.
     BIOL 6560: Prerequisite: Admission into the graduate program or permission of the instructor.
   - Classroom location and room number: T & R 9:30 am - 10:45 am, BC 2202
   - 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: Thursday, 2:00 pm - 3:00 pm
3. Course Description
   - Course description as printed in university catalogue: A study of the role of quantum mechanics in biological and biochemical phenomena. Basic concepts in quantum aspects of nature will reviewed and their implications in biology will be examined.
   - Required texts, resources, and materials: I will also use articles in class. They will be posted on Blazeview.
   - Required out-of-class activities: In addition to attending the lectures you need to
     - ✓ Read your notebook/ppt materials (very important).
     - ✓ Read the papers
     - ✓ 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. The use of mathematics will be minimized to the level of pre-calculus as this course is mainly targeted for biology students.
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 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) + 25 (A1) + 25 (A2) + 50 (Paper Review) = 400

Total Score for Graduates =
300 (In Class Exam) + 25 (A1) + 25 (A2) + 50 (Presentation) = 400

- Explanation of how grades are assigned:

Total score (%)	Grade
>= 90%	A
>= 80%	B
>= 70%	C
>= 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
8/18	Introduction to Quantum Mechanics. What is It? Quantum Theory - Full Documentary HD by Brian Greene https://www.youtube.com/watch?v=CBrsWPCp_rs (YouTube, about 60 min)
8/20	Syllabus; Philosophical introduction to science through Kang's research
8/25	Introduction to Quantum Physics (PDF1 page 1 – page 13) Quantization of Energy; The Photoelectric Effect; Photon Energies
8/27	Introduction to Quantum Physics (PDF1 page 13 – page 21) Photon Momentum; Particle-Wave Duality; Wave Nature of Matter
9/1	Introduction to Quantum Physics (PDF1 page 21 – page 27) Uncertainty Principle; Particle-Wave Duality Reviewed
9/3	Exercises for Exam 1
9/8	**Open Notebook EXAM 1 (100 pts)**
9/10	Atomic Physics (PDF2 page 1 – page 15) Main topic: Bohr's Theory of the Hydrogen Atom
9/15	Atomic Physics (PDF2 page 15 – page 28) X Rays; Atomic Excitation and De-Excitations; Wave Nature of Matter
9/17	Atomic Physics (PDF2 page 28 – page 34) More Quantization; Quantum Numbers
9/22	Atomic Physics (PDF2 page 34 – page 40) Pauli Exclusion Principle
9/24	Quantum Mechanics by Excel **(Assignment 1: Due 9/29)** *will be discussed in detail*
9/29	Particle in a Box; Quantum Mechanics of the Color of Carrots
10/1	Exercises for Exam 2
10/6	**Open Notebook EXAM 2 (100 pts)**
10/8	Basic concepts in spectroscopy
10/13	UV-Vis Spectroscopy
10/15	Fluorescence spectroscopy
10/20	NMR

10/22	Quantum Biology of Reactive Oxygen Species (paper)
10/27	Quantum Mitochondrion (paper) Minimum Biological Energy Quantum (paper) Energy Equivalence of Information (paper) **(Assignment 2: Due 10/29)** *will be discussed in detail*
10/29	Quantum physics meets biology by Arndt Matter Waves (paper)
11/3	Quantum Tunneling in Catalysis and Adaptive Mutation (paper)
11/5	Photosynthesis: A Little Coherence in Photosynthetic Light Harvesting (paper)
11/10	Quantum Mechanics of Consciousness (paper)
11/12	Review for Exam 3
11/17	**Open Notebook EXAM 3 (100 pts)**
11/19	**Student Presentation (50 pts)** *will be discussed in detail*
TBA	**Paper Review (50 pts)** *will be discussed in detail*

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.***