

## **MOLECULAR DELIVERY APPLICATIONS IN BIOTECHNOLOGY: 11:126:434 S16**

### **Brief Introduction:**

Both man and nature produce delivery systems for biomolecules. An increasing number of biotechnological innovations are being aided by packaging into various supramolecular or particulate delivery systems, often on the nano scale. This strategy has already evolved within a number of natural biological species as well. In this course, the applications and mechanisms-of-action of formulated and natural biological delivery systems are explored, such as liposomes, carbon-based nanostructures, polymeric complexes, dendrimers, viruses, extracellular vesicles, etc. A broad range of applications will be addressed, from agricultural to pharmaceutical.

### **Instruction method:**

Each week will typically involve one 80 minute lecture and one 80 minute period of lecture/discussion/student presentations.

### **Topics:**

- Natural cellular delivery/communication strategies versus man-made
- Large versus small molecule delivery issues
- Types of nanoscale constructs
- Vesicular versus solid particles; lipid-based vs. polymers
- Characterizing particles – analysis of the physical parameters of particles; assessing biological compatibility and suitability.
- Biological responses to particles –
  - various types of immune and non-immune responses
  - uptake mechanisms – endocytosis, pinocytosis, etc.
  - non-specific mechanisms of biological degradation of delivery particles
  - clearance mechanisms
- The relative importance of physical versus biological parameters in delivery
- Methods of targeting delivery
  - Antibodies, ligands, randomly-generated binding molecules
- Delivery using synthetic biology – the potential role of engineered extracellular vesicles
- Design of multifunctional delivery particles
- Monitoring delivery in tissues – (where did my molecule go? Is it bioavailable?)
- Biopharmaceutical applications
- Agricultural applications of formulation and nanotechnology

### **Learning goals:**

#### **Upon completion of this course, students will be able to:**

- Choose delivery systems for specific purposes or specific active molecules
- Describe the current experimental methods used to generate appropriate delivery systems
- Predict potential biological challenges to specific types of delivery
- Design experiments to test the bioavailability and efficacy of formulation
- Know how to design/develop targeting technologies
- Understand how to test for innate immune responses
- Understand how to choose analytical tools for physical characterization of delivery particles

### **Assessment measures:**

All goals will be assessed by:

- 1) Satisfactory completion of class and take-home assignments
- 2) Participation in group activities - in-class discussion and presentations
- 3) Performance in midterm and final exams
- 4) Completion of an individual or group project that designs a delivery solution to a specific problem.

**Grading:**

Coursework will be weighted as follows:

- Attendance/Class Participation 10%
- Midterm and Final Exams 30%
- Lab Homework/Quizzes 30%
- Individual/Group project(s) 30%

**Tentative Class Syllabus:**

Week 1 – Delivery issues – why do we need formulations or other carriers?

Week 2 – Types of delivery formulations; large vs. small molecule considerations

Week 3 – Liposomal delivery

Week 4 - Polymers

Physical properties of formulations

Week 4 – Biological uptake of particles

Week 5 – Toxic effects, immune responses

Biological Delivery Systems

Week 6 – Viral delivery for polynucleotides

Week 7 – Extracellular vesicles as delivery vehicles

Week 8 – Tools for monitoring biological distribution of delivery vehicles

Week 9 – Design and use of multifunctional particles

Week 10 – Agricultural delivery systems – foods and fertilizers

Week 11 - Small molecule drug delivery

Week 12 – Diagnostic nanotechnology

Week 13 - Recent trends in polynucleotide delivery

Week 14 – Theranostics

The midterm exam will be a take-home exam, and the final exam will be an in-class exam given during final exam week.

**Reading:**

Several reference sources will be made available at the library, some articles will be handed out and some assigned by internet access.

**ACCOMODATIONS FOR STUDENTS WITH DISABILITIES**

Please follow the procedures outlined at <https://ods.rutgers.edu/students/registration-form>.

Full policies and procedures are at <https://ods.rutgers.edu/>

**ABSENCE POLICY**

Students are expected to attend all classes; if you expect to miss one or two classes, please use the University absence reporting website <https://sims.rutgers.edu/ssra/> to indicate the date and reason for your absence. An email is automatically sent to me.

#### **COURSE SCHEDULE:**

TBD

#### **FINAL EXAM/PAPER DATE AND TIME**

Online Final exam Schedule: <http://finalexams.rutgers.edu/>

TBD

#### **ACADEMIC INTEGRITY**

The university's policy on Academic Integrity is available at <http://academicintegrity.rutgers.edu/academic-integrity-policy>. The principles of academic integrity require that a student:

- properly acknowledge and cite all use of the ideas, results, or words of others.
- properly acknowledge all contributors to a given piece of work.
- make sure that all work submitted as his or her own in a course or other academic activity is produced without the aid of impermissible materials or impermissible collaboration.
- obtain all data or results by ethical means and report them accurately without suppressing any results inconsistent with his or her interpretation or conclusions.
- treat all other students in an ethical manner, respecting their integrity and right to pursue their educational goals without interference. This requires that a student neither facilitate academic dishonesty by others nor obstruct their academic progress.
- uphold the canons of the ethical or professional code of the profession for which he or she is preparing.

Adherence to these principles is necessary in order to ensure that

- everyone is given proper credit for his or her ideas, words, results, and other scholarly accomplishments.
- all student work is fairly evaluated and no student has an inappropriate advantage over others.
- the academic and ethical development of all students is fostered.
- the reputation of the University for integrity in its teaching, research, and scholarship is maintained and enhanced.

Failure to uphold these principles of academic integrity threatens both the reputation of the University and the value of the degrees awarded to its students. Every member of the University community therefore bears a responsibility for ensuring that the highest standards of academic integrity are upheld.

#### **STUDENT WELLNESS SERVICES**

Just In Case Web App <http://codu.co/cee05e>

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

#### Counseling, ADAP & Psychiatric Services (CAPS)

(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901 / [www.rhscaps.rutgers.edu/](http://www.rhscaps.rutgers.edu/)  
CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

#### Violence Prevention & Victim Assistance (VPVA)

(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 / [www.vpva.rutgers.edu/](http://www.vpva.rutgers.edu/)  
The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

#### Disability Services

(848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / <https://ods.rutgers.edu/>  
Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: <https://ods.rutgers.edu/students/documentation-guidelines>. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: <https://ods.rutgers.edu/students/registration-form>.

#### Scarlet Listeners

(732) 247-5555 / <http://www.scarletlisteners.com/>  
Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.