

CHEMICAL ENGINEERING 4T3
January – April 2010

APPLICATIONS OF CHEMICAL ENGINEERING IN MEDICINE

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LECTURE HOURS: Tuesday 8:30-10:30 BSB/B137
Friday 8:30-9:30 BSB/B137

COURSE OBJECTIVE:

To impart some detailed knowledge and an overall appreciation of the contributions, actual and potential, of chemical engineering to medicine and biotechnology

TOPICAL OUTLINE:

Basic Biochemistry, Anatomy and Physiology – self study/ group project

Biomaterials - definitions, applications, properties, characterization

Biomaterials in blood contacting applications - blood vessels, cardiac valves, intra-aortic balloons, stents, left ventricular assist devices, total artificial heart, hemodialysis

Biomaterials in non-blood contacting applications - ophthalmic, orthopedic, dental applications

Controlled release drug delivery – materials, transport aspects, degradable systems, commercially available drug delivery systems

Tissue engineering – scaffolds, growth factors

Nanomaterials in medicine – unique properties at the nanoscale, applications, “personalized medicine”

FORMAT:

Full class sessions, smaller groups for discussion sessions, design projects

ASSESSMENT:

Midterm Exam (Take-Home)	15%
Biochemistry Group Project	2%
Final Examination Question and Solution	3%
Literature discussion	5%
Design projects	20%
Research paper	25%
Final exam	30%

KEY DATES:

January 12 – Biochemistry project in-class group time
January 22 – Biochemistry project due (in class; no later than 9:30AM)
February 12 – Design project #1 due (in class; no later than 9:30AM)
February 12 – Midterm test distributed
February 26 – Midterm test due (in class; no later than 9:30AM)
March 12 – Design project #2 due (in class; no later than 9:30AM)
March 30 – Final examination question due
(hard copy in class; electronic copy no later than 10:30AM)
April 2 – Design project #3 due (in class; no later than 9:30AM)
April 6 – Final project due (in class; no later than 10:30AM)

NOTES ON ASSESSMENTS:

- In order not to replicate material that some of the students know well, there will be a self-study project on General Biochemistry involving a small design/research project. Students must work in groups of four to complete this assignment. One lecture period in January (Jan. 12) will be allocated to completion of this project during which time the TA will be available.
- The research paper will be written on a topic of your choice. Any topic in the general field of applying engineering principles in medicine will be considered. This topic must be approved by the instructor – please submit two choices of topics by e-mail to Dr. Hoare no later than **January 29** for approval. A marking scheme for the paper will be available on ELM.
- The two-hour lecture each Tuesday will typically be divided into two one-hour segments; hour 1 will be a regular lecture while hour 2 will involve literature discussions, a patent mock-litigation, guest lectures on experts in specific areas of applying chemical engineering in medicine, or special topics of interest in biomedical research (how to read the literature, regulatory approvals, etc.)
- Journal articles and patents on various topics will be handed out throughout the term. The papers will be discussed in class during the second hour of lecture the following Tuesday. A maximum one page summary of your notes and assessment of the paper should be produced in anticipation of this discussion and will (at times) be submitted and assessed to make up part of the literature discussion evaluation mark.
- A final examination question worth 10 marks with a full solution must be developed and handed in based on the material covered in class (electronic copy preferred). All questions and solutions submitted will be distributed. One question will be selected and included on the final examination.
- Many of the sections that we cover will culminate in a design project which will require you to develop a new device or system to solve an existing biomedical engineering problem.

ASSESSMENT POLICIES:

- Any calculator may be used on the final examination. One page (8.5x11, front and back) of cheat notes may be used in the final examination. The final percentage grades will be converted to letter grades using the Registrar's recommended procedure. Adjustments to the final grades may be done at the discretion of the instructor.
- Late evaluations will be assessed a penalty of 20% per school day late. If deadlines cannot be met due to sickness or other valid reasons, the student should inform the instructor prior to the deadline to arrange alternate due dates. If a deadline is missed without informing the instructor prior to the deadline, you must present suitable documentation to the Associate Dean's office and present the form to the professor.

The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant as soon as possible.

Students are reminded that they should comply with the *Statement on Academic Ethics* and the *Senate Resolutions on Academic Dishonesty* as found in the Senate Policy Statements distributed at registration and reproduced below.

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at http://www.mcmaster.ca/senate/academic/ac_integrity.htm

The following illustrates only three forms of academic dishonesty:

1. *Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained. (Insert specific course information, e.g. style guide)*
2. *Improper collaboration in group work. (Insert specific course information)*
3. *Copying or using unauthorized aids in tests and examinations.*

RESOURCES:

There is no single textbook available to cover all aspects of the course. In addition to course notes, available online, the sources in the accompanying list may be found generally useful.

READING RESOURCES FOR CHE 4T3/6T3

- J. Enderle, S. Blanchard, J. Bronzino "Introduction to Biomedical Engineering" (2005). This is the recommended text for the course. Approximately 1/3 of the topics covered are in this book.
- J.D. Bronzino (ed.), "The Biomedical Engineering Handbook" (1995)
- R. Baker, "Controlled Release of Biologically Active Agents" (1987)
- D.A. Lauffenburger and J.J. Linderman, "Receptors: Models for Binding, Trafficking and Signaling" (1993).
- D.O. Cooney, "Biomedical Engineering Principles" (1976)
- A.C. Burton, "Physiology and Biophysics of the Circulation" (1972)
- T.E. Creighton, "Proteins: Structure and Function" (1992)
- F. Eirich (ed.), "Rheology" vol 4 (Chapter by Goldsmith and Mason) (1967)
- G. Cokelet, H.J. Meiselman, D.E. Brooks (eds.), "Erythrocyte Mechanics and Blood Flow" (1980)
- L. Dintenfass, "Blood Viscosity" (1985)
- J.O. Rowan, "Physics and the Circulation" (1981)
- S. Middleman, "Transport Phenomena and the Cardiovascular System" (1972)
- R.L. Whitmore, "Rheology of the Circulation" (1968)
- D.N. Ghista *et al* (eds.), "Theoretical Foundation of Cardiovascular Processes" (1979)
- D.H. Bergel (ed.) "Cardiovascular Fluid Dynamics" (1972)
- D.J. Schneck (ed.), "Biofluid Mechanics 2" (1980)
- A.C. Guyton, "Textbook of Medical Physiology" latest edition
- A.L. Shrier and T.G. Kaufmann (eds.), "Mass Transfer in Biological Systems" CEP Symposium Series No. 99 (1970)
- D. Hershey (ed.), "Blood Oxygenation" (1978)
- J.B. Park, "Biomaterials Science and Engineering" (1984)
- Shitzer and R.C. Eberhart, "Heat Transfer in Medicine" (1987).
- R.C. Seagrave, "Biomedical Applications of Heat and Mass Transfer" (1971)
- M.S. Lih, "Transport Phenomena in Medicine and Surgery" (1975)
- A.L. Lehninger, "Biochemistry", numerous editions or other biochemistry text
- C.W. Patrick, A.G. Mikos, L.V. McIntire (eds) "Frontiers in Tissue Engineering" (1998)
- R.P. Lanza, R. Langer and W.L. Chick (eds) "Principles of Tissue Engineering" (1997)