Engineering Faculty Document No. 49-02
April, 2003

TO: Engineering Faculty

FROM: The Faculty of the Agricultural and Biological Engineering

RE: New Undergraduate Course

The faculty of the Department of Agricultural and Biological Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ABE 303 Applications of Physical Chemistry to Biological Processes

Sem. 1, Class 3, cr. 3.

Prerequisite: ABE 210, CHM 257 and Co-requisite: CHE 377 or consent of instructor

Physical chemical principles associated with transport of mass, momentum and energy in bioprocesses. Principles for measuring physical chemical properties, a description of predictive equations for their evaluation and the role of these principles in the design and optimization of bioprocesses.

Reasons:

A background on physical chemical principles is essential to the understanding of biological processes. A version of this course has been offered as an elective course (ABE 591O) for two semesters attracting the interest of students from Agricultural and Biological Engineering, Mechanical Engineering and Biomedical Engineering. The number of students in these semesters has been (18, 15). Sem. 1 01 and Sem. 1 02

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Vincent F. Bralts
Head, Department of Agricultural & Biological Engineering

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Description: Physical chemical principles associated with transport of mass, momentum and energy in bioprocesses. Principles for measuring physical chemical properties, a description of predictive equations for their evaluation and the role of these principles in the design and optimization of bioprocesses.

Course Instructor: Osvaldo Campanella

Text: Course packets

References: Physical Chemistry of Foods, P. Walstra, Marcel Dekker, 2003
Rheological Methods in Food Process Engineering, Freeman Press, 1996

Assessment Method: Three exams, homework, final project and presentation

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Course Objectives:
Successful completion of the course will enable the students to:

1. Understand basic principles to measure and calculate physical chemical properties of biomaterials
2. Identify physical chemical parameters associated to heat, mass and momentum transfer phenomena occurring in bioprocesses.
3. Gain knowledge of main factors that determine numerical values of physical chemical properties associated to bioprocesses.
4. Use basic principles of rheology to correlate mechanical properties with quality parameters of biomaterials.
5. Write clear, concise and industrial style reports.
6. Develop an appreciation for working on a team to solve a problem related to the measurement or determination of transport properties associated to bioprocessing engineering

Course Content

Week

1-2	Introduction. Physical chemical principles of biological materials. Aspects of Thermodynamics associated to the prediction of colligative properties of biomaterials, e.g. freezing point depression, boiling point elevation, osmotic pressure. Applications to biopolymers such as proteins and starch
3-4	Bonds and interactions existing in biomaterials. Water relations, water activity, sorption isotherms, water binding concept. Application of water-related properties to the processing and storage of biomaterials.
5	Transport phenomena. Viscosity, thermal conductivity, diffusivity. Transport phenomena in composite biomaterials.
6-8	Estimation of thermophysical properties of biomaterials. Measuring principles. Prediction of freezing times. Application of thermophysical properties to the design of processes, notably freezing, and refrigeration. Estimation of diffusivity. Measuring principles. Application and role in analytical techniques such as chromatography, electrophoresis, sedimentation. Application to encapsulation and complexation.
9-10	Flow and viscosity. Rheology of liquid biomaterials, measurement of their rheology, capillary and rotational viscometry, non-traditional methods such as ultrasound and acoustics. Application to the design of piping and pump systems, application to mixing systems.
11-13	Soft semi-solid materials. Introduction of viscoelasticity. Measurement of biomaterial viscoelasticity. Phase transitions in biomaterials, concept of glass transition and gelation, their role into the processing of biomaterials. Applications to drying, thermal and chemical gelation. Extensional flow. . Measuring principles of extensional flow properties such as squeezing flow, planar extension. Extensional flow in bioprocesses
14-15	Surface phenomena. Surface Tension, adsorption, surfactants, contact angle and wetting, interfacial rheology. Colloidal interactions. Role of biopolymers. Application to emulsions and foams. Rheology of emulsions
16	Dispersity in biopolymers. Aggregation, sedimentation, coalescence, applications to emulsions and foams. Ostwald ripening.

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