Programme of "PRINCIPI DI INGEGNERIA BIOCHIMICA" BIOCHEMICAL REACTION ENGINEERING		
• Code: I0317 • type of course unit: OPTIONAL • level of course unit: second cycle, Chemical Engineering • year of study: 1st; semester: 1st		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)		
Teacher: Alberto Gallifuoco (alberto.gallifuoco@univaq.it)		
1	**Course objectives**	**At the end of the course the students should acquire the ability to:** • identify, model, and solve problems of biochemical reaction engineering which commonly arise in the industrial bioconversions; • develop the basic comprehension of the interactions between mass transfer and applied enzyme kinetics; • exploit their previous knowledge in basic chemical engineering for identifying analogies useful for modeling industrial bioreactors.
2	**Course content and Learning outcomes (Dublin descriptors)**	**Expected results at the end of the course**: • Acquiring knowledge and understanding on the phenomena occurring in bioreactors • Applying knowledge and understanding for solving the mass balances in different enzymatic reactors • Making informed judgments and choices on the operational conditions which could assure the highest yields of bioconversions • Communicating knowledge and understanding, mainly in multidisciplinary environments • Acquiring capacities to continue learning in the field of industrial bioprocesses **Topics of the module include**: Enzyme kinetics. Mechanisms of inhibition and deactivation. Complex kinetics. Ideal enzymatic reactors: batch, plug-flow, CSTR, membrane bioreactors. Analysis of stability: enzymatic CSTR. Enzyme and cells immobilizations: techniques, fundamentals, criteria of applicability. Immobilization yield and activity recovery. Transport phenomena coupled to heterogeneous biochemical reactions. Thiele modulus, Damkhöler number, effectiveness factor. Estimate of effective diffusivity. Discrimination of the controlling step. Apparent and intrinsic kinetics. Heterogeneous enzymatic reactors: UF membrane, fixed bed, CSTR, batch. Oxygen transfer to bioreactors: bubble fluid dynamics, effects of transfer rate on microbial growth. Scale-up criteria for aerated bioreactors. **On successful completion of this module, the student should:** - have profound knowledge of basic heterogeneous biocatalysis - have knowledge and understanding of complex phenomena occurring during bioconversions - understand and explain bioreactor performances - demonstrate skill in model bioreacting systems and ability to solve the resulting equations - demonstrate capacity for reading and understand other interdisciplinary texts on related topics.
3	**Prerequisites and learning activities**	To benefit from the course, students should know chemistry and organic chemistry fundamentals, and basic transport phenomena. A elementary knowledge in biology would be advantageous, although not essential.
4	**Teaching methods and language**	Lectures, exercises, home work Language: Italian/English (when required by students) Ref. Text books: Notes prepared by the Teacher; Bailey & Ollis "Biochemical Engineering Fundamentals", McGraw-Hill Segel "Enzyme Kinetics", Wiley
5	**Assessment methods and criteria**	Oral exam

ANNEX 1

List of verbs to be used for describing LO

Level of cognitive ability	What does it mean?	What verbs are useful?	Example outcomes – 'By the end of this module students will be able to…'
Knowledge	What do we expect students to know? This basic level focuses on recall and description.	Know; Define; Memorise; List; Recall; Name; Relate; Identify; State; Describe; Show; Quote; Present	List the operation principles of common digital circuit applications Identify key features of single celled organisms Identify and describe different forms of the sonnet
Comprehension	What do we expect students to be able to interpret? How do students convey their understanding as well as their recall?	Discuss; Review; Explain; Locate; Illustrate; Clarify; Select; Summarise; Conclude;	Explain how the life cycle of a lytic virus operates Review a range of social science research methods
Application	Can students use a theory or information in different situations? Are students able to articulate the relevance of teaching in other circumstances?	Solve; Examine; Modify; Interpret; Apply; Use; Practise; Demonstrate; Classify;	Use P200 and P1000 Gilson pipettes independently and accurately Use a Lineweaver-Burke plot to calculate Vmax and Km Apply appropriate statistical tests to a dataset
Analysis	Can students identify and explain relationships between material? Can they break knowledge down into constituent parts and show how these parts relate to each other?	Differentiate; Investigate; Appraise; Criticise; Debate; Compare; Contrast; Distinguish; Analyse	Calculate how many white blood cells are in a litre of blood Compare the replication processes of RNA and DNA viruses Analyse recent news stories using the IPA's seven common propaganda devices
Synthesis	Can students take the elements of what they have learnt and put them together in a different way? Can they develop a plan or a proposal from a set of knowledge?	Assemble; Organise; Compose; Propose; Construct; Design; Create; Manage; Develop; Specify; Modify	Construct a dichotomous classification key to identify plant specimens Design programs using selection statements Manage the budget for a practical film production project
Evaluation	Can students make judgements about knowledge? Can they construct an argument or compare opposing views?	Judge; Select; Evaluate; Choose; Assess; Rate; Measure; Argue; Defend.	Evaluate the possible approaches to film-editing Debate the statement "There is a gene for every behaviour" Assess to what extent educational theory is applicable to education policy