

Applied Microbiology and Biotechnology teaching tailored towards regional needs and graduate employment



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The University of the Sunshine Coast (USC) opened in 1996 and since 1999 held the full university status as well as being the first 'Greenfield' university to open in Australia since 1971 (<http://www.usc.edu.au/>). This status was in line with its mission to become an institution with strong emphasis on sustainability and environmentally friendly regional development while transforming a former cane farm into today's multi award-winning modern and distinctive sub-tropical architectural structure. Over the past 20 years the university has played a role as an 'urban catalyst' in one of the rapidly growing and transforming regions of Australia with a foundational mission statement: 'To be the major catalyst for the academic cultural and economic advancement of the region: by leadership; by pursuit of international standards in teaching and research; and by responsiveness to the needs of students, staff, community and the environment'.

Meanwhile simultaneously in the region the State Government of Queensland under the leadership of the former Premier Hon. Peter Beattie was placing emphasis into Biotechnology and the importance of the establishment of a knowledge-based economy for the regional advancement and transformation (<http://www.alumni.uq.edu.au/queensland-the-smart-state>). Again in the same years a discussion paper 'Developing Australia's Biotechnology Future' produced by Biotechnology Australia as a Federal Government Initiative was also highlighting the relevance of biotechnology for the sectors like: health, agriculture, forestry, mining, manufacturing, bioprocessing, environment, food processing and beverages and marine biotechnology and aquaculture¹. Microbiology has always been one of the fundamental disciplines supporting the listed sectors in the discussion paper via the implementation of

microbially mediated processes such as alternative energy generation, waste management, discovery of novel and effective therapeutic drugs and environmentally friendly agro-biologicals. Design and delivery of the courses within the Microbiology stream of the University of the Sunshine Coast related to applied, industrial and environmental aspects were thus implemented in parallel to these developments in the region since 2001².

Microbiology since the Pasteur days has been a discipline with a rich history of connecting research and teaching. Pasteur created pedagogics of the discipline by promoting the value of laboratory research for the individual and the society to grow and improve in harmony with the works of the nature. Since then microbiology continued to build on his 'use-inspired basic research' concept by incorporating it into the teaching practices^{3,4}.

One of the foundational pedagogies used for the design of the microbiology courses at the USC was the *Constructivism*⁵⁻⁷, which:

- 'Advocates teaching as a process that guides students to construct their own knowledge by building connections from what they already know to the information the teacher intends them to acquire'
- 'Students are more likely to learn and remember ideas that are reinforced by their own interests and experiences in the world around them'
- 'Classroom science teaching is recommended to make explicit links between scientific knowledge and everyday experiences'
- 'Microbiology is particularly well suited for these recommendations because the effects of microorganisms are more evident in the world around us (e.g. new infectious diseases, crop failures, food poisoning, antibiotic resistance...)'⁴.

Design pedagogies used during microbiology course development at the USC were targeted to encourage students to reflect on and utilise their own regional knowledge and experiences while transferring theory into design and application of innovative microbial technologies to provide solutions for the regional problems. Such encouragement has been in line with the strategic directions defined for the region by the state and regional governments and councils. In addition, the Pasteur's Quadrant (Figure 1) was also incorporated into the course design and delivery that was 'directly influenced in its course both by the quest of fundamental understanding and the quest of applied use'⁸.

To be able to respond to regional problems at graduate level target-directed teaching was implemented to develop student's understanding about the needs of the rapidly growing region and local

QUEST FOR FUNDAMENTAL UNDERSTANDING?	HIGH	PURE BASIC RESEARCH (BOHR QUADRANT)	USE-INSPIRED BASIC RESEARCH (PASTEUR QUADRANT)
	LOW		APPLIED RESEARCH (EDISON QUADRANT)
		LOW	HIGH
	CONSIDERATION OF USE?		

Figure 1. Pasteur's Quadrant⁸.

industries as well as gaining in-depth understanding in science and microbial biotechnology. Development of a graduate level understanding throughout student's learning was expected to be utilised towards the growth of sustainably advancing region. Examples might include the transformation of the traditional sugar cane industry into a biofuel generating one utilising the advancements in science and technology and opening new avenues for the farmers or converting excessively produced molasses in the region into value-added products such as acetone, butanol or glycerol.

Graduate qualities emphasised to students throughout their education in the University of the Sunshine Coast include:

- 'creative and critical thinking, generating original ideas and concepts, and appreciating innovation and entrepreneurship,
- empowered, having both the capacity and confidence to pursue the attainment of full potential,
- engaged, contributing positively to diverse communities through service and leadership,
- ethical, acting with integrity in intellectual, professional and community pursuits,
- knowledgeable, building disciplinary and interdisciplinary knowledge through a scholarly approach incorporating global and regional perspectives,
- sustainability-focussed, responding to ecological, social and economic imperatives'

Microbiology courses offered since the establishment of the University were thus constructed to embed these qualities.

The USC was also selected as the only university from Australia to be included in an OECD study in 2006 due to its engagement with the local regional community⁹. This recognition provided further impetus and drive for the implementation of microbially mediated processes in the region by empowered graduates via in-depth understanding in applied microbiology. At the graduate level it was expected that:

- the theoretical knowledge is translated by students into action learning by relating their previous regional and environmental knowledge to newly acquired knowledge (e.g. microbial biotechnology);
- students were able to relate the gained knowledge into the big picture as well as into their program of enrolment (e.g. interdisciplinary and holistic approach); and
- discipline-based educational self-development in line with global advancements in the field of microbiology while playing a major role as a graduate in the sustainable and environmentally friendly development of the region (e.g. regional waste management).

The current structure of the delivery of microbiology courses is given in Figure 2, which adapts cumulative learning in microbiology

as well as leading to Honours level studies. Pathway from SRP, WIL courses leading to Honours and post-graduate studies also results in regionally relevant data generation and publication of research papers in partnership with local industries or government bodies^{10–18}. USC's *Teaching-Research Nexus* (Figure 2) was also embedded into the microbiology stream that advocates 'mutually reinforcing connections between teaching and research that are central to the meaning of higher education and the idea of the university'. '*Teaching-Research Nexus* has traditionally driven both curriculum design and delivery, and the research efforts of many universities^{19,20}, and this tradition has also been pivotal at the University of the Sunshine Coast since its foundation. The dual pathway where research shapes and informs teaching, and teaching shapes and informs research defines the nexus' and is embedded in the operations of the University at several levels since its foundation. The significance of *Microbial Resource Centres* in microbiology education has been emphasised globally²¹ and to foster student research activities a *Microbial Library* containing bioactive micro-organisms was also established to provide support material for student research projects²² conducted under the Special Research Project courses. Work Integrated Learning courses are offered through regional industries and government agencies to provide graduate level understanding of the regional needs for sustainable solutions.

The University of the Sunshine Coast, consistent with its strategic plan and 'Aboriginal and Torres Strait Islander education and employment initiatives, also connects with employer and industry/professional bodies to build and extend pathways into higher education for Aboriginal and Torres Strait Islander people. It also has an *Indigenous Advisory Committee* to advise the University on Aboriginal and Torres Strait Islander student matters including equitable access, participation, retention and success. *Indigenous Cadetship Support* (ICS) aims to improve the professional employment prospects of Aboriginal and Torres Strait Islander peoples. It links Aboriginal and Torres Strait Islander tertiary students with employers in a cadetship arrangement involving full-time study and work placements. Cadetships enable Aboriginal and Torres Strait Islander students to gain the professional qualifications and experience needed for a range of jobs in the private, public and community sectors and assists them to move into employment on completion of their studies' <http://www.usc.edu.au/explore/structure/university-committees/vice-chancellors-indigenous-adv>

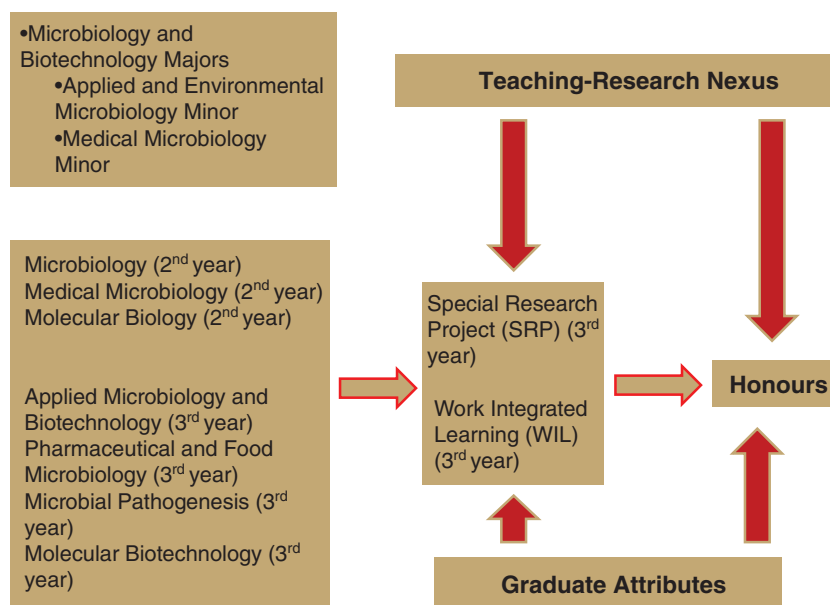


Figure 2. Target directed teaching structure of *Microbiology* and discipline based skills.



Figure 3. Delivery of Applied Microbiology and Biotechnology lecture series at the Perm State University, Russian Federation.

sory-committee. Indigenous communities lived for centuries in self-sustained ways and their increased immunities against microbial diseases are known due to traditional ways of nutrition and living. The discipline of microbiology and traditional knowledge can thus foster a valuable partnership in particular in the field of biomedicine for discovery of new and potent therapeutic compounds.

All above listed target-directed and constructed efforts in the microbiology major have also resulted in the development of international links. Relevance of applied microbiology and biotechnology in the development of sustainable solutions at the global

context for different regions of the world was a point of exchange when a series of invited lectures were delivered in the Perm State University, Russia in October, 2015 (Figure 3).

USC will celebrate its 20th year of its establishment this year. Microbiology teaching has been an important part of the degree programs ranging from science to biomedical science and developed in line with the USC's efforts in empowering the regional students with internationally compatible skills and knowledge and ensuring employment at regional, state, national and international levels.

I would like to conclude with Pasteur's words: 'I beseech you to take interest in these sacred domains so expressively called laboratories. Ask that there be more and that they be adorned, for these are the temples of the future, wealth, and well-being. It is here that humanity will grow, strengthen and improve. Here, humanity will learn to read progress and individual harmony in the works of nature, while humanity's own works are all too often those of barbarism, fanaticism and destruction', and add that microbiology is one of the disciplines has profoundly impacted and will impact global peace and advancements via delivery of innovative designs stemming from innovative microbial engines. Future industrial revolution lies in the hands of microorganisms if we understand fully their purpose of existence and fascinating diversity and functions in the environment.

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Biography

Dr Kurtböke has been working in the field of biodiscovery and has been an active member of the international actinomycete research community since 1982. She currently conducts research and teaches in the field of applied microbiology and biotechnology and is senior lecturer at the University of the Sunshine Coast (USC), Queensland. She has been a member of the *Biodiscovery Industry Panel* established by the AusBiotech and DEHWA, which networks Australian biodiscovery operators. She has also established a bioactive actinomycete library used for research and teaching activities at the USC as well as in partnership with regional, national and international collaborators for discovery of new therapeutic agents, agrobiologicals, enzymes and environmentally friendly biotechnological innovations. She has also been an active member of the World Federation of Culture Collections (WFCC) including serving as the Vic-President of the Federation (2010–2013).