The Quintessential Research World is Progressively Interdisciplinary

Sharadwata Pan, Dominic Agyei and Michael K. Danquah

Abstract— Today, the inevitability of cross-disciplinary research as the single most important current trend across various research groups worldwide is plausible. Though thought about years ago, the impact has grown exponentially only in recent times and slowly but surely, the entire research community is accepting interdisciplinary research to be the need of the hour to explain complex findings. This technical note looks at the trends and also explains the nature of involvement of multiple research areas with a case study of synthesis of bioactive peptides.

Index Terms— Bioactive peptides, interdisciplinary, research.

1 Introduction

Research is perhaps the most intriguing of all endeavors! Primarily because of the known excitement to explore the unknown coupled with moderate to severe stress levels normally associated with the process of discovery. In research, we cross boundaries, go to unfathomable depths and in the process seek solace in loads of junk data in the hope that this may trigger the unearthing of a new phenomenon! How far we go, and how best we unearth the novelty depends on the technology persisting at the time. Scientists are a rare species: in the sense that they spent hours in finding out what is the science behind what may look like a dead-end, even for an everyday observation like knot formation! But, unarguably, the scientific process of persistence has brought the world closer to solve mysteries that look impenetrable to the naked mind. Imagine what would have happened had Newton never sat under that apple tree! Imagine if Einstein had never looked at the sun and thought about the quanta! We would have been unimaginably crippled, to say the least. A new interface of research has categorically advanced this process to a level that was improbable, even impossible, a few decades ago! As researchers, we have acquainted ourselves with people who are trained in Physics, but conduct contemporary research in Chemistry, and may proudly declare that they are basically Biologists, but they consider the physico-chemical angle! Or may be that they are mathematicians, but are interested in the biochemical evolution of the human race with an avid interest in its population genetics! Is this weird? Or should we consider looking deep into it? Welcome to interdisciplinary research, currently the cynosure of the scientific community. Fascinating documentations of recent ground-breaking contributions have shown that these have occurred at a significantly deep level when they have transcended departmental and discipline barriers of most research centers around the world ([1], [2], [3], [4]). There is now a new paradigm in research: cross the limits, break the borders of your tertiary education and delve deep into combined areas of multiple disciplines to explain your results better. For example, ever since the highly cited article by Watson and Crick [5], DNA has been to science what Marilyn Monroe was to Hollywood! It created jobs, opened new research arenas and its double-helix structure and inheritance was rightfully anointed as one of the best discoveries ever made. But thanks to some interdisciplinary research by polymer physicists and chemical engineers, DNA is now a model polymer to carry out excellent microfluidic and polymer chemistry research ([6], [7], [8], [9], [10]). There lies a modest truth: the amalgamation of knowledge from various disciplines is probably better suited to explain complexity along with a definitive assurance and prodigal consistency which was lacking until recently.

2 Bioactive Peptides: A Case Study

Let's consider as a case example, a study that seeks to develop or produce food-derived bioactive peptides with immunomodulating (adjustment of the immune response to a desired level) properties by exploiting the activity of a special class of enzymes: cell-envelope associated proteinases (CEP) of a particular type of bacteria that is *Lactobacilli*. A proteinase is any enzyme that catalyzes the splitting of proteins into smaller peptide fractions and amino acids. The rationale of such a study stems from the fact that certain peptides have hormone-like properties and thus can be incorporated into food and drug formulations for overall health improvement and / or the control of certain ill health conditions.

The processes that feature in such a study should factor in the safety, potency and economy of the final product and to achieve this end, multidisciplinary fields in science must be employed. The raw materials necessary for peptide development include proteins and enzymes. An appropriate food protein is chosen as well as the selection of a *Lactobacillus* species. The proteolytic potential of the *Lactobacillus* species can be

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improved via an appropriate recombinant DNA technology

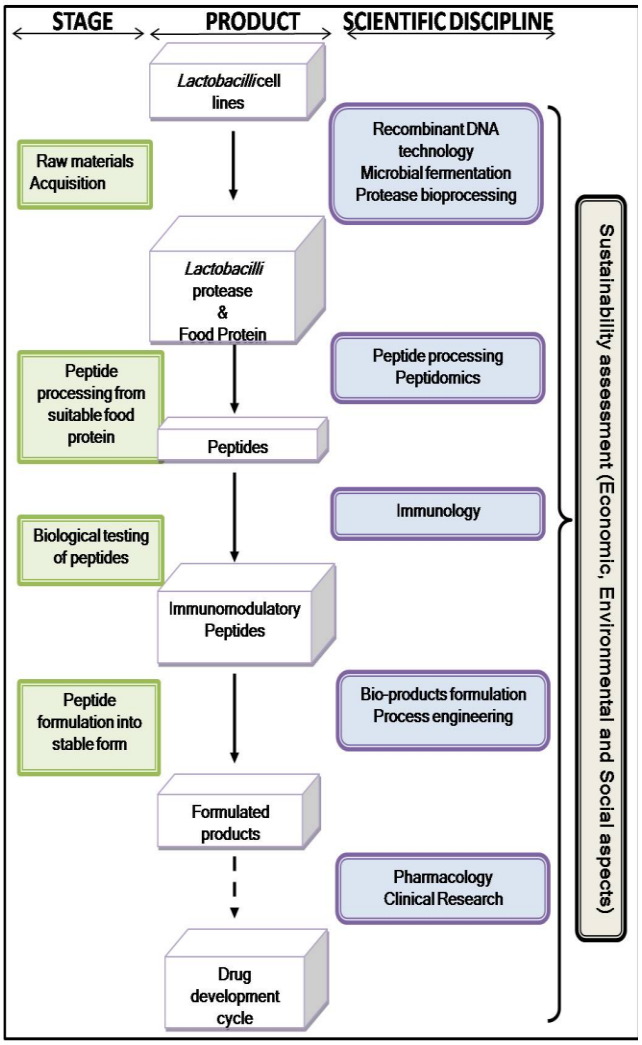

Fig.1. A schematic representation of the multidisciplinary bioactive peptide technology.

and / or by optimizing the necessary growth factors that conduce to a response in high CEP yield. These require some expertise in Microbiology, Genetics and Enzyme Bioprocessing. The next stage will be the production, isolation and enrichment of peptide generated from the hydrolytic reaction (which is mediated by the action of water) between the microbial enzymes and the food protein. This will require some knowledge in solid / liquid-phase protein chromatography of proteins and peptides. Ultimately, a large number of peptides will be generated and thus biological testing of peptides is necessary to identify the bioactive lots. By the use of in vitro and in vivo immunological protocols, the peptides can then be identified and further characterized via Mass Spectrometry analyses and peptide sequencing. Further, the final products may need to be formulated into stable, 'dosable' forms. All these stages require the use of varied techniques and protocols which employ a plethora of laboratory equipments. The final product may be incorporated as a component of functional food formulations, or can be entered into the drug development cycle if intended for drug application. Finally, for such a study a huge amount of data is generate which requires the services of mathematicians and statisticians to interpret accumulated data and also fit appropriate models for future predictions of the processes utilized. Also, the entire bioprocess has to undergo a sustainability assessment where the services of economists, environmental scientists and social scientists are employed to ascertain the reaction of customers to final products as determined by economic, environmental and social factors. A schematic of the described process is shown in Fig. 1. Unarguably, bioactive peptide research is just one example of many areas where interdisciplinary research comes into play.

3 Conclusions

As young researchers, the onus lies on us to continue this trend of borrowing from other disciplines to explain phenomena that are hitherto unexplained using traditional tools and methods known in our own discipline. We need to be prepared to make a leap of faith to cross our own disciplinary boundaries. For tomorrow's discoveries often lie at the interface between today's disciplines. The present scenario is bright and the future is brighter. How do we achieve this? Instead of having scattered research groups across various research schools, multipurpose research academies ought to be introduced for focusing on and prioritizing high throughput interdisciplinary research that will address global grand challenges. These grand challenges need to be as colossal as identifying a definitive cure for cancer, or maybe a model for eradicating world hunger or an end to global warming. Today's dreams will be tomorrow's reality and interdisciplinary research may act as a catalyst that helps us get there. *"We are not students of some subject matter, but students of problems. And problems may cut right across the borders of any subject matter or discipline."* said the Late Karl Popper (Popper, 1963, p. 88) [11]. This quote aptly conveys a message that while one is given a colossal responsibility, one should put aside the initial bewilderment and awe to justify it with surreal logic and innovative thinking.

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