

# The Technology Explosion in Biology and its Implications for Biotechnology and the Potential of Systems and Synthetic Biology

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Technological and scientific breakthroughs have added novel products to those traditionally produced by biological means. In this letter to the editor, some of these recent trends are summarized to raise the awareness of the power of Biotechnology.

The manufactures based on biological entities have been with us since dawn of time and there are no exact records when bread, cheese, wine or beer (biological products) was introduced into our diets [1]. The use of biology was further developed and in the end of the 19<sup>th</sup> and beginning of the 20<sup>th</sup> century it was possible to harness different cells for the production of specific compounds. Acetone-butanol was produced at large scale by bacteria starting during World War I and citric acid from fungi in the 1920's. The potential of fumaric acid as a precursor for other chemicals pushed the development of large-scale aerobic fermentations [2] and the discovery of the antibiotic penicillin produced at large scale after methods for its purification was developed and successful when a fungal strain that could grow at submerged conditions was isolated [3]. The characterization of DNA followed by the capabilities for its utilization with unambiguous techniques has revolutionized both biology and biotechnology [4]. The knowledge obtained of a plethora of organisms is published in an ever-increasing stream of journals. The potential to utilize this knowledge for industrial purposes is still limited. The number of compounds produced by biological means is restricted by the criterion for profit. Many of the biologically produced compounds are characterized by production of comparatively low volumes with a high value or that the chemical route is not cost-effective. The main challenge for biotechnology remains to produce low value high volume type of compounds such as feed acids, precursors for polymers, other bulk chemicals and biofuels [5,6]. The novel technologies that are constantly being developed holds great promise for the future manufacture of a wide variety of bulk chemicals, presently originating in fossil resources. Chemicals such as 1,3-propanediol, isobutanol, polyhydroxyalkanoate, succinic acid, artemisinin and lactic acid have recently been added to the list of products with profitably. Future bio based chemicals under development are among others adipic acid, itaconic acid, levulinic acid, terpenes (valencene & nootkatone) and the phenolic aldehyde vanillin [7]. The development of omic techniques, systems biology, and the utilization of synthetic biology allows for the directed construction of strains, either the natural producer, or the use of platform organisms to hopefully obtain a yield (g product/g substrate), concentration (g/L) and productivity (g/L/h) that will make production economically viable. The omics tools allow for the characterization of the cell under study on all levels from the genome through the transcriptome, proteome, metabolome to the fluxome [8,9]. The tools provided by current analytical techniques result in a voluminous data stream that if used correctly can give a better comprehension of the biology of the cells of industrial relevance [10,11].

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