

Basic sciences applied to Bioengineering and its relations with the COVID-19 Pandemic

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Abstract— Recently, the experiences of countries affected by the new coronavirus, SARS-CoV-2, better known as COVID-19, as well as the evolution of the disease and the number of deaths in the world, have generated evident changes and repercussions on a global scale. Many advances have occurred, but there are still significant challenges facing the government, scientific and clinical communities. In view of this global scenario, it arose the need to ensure that basic research remains active, focused on improving scientific theories, through the scientific foundation provided by basic disciplines in continuing academic education. Among them, bioengineering has played an extremely important role in translating basic science research into practical applications, known as translational science, promoting precisely targeted therapies. This is due to prior and well-founded knowledge in the basic disciplines, which makes it possible to address current and emerging challenges in health and biomedical innovation

Keywords— COVID-19, Health Sciences, Bioengineering, Anatomy

I. INTRODUCTION

The basic sciences constitute a set of elementary and fundamental disciplines for the training of professionals in different areas of knowledge. Its broad spectrum makes its scope almost borderless, providing theoretical-practical foundation for future professional activities [1].

These basic subjects are generally available in the first years of undergraduate courses, and with the new curricular guidelines they can be distributed throughout the

duration of the course to teach the student in an integrated manner [2].

Among the courses, biological engineering or also called bioengineering involves interdisciplinary activities that integrate engineering science with biomedical science and clinical practice, in order to develop new systems, equipment and devices that assist in the treatment of diseases or in the improvement of quality of life [3] (Fig. 1).

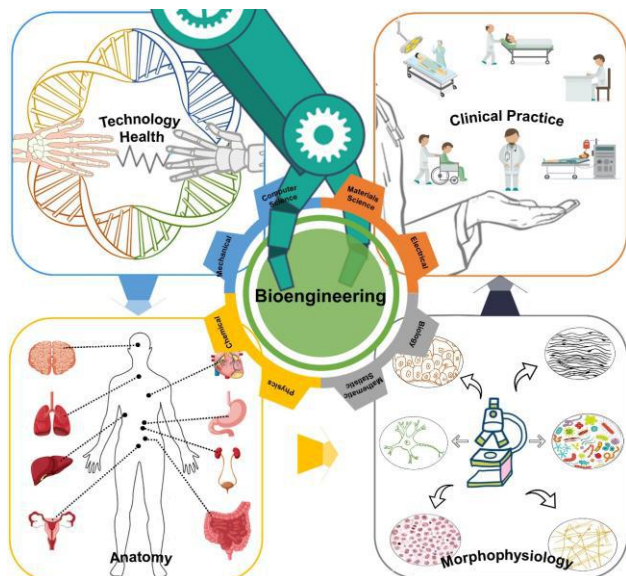


Fig. 1: Illustration of the interrelationship of basic bioengineering sciences combined with health technology and clinical practice. The layout elucidates the need to promote an adequate validation of the basic sciences of bioengineering, in order to improve the global training of the technical-scientific professional, followed by a contextualized view of the study of health, disease and human-environment interaction.

In recent months, humanity has been caught by a pandemic caused by the new coronavirus, severe acute respiratory syndrome coronavirus 2, SARS-CoV-2, producing repercussions on a global scale, both medical, epidemiological, as well as major social, economic, political impacts, and cultural events unprecedented in recent history [4,5].

It is in this context that the comprehensiveness of the basic bioengineering disciplines, the morphophysiological, combined with health technology made it possible to develop equipment, such as mechanical respirators, attributed to the knowledge of the anatomy of the lungs, together with the necessary calibration for the equipment to perform with the same operating parameters as the human respiratory system [6].

In addition, the search for new testing methods that add knowledge of nanobiotechnology, with greater accessibility and assertiveness of the results, has expanded the diagnostic capacity of the SARS-CoV-2 virus, in controlling the spread of the disease, especially in medical conduct, in prognosis and in patient care [7].

In fact, many advances have occurred, however, they raise new challenges, in order to obtain additional information to determine the metabolic dynamics and the

timing of this SARS-CoV-2 infection, given that the virus exhibits idiosyncrasies that differentiate it from other coronaviruses previously reported [8,9].

The infection apparently occurs in the nasal passage and continues to spread to the lower airways, intestines, heart and other tissues in a way that has not been fully elucidated. Even the symptoms are unpredictable and appear to change abruptly over time, due to their effects on a wide range of tissues, as well as their progression [10].

The most recurrent symptoms already reported are severe acute respiratory infection, which causes great difficulty in breathing, fever, cough, dyspnoea, malaise, myalgia, gastrointestinal disorders and neurological complications, the most common of which are decreased ability to taste or ageusia, and low olfactory sensitivity or anosmia [11,12].

Most investigations of these impairments in the peripheral nervous system have shown bias-prone evaluation. Such fact may be related to the lack of smell and taste tests in general health examinations, and the reports of symptoms are presented by the patients themselves, which can lead to an underestimated statistical analysis of these symptoms [13].

Therefore, based on an in-depth morphophysiological knowledge about the neural systems that mediate these sensations, and possibly, as the virus affects these areas, it becomes extremely important to obtain a differential diagnosis. Considering that the integrated understanding can ensure faster and more efficient detection, through bioengineering strategies in the development of technological devices [14].

The anatomical organization of the sense of smell begins in the specialized neuroepithelium, in the upper part of the nasal cavity, by means of chemoreceptors, the olfactory cilia of the olfactory vesicles, which are small dilations of the peripheral extension of bipolar neurons. The odorant molecules come into contact with specific chemoreceptors to effect the transduction necessary for the amplification of sensory signals and the generation of action potentials in the neuron axon [15–17].

Regarding the gustatory route, the chemical substances come into contact with the taste cells, which are sensitive chemoreceptors located on taste buds distributed in the papillae of the tongue, pharynx, larynx and proximal esophagus. This interaction generates electrical potentials that lead to the release of neurotransmitters, and consequently trigger action potentials that follow the afferent fibers of the facial, glossopharyngeal and vagus nerves [15].

The possibility that SARS-CoV-2 may cause olfactory and taste disorders is certainly acceptable. However, previous data suggest that the exact mechanism of olfactory and gustatory dysfunctions requires further investigation, as they believe that there may be more than one pathophysiological pathway. Detailed clinical assessments and functional tests related to these olfactory and gustatory disorders, including the exact classification and duration of complaints, are of high priority [18].

Many prophylactic, therapeutic immunological preclinical approaches have been analyzed, among them, the accelerated search for a vaccine that induces a neutralizing effect through specific T cell responses, drugs that provide a reduction in viral load and safe devices in detection of the disease as well as its symptoms [19].

An issue that arises, however, is the need to promote the integration of scientific research and development, defining research priorities, integrating research initiatives, and promoting the development of technologies on emerging viruses [20].

As a way of promoting these efforts, it is necessary, initially, to recognize the essential role of basic sciences, not only as a list of topics to be fulfilled in the curriculum, but part of a structured experience that leads to understanding and solving complicated clinical problems or unusual, such as the disease caused by the new coronavirus.

The gravity of the situation has caused in the governmental, scientific and clinical communities, a careful attention in the basic disciplines in academic institutions, in order to achieve greater knowledge and integrate with previous experiences, and thus enable solutions.

II. FINAL CONSIDERATIONS

Bioengineering will undoubtedly accelerate the pace of research on the new coronavirus, developing viable treatment strategies, through model systems that integrate the investigation of physiological variables, such as information on how the virus spreads and how the body reacts to it, helping to understand the pathophysiology of this disease.

Thus, the impact of this area of knowledge will have far-reaching potential, if it is based on scientific and technological advances, and these necessarily tied to the contextualized basic disciplines (Fig. 1).

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