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PIONEERS IN NEUROLOGY

Claude Bernard (1813–1878)

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Claude Bernard (1813–1878)

Claude Bernard (Fig. 1) was born in 1813 in Saint Julien, France. He was the son of a modest proprietor of vineyards and wine merchant. In 1832 he passed his baccalaureate examination and in 1835, he enrolled at the medical school at the University of Paris [1–3]. Bernard is one of the most important physicians of all times, having devoted all his life to research and medicine. His precious contributions touch the most diverse areas of Medicine, including Neurology.

From the beginning of his career, he has shown a deep interest in scientific investigation of the nervous system. Not coincidentally, as a student he was influenced by the neurologist Charles Lasègue (1816–1883). In 1843, Bernard published his first work under the title: *"Recherche anatomiques et physiologiques sur la corde tympan, pour servir à l'histoire de l'hémiplegie faciale"*. It dealt with the nerve chorda tympani and its role in the facial paralysis.

Claude Bernard also dedicated himself to the study of the peripheral nervous system. He scrawled the physiological principle of the reflex arc, demonstrating that simple reflex movements were due to the influence of sensory roots exerted on the motor roots. In line with his finding, he demonstrated the eminently efferent nature of vagus nerve [3]. Another important landmark of his career was the concept of the physiological equilibrium of the two antagonistic innervations [1,4,5]. Not far from his theory of homeostasis and the brain's influence on every organ in the body, Bernard described the physiology of the autonomic nervous system. About this the French scientist said that "the nervous system is called upon to regulate the harmony between all these conditions". Part of this theory was built from the pioneering description of vasomotor nerves. Through his investigations of the neurophysiological mechanism of the body's conservation and dissipation of heat, he described that they were of two kinds, vasoconstrictor and vasodilator nerves [1,6,7]. Some of these observations were summarised in the publication of "*Recherches expérimentales sur le fonctions du nerf spinal ou accessoire de Willis*" in 1851.

One of the highlights of Bernard's scientific career was his interest in the role of the brain in relation to the organism as a whole. In 1849, the Frenchman discovered that there was a central nervous control capable of acting on the liver and producing diabetes. The publication named "*Chiens rendu diabétique*" was the result of an experimental puncture of the fourth ventricle of the brain that resulted in a temporary glycosuria [1,7]. Another fascinating discovery related to this field was the description of the brain–heart interaction. Indeed, in 1865 Claude Bernard delivered an impressive lecture at the Sorbonne on the physiology of the heart and its connections with the brain. Bernard was the first to describe systematically that the modulation of cardiac activity was in part mediated by the brain through vagus nerve [4]. No less than Charles Darwin commented on his theory: ''Claude Bernard also repeatedly insists, and this deserves especial notice, that when the heart is affected it reacts on the brain, and the state of the brain again reacts through the pneumo-gastric (vagus) nerve on the heart, so that under any excitement there will be much mutual action and reaction between these, the two most important organs of the body''. Actually, Bernard considered that the regulation of vital functions in general was the leading function of the brain, leading to a pioneering comprehension of the nervous system complexity that never ceases to fascinate many neuroscientists [3–5].

In a scientific world still rudimentary and under construction, Claude Bernard announced what would only be better understood in this century [8]: "when it is said that great thoughts come from the heart, it means that they come from the feelings, for our feelings, which have their physiological origin in nerve-centers, act upon the heart like peripheral sensations" [5].

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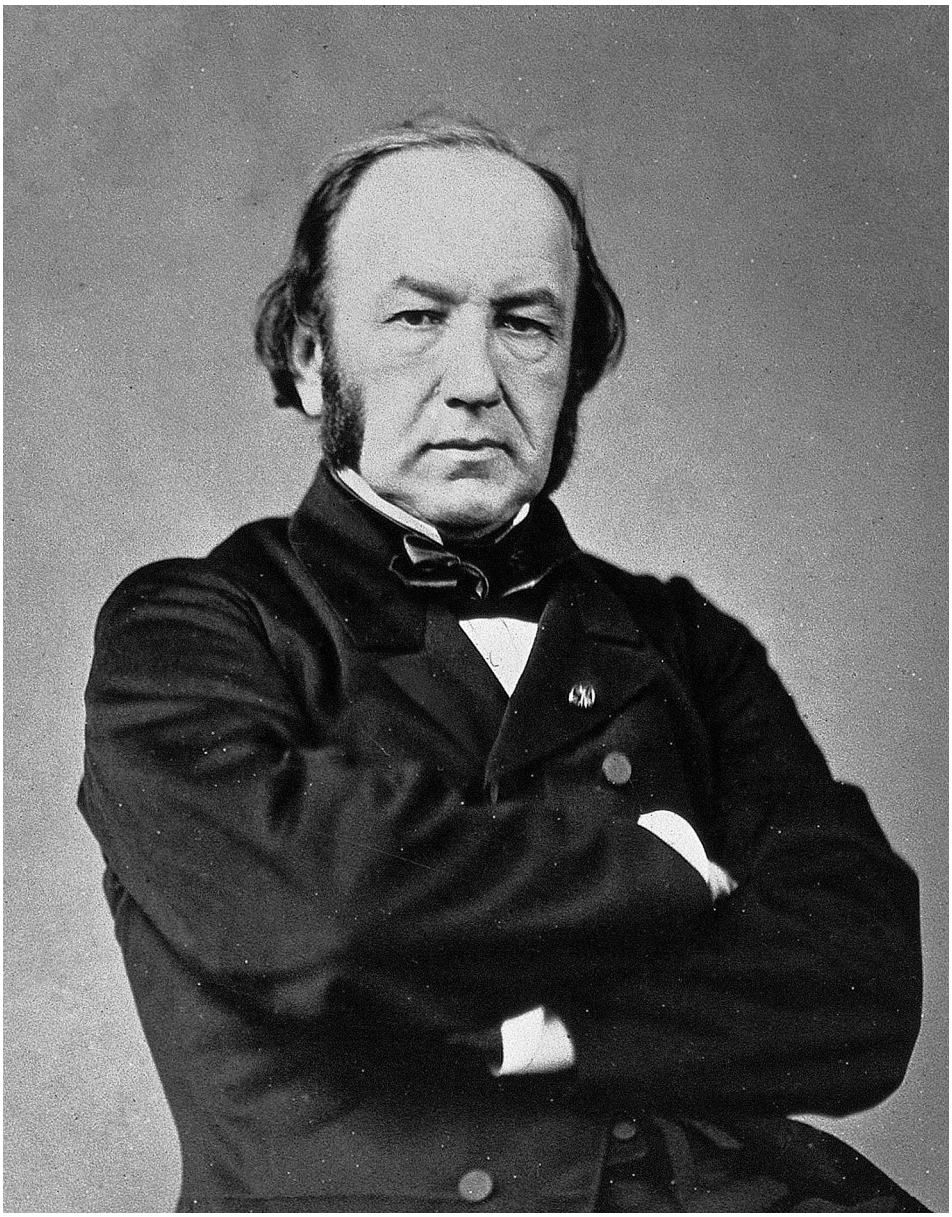

Fig. 1 Claude Bernard, the author of "*Leçons sur la Physiologie et la Pathologie du Systhème Nerveux*"

Claude Bernard became a pupil of François Magendie, a central figure in his scientific initiation. Magendie was responsible for introducing the term "cerebrospinal fluid" and gave a full neuro-anatomical description of it. Following his discoveries, in 1855 Bernard was the first scientist to verify the presence of sugar in the cerebrospinal fluid [2,3].

Another discovery of extreme importance to current neurophysiology concerns the mechanism of action of curare. In 1858, Bernard's experiments with curare showed how this dread poison causes paralysis and death by attacking the motor nerves while having no effect on the sensory nerves. He demonstrated that even with the injection of curare, there was muscle contraction with the direct application of an electric stimulus, while if the nerve supplying the muscle was electrically stimulated, curare prevented muscular contraction. His findings meant that curare could be used as an experimental tool in differentiating neuromuscular from primary muscular mechanisms due to its selectivity [1,3]. Actually, this would be the first evidence of what would be known in the future as myoneural junction.

One of Claude Bernard's most important and popular concepts is that of homeostasis: "The living body, though it has need of the surrounding environment, is nevertheless relatively independent of it. This independence which the organism has of its external environment, derives from the fact that in the living being, the tissues are in fact withdrawn from direct external influences and are protected by a veritable internal environment which is constituted, in particular, by the fluids circulating in the body" [1,5,7]. Although sometimes considered simple or banal, the importance of

the principle of homeostasis continues to find application in the research of neuroscientists to understand the functioning of the brain. Recently, the eternal principle of homeostasis was raised by the neurologist Antônio Damásio as one of the rulers of the cerebral evolutionary process, the emergence of emotions and the mind–body interaction [8].

One of Bernard's most famous contributions to clinical neurology is the description of the syndrome that bears his name. Claude Bernard-Horner syndrome occurs when there is an injury to the sympathetic fibers that innervate the eye and consists of the association of miosis, incomplete eyelid ptosis, enophthalmos, anhidrosis and vasodilation in the ipsilateral hemiface to the lesion [9]. It was described from an experimental point of view by Claude Bernard in 1858, and from a clinical point of view by Horner in 1869.

Claude Bernard is the father of experimental medicine. It was in Magendie's laboratory at the Collège de France, that Bernard, even before the end of his clinical studies, discovered his real vocation to physiological experimentation [6,10]. In his words: "I consider the hospital the antechamber of medicine, it is the first place, where the physician makes his observations. But the laboratory is the temple of the science of medicine". Can any neurologist imagine the future of neurology without advancing clinical and experimental research? Definitely, the one who took the first step to make this answer obvious was Claude Bernard, more than 200 years ago.

At the end of his life, Bernard approached philosophy but he could not abandon his knowledge of neurophysiology. The Frenchman has also dared to talk about the function of the brain: "Similar concepts eventually embraced by philosophers and some naturalists; the brain, the seat of the principal functions of the nervous system, would not be the actual organ of thought, but the mere substrate of intelligence" [3]. He also wrote: "From the physiological point of view, the metaphysicial phenomena of thought, consciousness and intelligence that underlie the different manifestations of the human soul are common vital process and cannot but result from the function of the organ expressing them. We shall demonstrate below that brain physiology must be inferred from anatomical observations, physiological experiments, and the knowledge of pathological anatomy exactly like that of all the other body organs… The advances of general anatomy and histology have taught us that the brain possesses the most delicate and complex structure of all nervous systems" [3].

Claude Bernard died in February 10, 1878, in Paris [2]. His work is considered by some to have laid the foundations for modern neuroscience. His funeral was arranged and financed by the government, the first ever granted to a scientist in France.

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Compliance with ethical standards

Conflicts of interest No potential conflict of interest relevant to this article was reported.

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