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Review

Laboratories at the Faculty of Medicine of the University of Coimbra in the XIX century

Maria Burguete

Instituto Rocha Cabra, I Calçada Bento da Rocha Cabral, 14; 1250-047 Lisboa, Portugal.
E-mail: mariaburguete@gmail.com.

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The beginning of natural sciences came to predominate in medicine with the emergence of natural scientific thinking in the first half of the 19th century. Philosophical approaches became less relevant. Research concentrated on the biological, physiological and chemical foundations of life. Therefore, the creation of laboratories of experimental physiology, histology, toxicology and pathological anatomy was the result of the reorganization of the medicine faculty at Coimbra university between 1866 - 1872, according to the following paradigm replacement: The superficial look at disease was replaced by the study of the inner body, an attempt to understand the symptoms, giving rise to a new paradigm of medicine practice – evidence-based-medicine (EBM). However, in spite of the good conditions of space and light provided by the Colégio de Jesus in Coimbra to accommodate the laboratory of physiology and histology, an important "ingredient" was missing: the experimental instruments to design experimental works to provide - good teaching and research model for the Coimbra faculty of medicine. In peripheral countries, as Portugal, some professors played a central role in this development, bringing in new ideas, new instruments, and new techniques and producing scientific and didactic texts in native languages. In this process, the creation and equipment of laboratories was fundamental to assure the modernization of the University and the development of scientific research. In this article we intend to sketch an overview of this process with particular focus in the scientific trips undertaken by Costa Simões in 1865, by establishing contacts and attending practical lectures and courses with the most influential personalities of the world of medicine of the 19th century, namely; the physiologist Emil Du Bois-Reymond (1818 - 1896), the pathologist Rudolf Virchow (1821 - 1902) and the inventor of the ophthalmoscope and physiologist Hermann von Helmholtz (1821 - 1894), from the famous "Berlin School" of medicine in the 1840's, today the Humboldt university. Here, we will emphasized that in Portugal, as probably in other countries, some university professors had a main role in the process of transfer of scientific knowledge and also, how the study of scientists, as well as laboratories, instruments and texts that were relevant for the implementation of new ideas and practices in teaching and research during the nineteenth century.

Key words: Scientific instruments, history of medicine, history of science, Coimbra University.

INTRODUCTION

The reform of the university of Coimbra ordered by the Marquis of Pombal in 1772 included the creation of the Faculties of Philosophy and Mathematics and the reorganization of the Faculty of Medicine (Mirabeau, 1872) (only much later, in 1911, the Faculties of Philosophy and Mathematics merged to give rise to the Faculty of Sciences). There always was a close relationship between those faculties since the medicine students had to attend preparation courses in Mathematical and Natural sciences.

Pombal´s Reform must be considered a fantastic effort to modernize Portugal via experimental sciences and by the introduction of teaching of Natural sciences such as Physics and Chemistry as well as the emergence of the first laboratories (Mirabeau, 1892). Regarding medicine, the first stones for practical teaching, including experimental and clinical support, were laid down with the establishment of the first laboratories, such as the

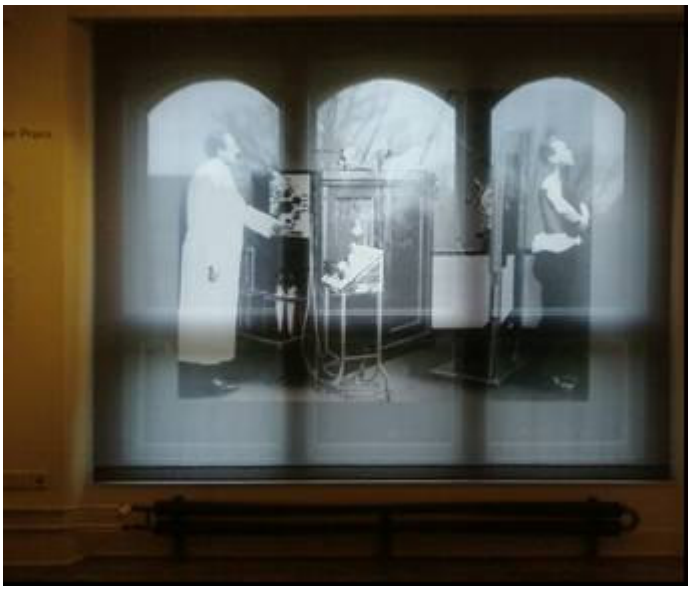


Figure 1. X Rays at the end of XIX century.

laboratory of medicinal chemistry founded in 1859 by José Ferreira de Macedo, where experimental toxicology was taught, namely the applications of Chemistry to the study of anatomical and physiological samples (Burguete et al., 2008).

However, only a century after Pombal's reform, the laboratories of physiology and histology, toxicology and pathological anatomy were established from the experimental point of view (experimental laboratory of physiology and histology), after the reorganization of the medicine faculty at Coimbra university between 1866 - 1872.

This reorganization can be seen as a consequence of the scientific trips undertaken by some professors of medicine to European universities where the experimental feature of medicine had already been adopted and developed, according to the new paradigm of Evidence-Based-Medicine. Some "scientific travellers" have sought to advance in their discipline as happened with Costa Simões from the Faculty of Medicine of Coimbra university. The laboratory took its place next to the pathologist's dissection hall as a central location for medical research. Around 1900, the methods used in laboratories became more widespread in everyday medical practice and young researchers transferred the latest insights from biology, physics and chemistry to human beings. Regardless whether the waves of the heart (1889) or the blood pressure (1896) were measured or blood type determined (1901), it was no longer an issue to get basic information about particular bodily functions from this data. Instead, the information collected from the private patient could be used directly to treat the sick person.

This development was supported by the introduction of new pictorial techniques. Probes equipped with light (endoscopes) and external radiation (×-rays) made images of the inside of the living body possible (Figure 1). These standards reflect the expectation that objective models of the functioning of the human body could be developed in order to derive sustainable diagnostic and therapeutic measures.

One of the most influent contributions to the elaboration of objective models of the functioning of the human body, namely in the field of human physiology, was given by António Augusto da Costa Simões following his scientific trip to Berlin, Paris and Liège among other European countries. Due to these voyages, new experimental works in histology and experimental physiology were included in the medical course, once the acquisition of new scientific instruments as well as new "know-how" had been performed, as recommended by the European scientists from the various places where this professor of the Medicine Faculty had done experimental research work as we can read in his scientific report issued in December 1866 (Costa Simões, 1866).

Scientific travellers and the development of histology and physiology teaching

The teaching of histology and physiology was initiated in 1863 when Costa Simões (1819 - 1903) was appointed professor, therefore, creating a specific programme for this subject. The laboratory of histology and experimental physiology was at the old Colégio de Jesus (Figure 2), where good conditions of space and light existed. However, an important "ingredient" was missing: the experimental instrumentation to design experimental works in order to provide good teaching and research model thus allowing a better understanding of animal and human histology and physiology studies.

In order to acquire new insights to overcome the missing "ingredient", a year later, on 18th August 1864, Costa Simões (Figure 3) and his assistant Costa Duarte started a scientific trip to several international universities and research centres in Germany (Bonn, Würzburg, Heidelberg, Munich, Göttingen and Berlin), France (Paris), Belgium (Brussels, Louvain, Gand and Liège), Holland (Amsterdam, Leyden and Utrecht) and Switzerland (Zurich) with the purpose of developing an histology and physiology course (Costa Simões, 1866a).

Costa Simões studied experimental physiology and histology at the university of Paris noting the excellence of their animal histological preparations, in spite of the lack of human histological preparations. Similar studies were also performed at Belgian, German and Dutch universities, including a report with the best scientific instrumentation found in the Laboratories of Experimental Physiology at Gand, Liege, Utrecht and Berlin. Costa Simões developed relationships with some of the most prominent scientific researchers all over the world. Among others, the physiologist Emil Du-Bois Reymond (1818 - 1896), the pathologist Rudolf Virchow (1821 -

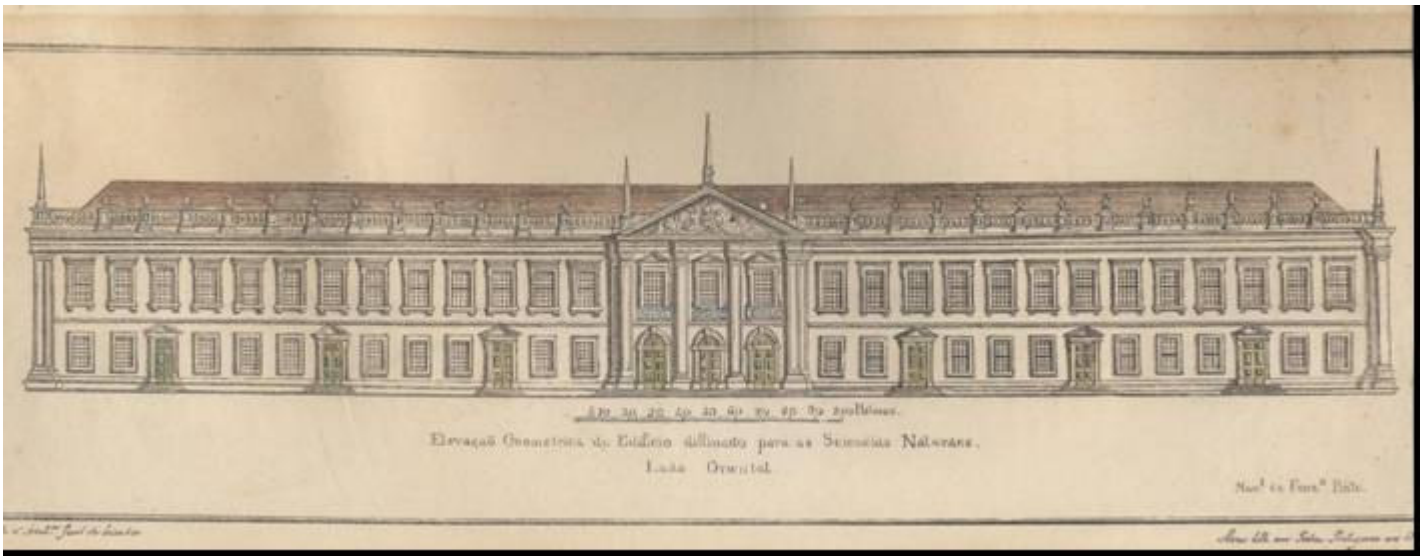


Figure 2. Colégio de Jesus in the XIX century.

Figure 3. António Augusto da Costa Simões in 1881.

1902) and Hermann von Helmholtz (1821 - 1894), belonged to the circle of students around the Berlin anatomist and physiologist Johannes Müller (1801 - 1858), who played a significant role in the development of the dawn of the natural scientific era (Figure 4).

Costa Simões also attended some practical courses at Ghent university where Richard Boddaert was appointed pathological anatomy teacher from 1863 - 1892 once he became a specialist in physiological sciences in 1862. In the following text (Figure 5) we find a small fragment of a tribute by some of his students. It's in French and illustrates that the physiology laboratories were at that time one of the best in Europe. This fragment (Figure 5) is a courtesy given by David Mannaert, curator of the archives of Richard Boddaert from Ghent University.

"... Permettez-nous de rappeler ici ce que cette organisation a dû vous coûter de labeurs et de peines, surtout si l'on songe à l'énormité de la tâche qui vous incombait en ce moment. Car, outre le cours d'Anatomie générale, vous donniez en même temps et la zoologie et

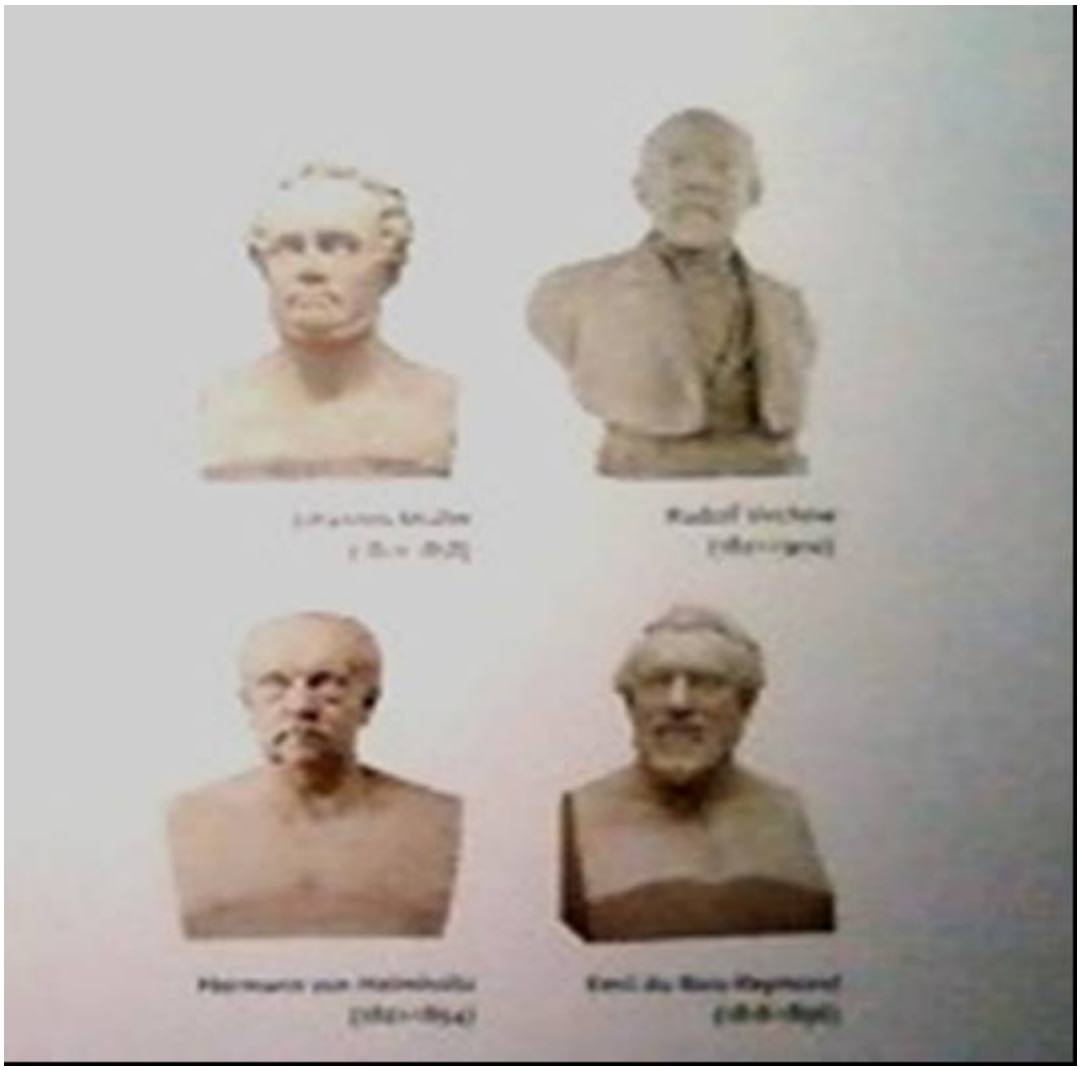
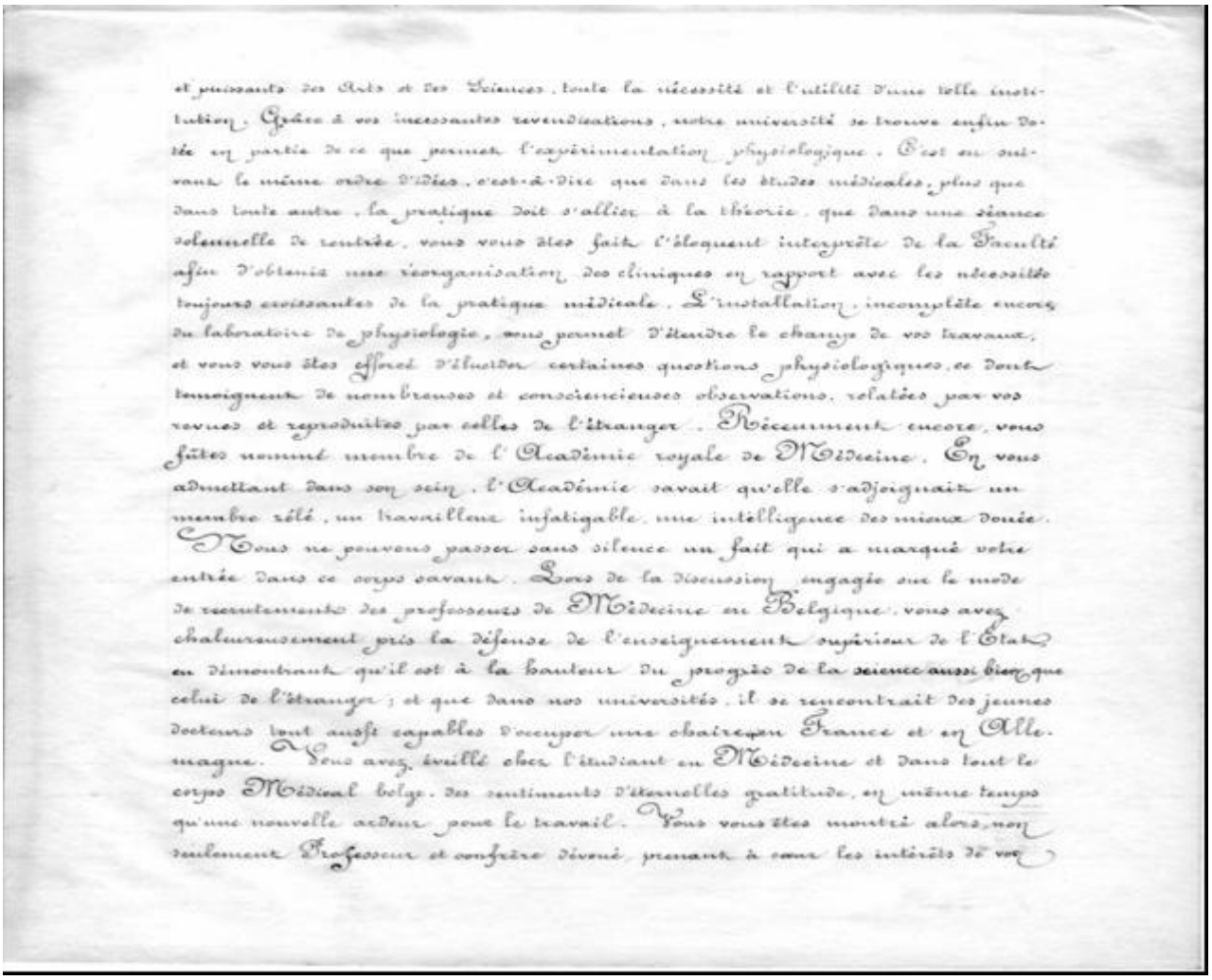


Figure 4. The founders of the natural scientific era.

la pathologie spéciale des organes thoraciques, ce dont les étudiants de cette époque parlent encore en des termes les plus élogieux. De plus, vous y joigniez le cours si important de physiologie humaine. Cette branche, la plus nécessaire des études médicales, et sans l'intelligence de laquelle les études pathologiques et thérapeutiques deviennent impossible, fut complètement transformée par votre méthode. Convaincu que les sciences physiologiques se basent avant tout sur des faits observés, et que l'expérimentation est nécessaire pour faciliter et compléter l'instruction de l'élève, vous n'avez cessé de faire appel au gouvernement pour obtenir l'installation de laboratoires convenables. Bien plus, dans un discours prononcé devant sa Majesté, vous avez démontré à celui qui est le protecteur éclair et puissant des arts et des sciences, toute la nécessité et l'utilité d'une telle institution. Grâce à vos incessantes revendications, notre université se trouve enfin doté en partie de ce que permet l'expérimentation physiologique. C'est en suivant le même ordre d'idées, c'est-à-dire que dans les études médicales, plus que dans toute autre, la pratique doit s'allier à la théorie, que dans une séance solennelle de rentrée, vous vous êtes fait l'éloquent interprète de la Faculté afin d'obtenir une réorganisation des cliniques en rapport avec les nécessités toujours croissantes de la pratique médicale. L'installation, incomplète encore, du laboratoire de physiologie, vous permet d'étendre le chanys de vos travaux, et vous vous êtes efforcé d'élucider certaines questions physiologiques, ce dont témoignent de nombreuses et consciencieuses observations, relatés par vos revues et reproduites par celles de l'étranger.»

After the performance of several experimental works, Costa Simões decided to adopt the German model from Berlin University, to set up the laboratory of experimental histology and physiology equipped with scientific instruments from Berlin, Breslau, Vienna, Munich and Paris. Some of them are described at Gerhardt



et puissants des Arts et des Sciences, toute la nécessité et l'utilité d'une telle institution. Grâce à vos incessantes revendications, notre université se trouve enfin dotée en partie de ce que permet l'expérimentation physiologique. C'est en suivant le même ordre d'idées, c'est-à-dire que dans les études médicales, plus que dans toute autre, la pratique doit s'allier à la théorie, que dans une séance solennelle de rentrée, vous vous êtes fait l'éloquent interprète de la Faculté afin d'obtenir une réorganisation des cliniques en rapport avec les nécessités toujours croissantes de la pratique médicale. L'installation, incomplète encore du laboratoire de physiologie, nous permet d'étendre le champ de vos travaux, et vous vous êtes efforcé d'élucider certaines questions physiologiques, ce dont témoignent de nombreuses et consciencieuses observations, relatées par vos revues et reproduites par celles de l'étranger. Récemment encore, vous fûtes nommé membre de l'Académie royale de Médecine. En vous admettant dans son sein, l'Académie savait qu'elle s'adjoignait un membre zélé, un travailleur infatigable, une intelligence des mieux douée. Nous ne pouvons passer sans silence un fait qui a marqué votre entrée dans ce corps savant. Lors de la discussion engagée sur le mode de recrutement des professeurs de Médecine en Belgique, vous avez chaleureusement pris la défense de l'enseignement supérieur de l'Etat en démontrant qu'il est à la hauteur du progrès de la science aussi bien que celui de l'étranger ; et que dans nos universités, il se rencontrait des jeunes docteurs tout aussi capables d'occuper une chaire en France et en Allemagne. Vous avez éveillé chez l'étudiant en Médecine et dans tout le corps Médical belge, des sentiments d'éternelles gratitude, en même temps qu'une nouvelle ardeur pour le travail. Vous vous êtes montré alors, non seulement Professeur et confrère dévoué, prenant à cœur les intérêts de vos

Figure 5. Fragment from the archives of Professor Richard Boddaer.

Catalogue (Figure 6) still existing at medicine faculty of Coimbra university. Those from Berlin came from Sauerwald workshops, one of the greatest German craftsmen; those from Liege were supervised by Schwann and Bois-Raymond was responsible for all the others of his invention. A detailed description is given of all the instruments used in experimental physiology. In this catalogue, we can see the detailed description of the spectrophotometer Ernst Leitz, one of the acquired instruments from Gerhardt catalogue and can be visualized in Figure 7.

The laboratory of experimental physiology was used for vivisections and other physiology experiments in the classes of physiology and toxicology. according to the existing microscopes and other scientific instruments belonging to the laboratory of physiology at Coimbra university in 1872, several experimental works have been performed for the subject of general histology and physiology, some of them can be visualized in the collection of histology preparations catalogue together with the catalogue of instruments of experimental physiology (Figure 8a, b) from 1873 as well as those in the “Histologia e Physiologia Geral dos Musculos” from 1878 (Figure 9).

This knowledge resulted from the experimental lectures attended at several European laboratories, namely the works developed at the Berlin school of medicine during the scientific trip of Costa Simões. A few details about the Medical Faculty of Berlin university will be presented below in order to understand why the Berlin school was the chosen model for the Coimbra Faculty of Medicine.

The Berlin School of Medicine

The great Berlin University Hospital, the Charité, had been in search of life for 300 years, since King Frederick I (1657 - 1713). A plague house had been built outside the town walls to the northwest side of Berlin to fight the terrible 1709 epidemic plague that moved towards

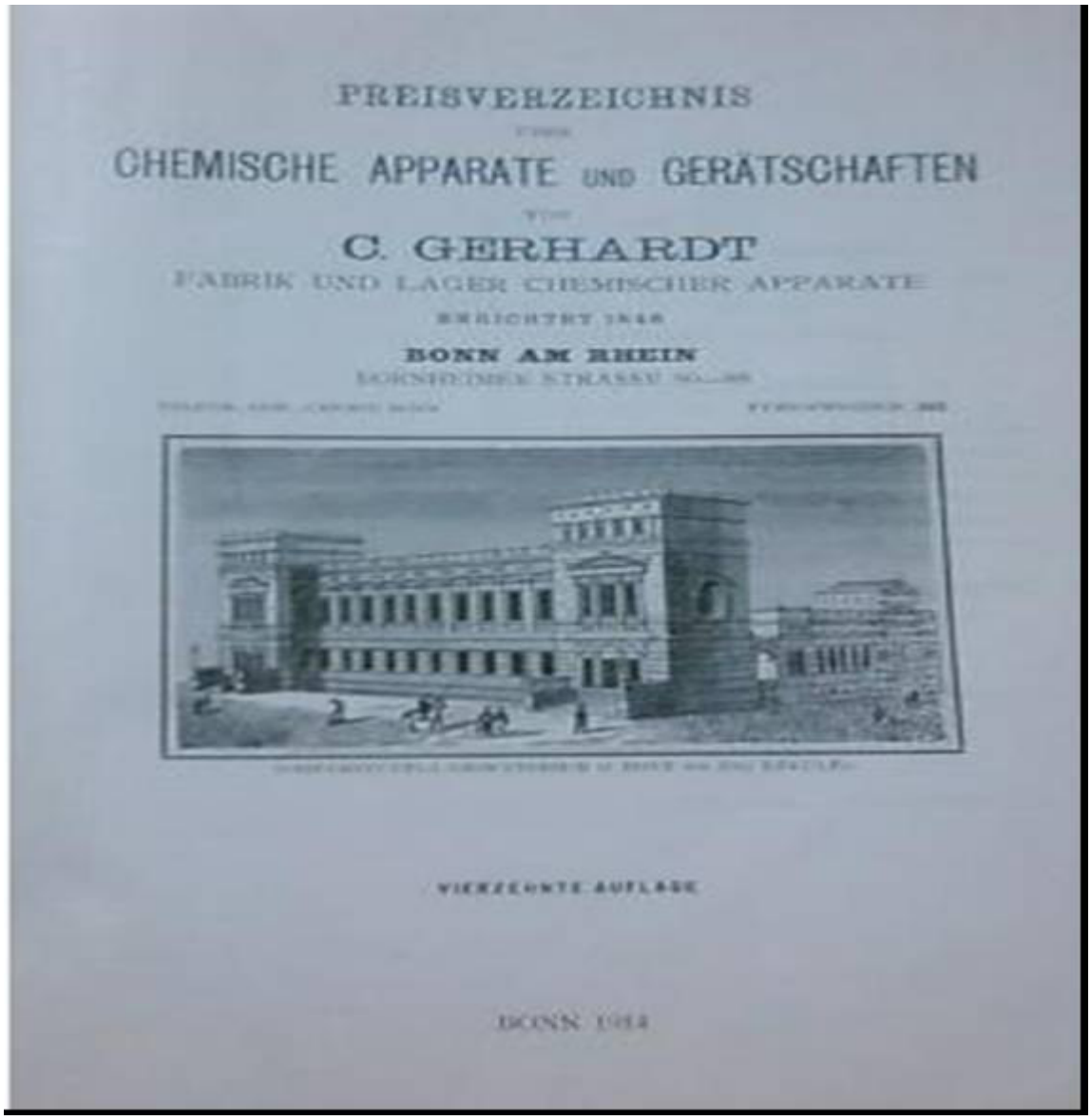


Figure 6. Gerhardt Catalogue.

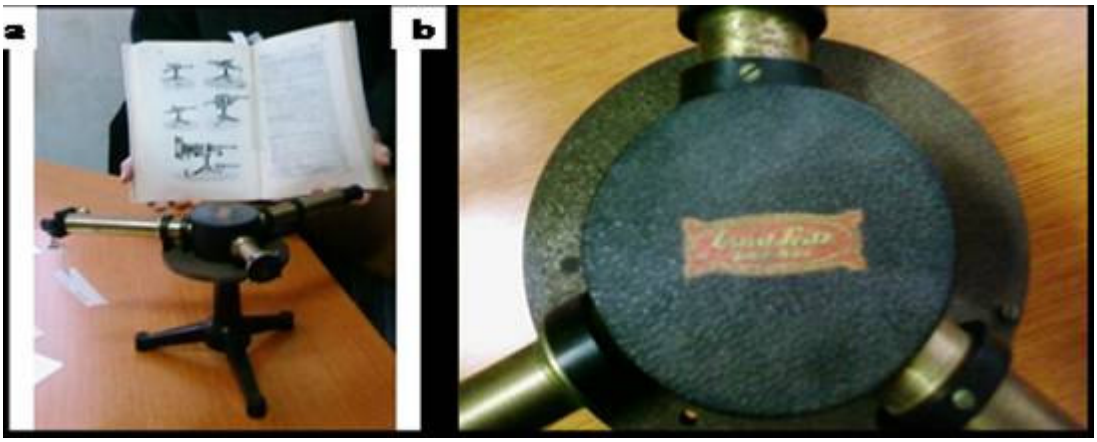


Figure 7. Spectrophotometer of Ernst Leitz (catalogue number # 6970).

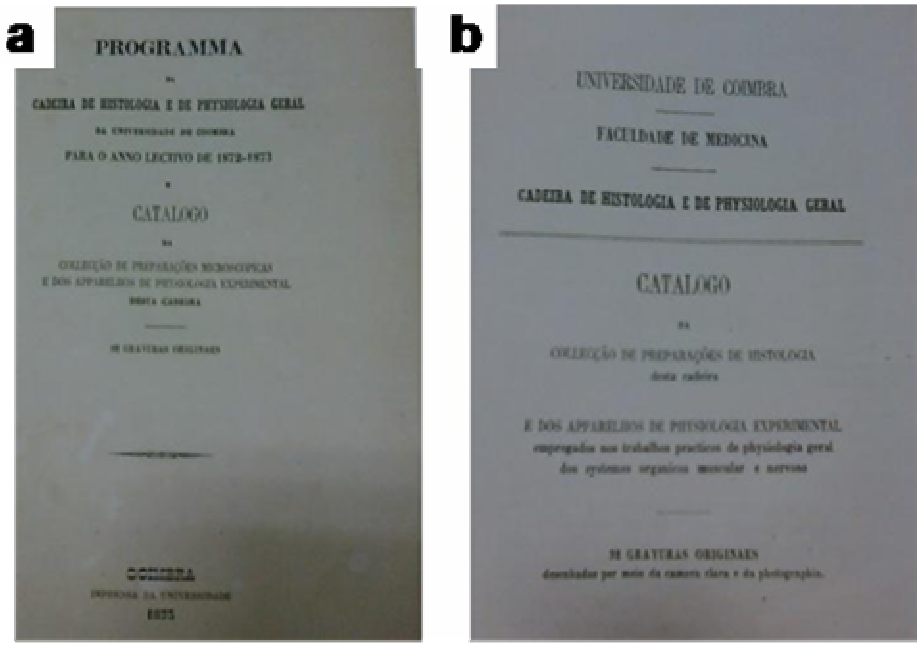


Figure 8. (a) Collection of histology preparations catalogue from 1873, (b) Catalogue of instruments of experimental physiology 1873.

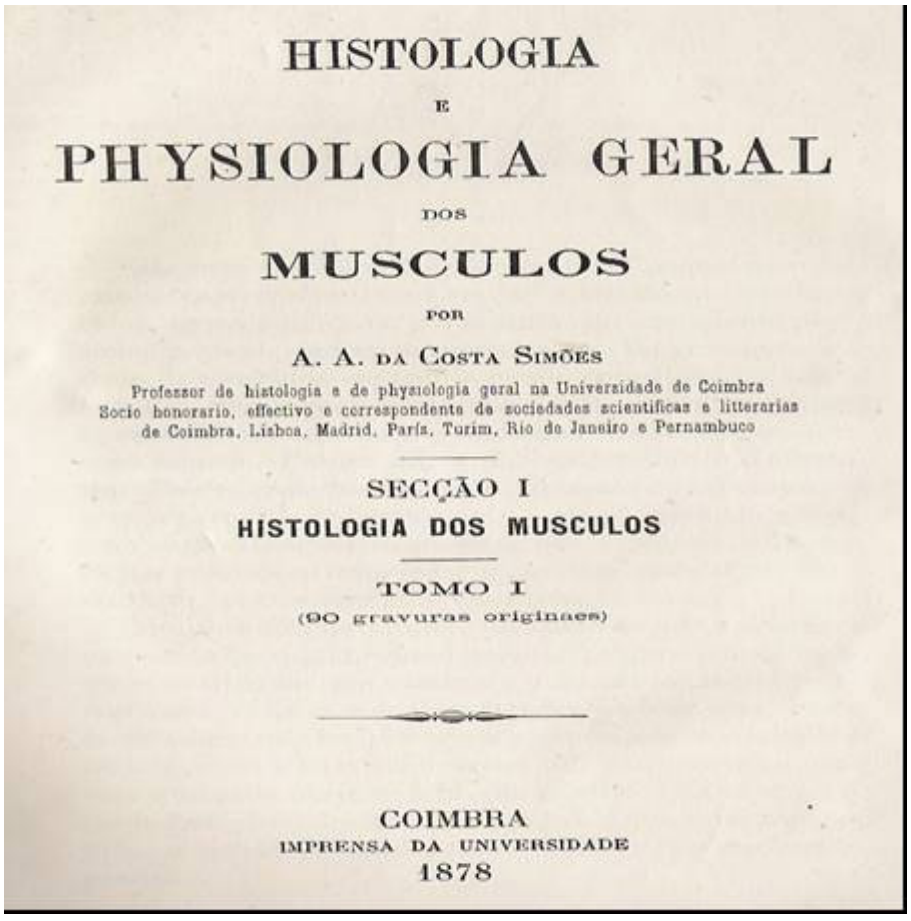


Figure 9. Histology and general physiology of muscles.

Figure 10. The Berlin anatomical theatre seen through the telescope of Berliner Medizinhistorisches Museum der Charité at Berlin since 2009.

Prussia's borders from northeast Europe.

Three years later in 1713, Berlin received an anatomical theatre where, under the care of the Royal Society of Sciences", military barber surgeons, surgeons, midwives and students from outside Berlin received tuition. In Figure 10 we can see Berlin Anatomical Theatre through the telescope of Berliner Medizinhistorisches Museum der Charité at Berlin since 2009. It offered space for 167 students on 6 levels. Yet a good army also needed good military physicians who were experienced in surgery and internal medicine. Therefore, anatomical and surgical instruction in the anatomical theatre was extended to include the subjects of pathology and Therapy, Physics, Chemistry, Mathematics, Botany and Pharmacy. In 1724, the "newly" established Collegium Medico-Chirurgicum", consisting of six professors and a demonstrator, carried out the dissections for students as well as instructions in the basic medical subjects., However, only in October 1810, almost a century later, the Medical Faculty of Berlin University was founded. Berlin Frederick William University – the Medical Faculty – today the Humboldt University - was founded in October 1810 and the founding dean of the Medical Faculty was the royal physician Christoph Wilhelm Hufeland (1726 - 1836). In the first semester, there were already 117 medical students enrolled. Wilhelm von Humboldt (1767 - 1835) was the intellectual father of the new university as we can see in Figure 11 (taken from catalogue "Berliner Medizinhistorisches Museum der Charité", Berlin 2008).

Ludwig Traube (1818 - 1876) together with the anatomist and physiologist Johannes Müller can be credited for the founding of the famous "Berlin school of Medicine" in the 1840's. When anesthesia and hygienic standards (antisepsis and asepsis) were introduced, surgery experienced a great upswing and the university surgical clinic in the Ziegelstrasse (Figure 12) achieved world renown as the "Berlin School of Surgery" under Carl Ferdinand von Graefe (1787 - 1840); Johann Friedrich Dieffenbah (1792 - 1847; Bernhard von Langenbeck (1810-1887); and Ernst von Bergmann (1836 - 1907) (Figure 13).

In the first half of the 19th century, natural scientific thinking came to predominate in medicine. Philosophical approaches became less relevant and research concentrated on the biological, physiological, chemical and biochemical foundations of life. In 1861 the medical curriculum and examination guidelines at Prussian universities were reformed and "tentamen philosophicum" was replaced by a new "tentamen physicum". Medical

Figure 11. The University Unten den Linden at the beginning of the 19th century.

Figure 12. University clinic in the Ziegelstrasse 1880.

students today are still required to attend this subject after their first semester of study. Since then, questions about humanities have occurred rarely; the content is primarily about anatomy, physiology, physics and biochemistry. Curiously, a similar reform occurred in 1866 in the medical curriculum at Coimbra Faculty of Medicine but only six years later, in 1872 (Mirabeau, 1872) by the celebration of 100 years of Coimbra University reform

Figure 13. Ernst von Bergmann in the Royal university clinic Berlin.

Table 1. Medical curriculum reform 1872.

University of Coimbra - Medical Course in 1872		
Year	**Issues**	**Subjects**
1	1	Anatomia descritiva humana e comparada
	2	Histologia e physiologia geral
2	3	Physiologia especial e Hygiene Privada
	4	Anatomia topographica e medicina operatoria
3	5	Materia medica e pharmacia
	6	Pathologia geral, pathologia externa e clinica cirurgica de homens
	7	Anatomia pathologia geral e toxicologia
4	8	Pathologia interna, doutrina hippocratica e historia geral da medicina
	9	Tocologia, molestias de perperas e recem-nascidos, clinica tocologica e clinica cirurgica de mulheres
5	10	Clinica de mulheres
	11	Clinica de homens
	12	Medicina Legal, hygiene publica e policia hygienica

when this action really happened (Table 1). This reform just happened after the scientific trip made by Costa Simões during the period of 1864-1865 while attending several courses and studying the developments of medical courses in the most developed countries around the Europe. The names connected with this natural scientific era are Emil Du Bois Reymond, Rudolf Virchow and Hermann von Helmholtz with special relevance to

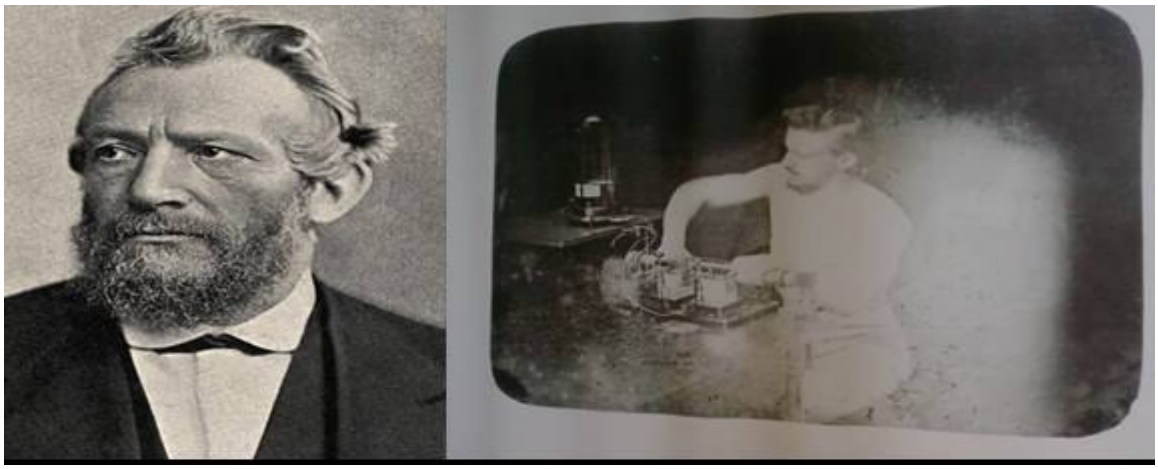


Figure 14. Daguerreotype (reproduction) around 1847.

Figure 15. Rudolf Virchow .

Emil Du Bois-Reymond who was able to show the human being as a power plant (Figure 14).

The modern laboratory started in the kitchen. In 1847, the Berlin physician and physiologist Emil du Bois-Reymond built a simple experimental device (Fig. 14) in his private apartment near the Charité. By measuring electrical current with a string galvanometer, he was able to show that human beings can produce electricity simply by tensing their muscles. Emil Du Bois-Reymond (1818-1896) started his career in 1837 with studies of theology, philosophy, and psychology at the University of Berlin; 1838 -1839 studies of logic, metaphysics, and anthropology, in addition to botany, geology, geography, and meteorology at the university of Bonn; return to Berlin where he began to study medicine; in 1840 he worked closely with Johannes Müller with a historical-literary paper on electric fishes on 10 February 1843; on 14 January 1845 he founded the Physikalische Gesellschaft in Berlin and from 1848 - 1853 instructor in anatomy at the Berlin Academy of Art; 1855 associate professor; 1858 professor of physiology at the Physiological Institute, University of Berlin; from 1876 permanent secretary of the Prussian Academy of Sciences.

Rudolf Virchow (1821 - 1902) (Figure 15) started his career in 1839 as military fellowship to study medicine at

Figure 16. Hermann von Helmholt.

the Friedrich-Wilhelms Institute (the "Pépinière") in Berlin under Johannes Müller, Johann L. Schönlein, and K. A. Rudolphi; and in 1843 received a medical degree from the university of Berlin with a doctoral dissertation on the corneal manifestations of rheumatic disease; "company surgeon" (or medical house officer) at Charité Hospital in Berlin; in 1847 was appointment as an instructor under the deanship of Johannes Müller at the University of Berlin; prospector at Charité Hospital in succession to Froriep; founder and editor of the medical journal Archiv für pathologische Anatomie und Physiologie, und für die klinische Medizin with Benno Reinhardt; and editor of the weekly Die medizinische Reform; as well as editor of the medical yearbook Jahresbericht. In 1856 return to Berlin as professor of pathological anatomy and was appointed director of the newly created Pathological Institute; for almost two decades in charge of a clinical section at Charité Hospital.

Hermann von Helmholtz (1821 - 1894) (Figure16) was government stipend for five years' study, since 1837 at the Königlich Medizinisch-chirurgische Friedrich-Wilhelm-Institute in Berlin; in return Helmholtz committed himself to eight years' service as an army surgeon; in 1838, entry into the university of Berlin, studied chemistry under Eilhardt Mitscherlich, clinical medicine under Lucas Schönlein, and physiology under Johannes Müller; in 1841, research for his dissertation under Johannes Müller and later move into the circle of Müller's students (chief among these were Ernst Brücke and Emil Du Bois Reymond); with Carl Ludwig, they made up the '1847 school' of physiology'; M.D. degree in 1842; in 1845 Du Bois-Reymond brought him into the newly founded Physikalische Gesellschaft; in 1849, associate professor of physiology at Königsberg; in 1855, transfer to the chair of anatomy and physiology at Bonn; in 1858, chair at

Figure 17. An old collection of instruments of physiology

Heidelberg; in 1871, chair of physics at Berlin; in 1887, assumption of the presidency of the newly founded Imperial Physico-Technical Institution for research in the exact sciences and precision technology.

Now we can perfectly understand the idea of Costa Simões while adopting the model of the Berlin school of medicine and why he developed the experimental works executed by remarkable scientists such as Hermann von Helmholtz, Emil Du Bois Reymond, Claude Bernard and Theodor Schwann, also known as the father of Physiology (*). Theodor Schwann studied medicine at Berlin school of Medicine, in 1838, he was professor at Louvain University (Belgium) and ten years later was appointed Professor at Liege university, where Costa Simões had the opportunity to develop his knowledge on experimental works of physiology. Therefore, in October 1866, the laboratory of experimental physiology based on the German model of the Berlin school was ready to start at Coimbra's faculty of medicine. The collection of scientific instruments of this laboratory consisted mainly of instruments recommended in Berlin, Bonn, Breslau, Vienna and Paris, during the scientific trip of Costa Simões in 1865.

The program of the subject of histology and general physiology was based on the textbook notes taken,

*The term metabolism to designate chemical processes in biological organisms belongs to Schwann.

Figure 18. Large galvanometer du Bois-Reymond.

Figure 19. Du Bois Raymond induction instruments.

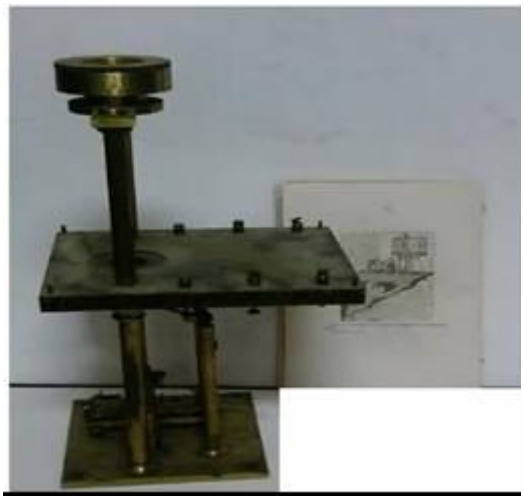
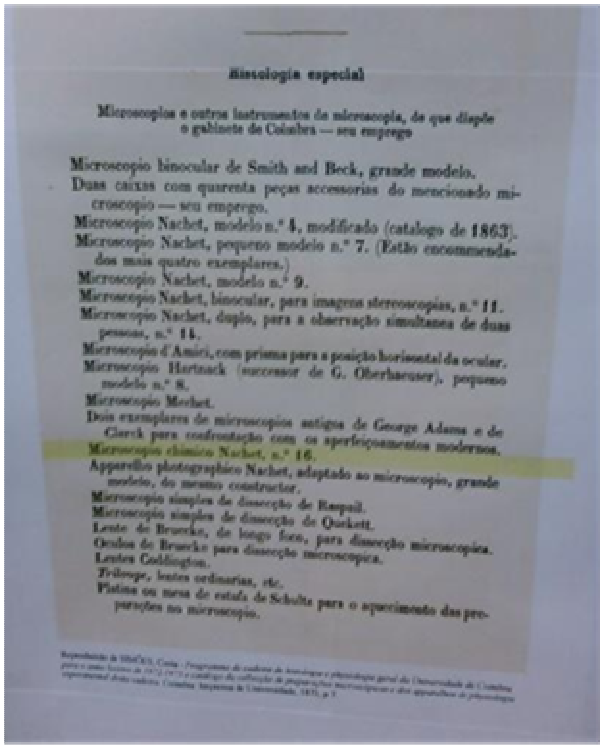


Figure 20. Myograph of Helmholtz.



Histologia especial

Microscopios e outros instrumentos de microscopia, de que dispõe o gabinete de Coimbra — seu emprego

Microscopio binocular de Smith and Beck, grande modelo.
Duas caixas com quarenta peças accessorias do mencionado microscopio — seu emprego.
Microscopio Nachet, modelo n.° 4, modificado (catalogo de 1863).
Microscopio Nachet, pequeno modelo n.° 7. (Estão encommendados mais quatro exemplares.)
Microscopio Nachet, modelo n.° 9.
Microscopio Nachet, binocular, para imagens stereoscopias, n.° 11.
Microscopio Nachet, duplo, para a observação simultanea de duas pessoas, n.° 14.
Microscopio d'Amici, com prisma para a posição horisontal da ocular.
Microscopio Hertzack (successor de G. Oberhaeuser), pequeno modelo n.° 8.
Microscopio Meyhet.
Dois exemplares de microscopios antigos de George Adams e de Clerck para confrontação com os aperfeiçoamentos modernos.
Microscopio chimico Nachet, n.° 16.
Apparelho photographico Nachet, adaptado ao microscopio, grande modelo, do mesmo constructor.
Microscopio simples de dissecção de Raspail.
Microscopio simples de dissecção de Quekett.
Lente de Brueche, de longo foco, para dissecção microscopica.
Oculos de Brueche para dissecção microscopica.
Lentes Coddington.
Triloupe, lentes ordinarias, etc.
Platina ou mesa de estufa de Schultz para o aquecimento das preparações no microscopio.

Figure 21. Microscopes at laboratory of histology in 1873.

during 1861 - 1864, by Costa Simões, while attending his courses. The experimental study of the general physiology of organic systems within this programme is limited to both the muscular and the nervous system. Within the muscular system mechanical and chemical excitation were studied as well as the stimulation of nervous system by several scientific devices.

In Figure 17 show an old cupboard with some of the scientific instruments used at the physiology laboratory at Coimbra university since the beginning of the academic year of 1872 - 1873. Among these scientific instruments we have those used for the study of general physiology of the muscular system (Figures 18 - 20). Some were used to measure muscular strains (Figure 18), some others used to measure the speed of the nervous action (Figure 19) and several induction instruments such as those of Figure 20 used for the electric stimulation of the muscular system.

The description of the twelve microscopes available at the Laboratory of Histology of Coimbra in 1873 is given in page 7 of this book (Figure 21), once the study of special histology (Turner, 1989; Bernard, 1886) necessarily

Figure 22. "Indispensable" ranvier.

Figure 23. Microtome

implies a practical notion of all microscopes including its accessories such as microtome tube, Nachet haemocytometer and the material for the preparation of Ranvier slides for microscopy, which can be seen in Figures 22-24. Later on, in 1866, a book entitled "Elementos de Physiologia Humana" (Elements of Human Physiology) was published in three volumes. The publication of this book was another outcome of the European scientific trip made by this professor.

The microscopes collection

These photographs were performed by Lucinda Moraes at the faculty of medicine with the permission of Vasco Bairos, actually, responsible for the Institute of histology and embryology, together with the collaboration of Poiares Baptista and Alfredo Rasteiro). From the collection mentioned in Figure 21, four instruments – two Nachet a small and a large monocular model together

Figure 24. Nachet Haemocytometer.

with one Hartnack small model and one Mechet– were acquired by Costa Simões after his trip. All the rest already existed in the laboratory of the medicine faculty. Small and Large Monocular Nachet, Large Binocular Nachet (1870). In the words of William Carpenter, the president of the microscopic society of London in 1861, this microscope Smith, Beck and Beck was recognized as a scientific instrument - "in point of general excellence of workmanship, this instrument cannot be surpassed" (Santos Viegas, 1862).

CONCLUSION

Electrical phenomena in nerves and muscles, muscle tension and muscle power, acoustic connections, optical questions and the visual ability of the eye: these are the core topics of the rapidly developing research into bodily functions in the second half of the nineteen century. All these phenomena fall within the scope of physiology. With usefully conceived and artistically crafted experimental instruments, physiologists attempted to fathom the biological regularity of life especially through experiments on animals. Using the apparatus in experiments demanded deftness, training and much practice. Only when masterful use of the instrument had been achieved, could isolated natural phenomena be exposed and the knowledge made clear.

In the middle of the 19th century, the laboratory took its place next to the pathologist's dissection hall as a central location for medical research. Young researchers transferred the latest insights from biology, physics and chemistry to human beings and the study of medicine started a new paradigm of medicine practice – Evidence-Based Medicine – to understand the symptoms by the study of the inner body leaving behind the superficial look of disease.

Their aim was to perform pure science and not to lose

Figure 25. A letter from Theodore Schwann.

themselves in philosophical speculations about the essence and meaning of life. According to them, organic life was joined indivisibly with the solid structures and liquid parts of the body. Using special experimental devices, they wanted to find, define, measure, note and evaluate the mechanisms of life – in the healthy as well as the sick – that can be perceived with the senses.

These standards reflect the expectation that objective models of the functioning of the human body could be developed in order to derive sustainable diagnostic and therapeutic measures.

Spaces, laboratories and instrumentation were implemented and developed as a result of Costa Simões involvement concerning scientific trips. From these trips an interesting collection of scientific instruments merged at the faculty of medicine at the university of Coimbra, which were acquired from several European countries (Paris, Berlin, Liege and Vienna), and implementation of new ideas and practices in teaching and research allowed experimental teaching.

Since then, Costa Simões started correspondence with several friends and colleagues such as: Claude Bernard (1813-1878) and the histologist Charles Robin (1821 - 1885) in Paris; Theodor Schwann (1810-1882), the father of cellular theory from Liege; the neurophysiologist Eduard-Friedrich Weber (1806-1871) from Bonn; Hermann Helmholtz (1821-1894) in Heidelberg and Emil Du Bois-Reymond (1818-1896), director of the experimental physiology laboratory of Berlin, the founder of electrophysiology, to mention but a few. Unfortunately, most of this correspondence got lost and there is only a remaining postcard from Schwann (Figure 25) found among several personal letters from this professor of medicine faculty of Coimbra.

At the end of the 19th century, it became possible to gain completely new insights into the living human body. In Würzburg, on 8th November 1895, Wilhelm Conrad Röntgen (1845-1923) discovered the type of radiation He called ×-rays. Bones become visible and later on (with the use of intensified contrast agents) soft tissue such as stomach and intestines could also be seen. At the microscopic level, microscopes were useful scientific instruments, which could be easily operated. By the end of the 19th century, the basic design of the microscope was firmly established. The microscope must surely rank as the most useful scientific instrument ever to have contributed to the biological and medical sciences (William, 1868). Although, the binocular microscope had been invented by 1677, no interest was shown in it until almost the mid nineteenth century. By then microscopy was becoming a hobby of wide appeal; it particularly flourished with public interest in natural history generated by Charles Darwin's on the origin of species.

These instruments were the trigger to the development of new subjects at the medical school such as electrophysiology and neurophysiology which otherwise could never been developed. In his vision of modernity, Costa Simões a “scientific traveller” joint together the art of science with the science of art, enhancing the characteristic of the new paradigm of medicine practice: the importance of the experimental feature of medical studies is well depicted in his works since, he created the possibility to provide the experimental conditions concerning spaces, laboratories and instrumentation. The laboratory in all of its numerous permutations continues to be the central location of science in medicine. To put it more broadly: How does a thinking, feeling, socially connected and culturally active individual develop from biological hereditary rudiments? This question is still waiting for an answer.

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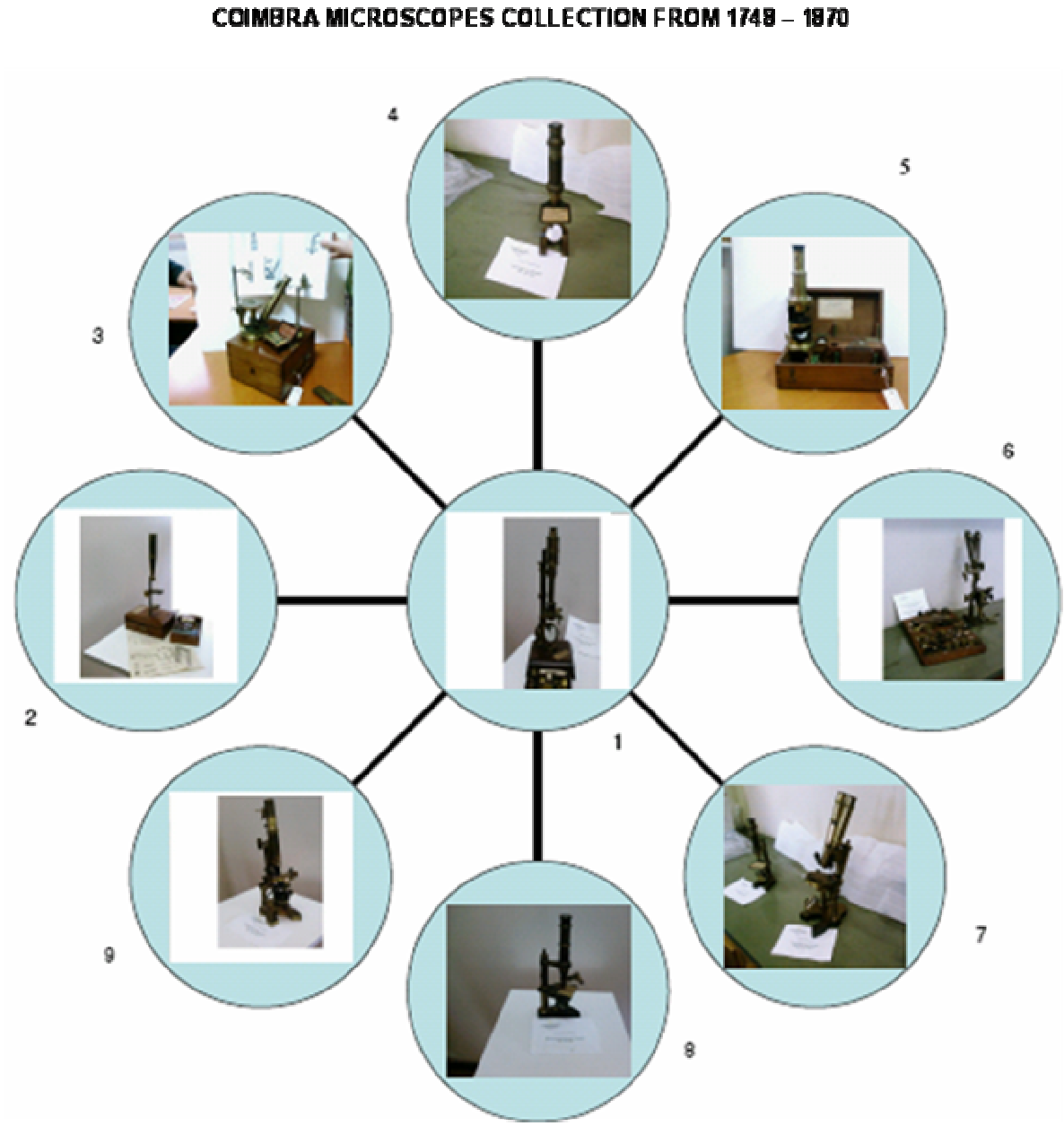
Appendix



Here we have Coimbra microscopes collection from 1748-1870 in a circular diagram where we can see the 9 microscopes.
1. - Microscope of George Adams (1748).
2. - Clark Microscope with box (1830).
3. - Nachet Chemical Microscope (1850).
4.- Hartnack Microscope(1860).
5.- Lerebours et Secretan (1860).
6. - Smith, Beck & Beck (1861).
7. - Large Binocular Nachet (1870).
8. - Small Monocular Nachet (1870).
9. - Large Monocular Nachet (1870).