

# The Pasteur hospital as an element of Emile Roux's anti-diphtheria apparatus (1890-1914)

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**SUMMARY:** 1.—Introduction. 2.—The context of the development of serotherapy against diphtheria. 3.—Roux's project. 4.—The production site of the serum: Marnes-la-Coquette (Garches). 5.—The *Hôpital Pasteur*. 5.1.—Financing. 5.2.—The order. 5.3.—The architect. 5.4.—Description. 5.5.—Internal distribution and circulation. 5.6.—Influence and inspirations. 6.—The *Hôpital Pasteur* as a model. 7.—Contestation of the model. The *Hôpital Pasteur*: an expensive ideal.

**ABSTRACT:** Before the decisive discovery by Gaston Ramon of a vaccine («*anatoxine diphtérique*») in 1923, the fight against diphtheria in France had started in 1894 with the serotherapy approach of Martin and Roux. Emile Roux, director of the Institut Pasteur, developed a dynamic concept of research/production/application expressed in the organization of a specialized hospital, the *Hôpital Pasteur*, which was constructed near the research laboratories and also incorporated production centres outside Paris in Marnes-la-Coquette. Roux implemented a well-defined project against diphtheria that took account of all of the logistical implications. By associating this therapeutic project with an architectural project, Roux established a coherent anti-diphtheria apparatus.

**PALABRAS CLAVE:** difteria, Francia, Hospital Pasteur, seroterapia, higiene hospitalaria.

**KEYWORDS:** diphtheria, France, Hôpital Pasteur, serotherapy, hospital hygiene.

## 1. Introduction

Diphtheria, first named by Bretonneau in 1817, is a contagious microbial disease, characterised by local throat lesions due to the colonization of tissues by the Klebs-Loeffler bacterium (bacillus identified in 1883, the proof of the causal link being brought by Roux and Yersin in 1888) and by general signs due to the toxin secreted by the bacteria. Diphtheria, or diphtheritic angina, appears as a pseudo-membranous sore throat. In severe forms of the

disease, diphtheria is associated with clinical signs of intoxication: phonation trouble, polyneuritis, myocarditis, low blood pressure and collapse. The clinical picture also includes a high albumin level, high temperature and a poor general state. Digestive tract and kidney dysfunctions are frequently observed. The best-known localization of diphtheria (the croup), and that most often leading to death if not treated, is the larynx, with a high risk of obstruction of the upper aerial passageways, requiring tracheotomy. The most serious cases are associated with streptococcus or staphylococcus. In 1894, without treatment by serotherapy, the mortality rate could reach up to 60% in hospital-admitted children<sup>1</sup>. Serotherapy treatment consists of the administration of serum from a hyper-immune horse, which procures passive immunity (contrary to active immunity given by vaccine).

## 2. The context of the development of serotherapy against diphtheria<sup>2</sup>

Before Roux's 1894 experiments on serotherapy, a set of rules had been established by Joseph Grancher to reduce the risk of infection. Grancher (1843-1907), the physician in charge of the infectious diseases service at the *Hôpital des Enfants-Malades* in Paris, propagandist of asepsis and isolation techniques compatible with the functioning of a section of infectious diseases in a large hospital, advocated and tried out a strategy based on the association of isolation and asepsis, the latter of which was thus far restricted to surgery and obstetrics departments<sup>3</sup>. Grancher's 1890 report —answering to the question rised by the Ministry in charge of public health concerning the building, out of Paris, of a hospital for diphtheria patients— does not favour the establishment of such a hospital but rather the implementation of rigorous rules on hygiene and asepsis in the hospital, along with the limitation of external contamination during transportation of the patient

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1. ROUX, Émile; MARTIN, Louis; CHAILLOU, A. Trois cents cas de diphtérie traités par le sérum anti-diphtérique. *Annales de l'Institut Pasteur*, 1894, 8, 642.

2. I wish to thank Gabriel Gachelin for his help concerning that section of the paper. See also his contribution to this issue for the European context.

3. GRANCHER, Joseph. Essai d'antisepsie médicale. *Revue d'hygiène et de police sanitaire*, 1890, 12, 495-509 and commentaries, 992-1003.

to the hospital, thanks to the newly created ambulance service<sup>4</sup>. Grancher reorganised the large common rooms by isolating each bed with a 1.2-meter high screen made of wire gauze, aimed at reducing to a minimum the movement from bed to bed, and by providing each half-closed box with individual equipment for food and care, sterilized every other day. The staff obeyed very strict rules of asepsis (hand washing with mercury sublimate, change of coat) when progressing from box to box. As a rule, bed clothes were sterilised after each discharge from hospital. Results appeared to be convincing, thus eliminating the until then dominant role of circulating air as the principal vector of contamination within wards as well as outside: person to person contacts among patients, visitors and hospital staff are the main agents of contamination<sup>5</sup>.

That therapeutic structure and organization were implemented in Grancher's service at the *Hôpital des Enfants-Malades*. Roux and his collaborators carried out their anti-diphtheria serotherapy experiment on 300 children in this department suffering from the disease<sup>6</sup> starting on February 1<sup>st</sup> 1894 and ending on July 24 of the same year. The children receive standardized doses of hyper-immune horse serum. Comparison is made with a cohort of children hospitalized at the *Hôpital Trousseau* treated in the same way but not receiving serum injections. In the groups clinically and bacteriologically defined as diphtheria by Chaillou and Martin, mortality is reduced two-fold. The result is far better among patients suffering from microbiologically pure diphtheria (5-fold reduction), whereas the association of the diphtheria bacterium with streptococci proves to be an aggravating factor. These very data are used in the communication made by Roux at the International Congress of Hygiene held in Budapest in September 1894, and which is the hallmark of the wide spread of serotherapy in Europe<sup>7</sup>.

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4. GRANCHER, Joseph. Prophylaxie de la diphtérie. Transport et isolement des diphtériques dans les hôpitaux. *Revue d'hygiène et de police sanitaire*, 1890, 12, 1084-1097.
  5. This final conclusion is made clear in the discussion of Grancher's contribution. GRANCHER, note 3, pp. 992-1003.
  6. ROUX, Émile; MARTIN, Louis. Contribution à l'étude de la diphtérie (serum-thérapie). *Annales de l'Institut Pasteur*, 1894, 8 (9), 608-639 and ROUX, MARTIN, CHAILLOU, note 1.
  7. Roux's communication and its discussion by Behring are published in the *Revue d'hygiène et de police sanitaire*, 1894, 16, 784-798. A similar experimental series was reported by Dr Aronson of Berlin and Roux added the suggestion of a code of good practices towards diphtheria. The discussion of the proposal is postponed to the Congress of 1897.

### 3. Roux's project

When working in Grancher's service, Emile Roux (1853-1933), vice-director of the Institut Pasteur, rapidly perceived that serotherapy alone was not sufficient to combat diphtheria, and that treatment should include an individual, complementary therapeutic aspect<sup>8</sup>. Beyond all these considerations, the note signed by Roux alone, associated with the second 1894 article, defines the reforms to be introduced into the institutional framework to make the serotherapeutics of diphtheria efficient:

«I would be lacking in my duty were I to not mention here the poor organisation of the diphtheria services in Paris. Due to a deplorable rotation system, the doctors in the diphtheria pavilion change every three months, with the different heads of service of the hospital each serving as head. In order to be well conducted, a diphtheria service must remain in the hands of one physician, who has the obligation to become a specialist in the study of this disease: he will have under his orders permanent aides and personnel, who will be veritable collaborators. The material organisation does not begin to correspond to the exigencies of the most elementary hygiene. At the Hôpital des Enfants, there is a girls' ward and a boys' ward, with an isolation room at one end. They have to keep the measles patients, the scarlet fever patients in common wards. Bronchial pneumonia, so fearsome for patients having undergone operations, reigns almost permanently despite the efforts of the chiefs, interns and personnel. The director of the hospital is full of good will concerning disinfection, but all it takes is the admission of a contaminated child to re-contaminate. In winter, especially, when the pavilion is full, and the windows remain closed, bronchial pneumonia becomes terrible. It is necessary to isolate not only the patients with diphtheria accompanied by measles and scarlet fever, but also patients with sore throat or croup with associated infection. Furthermore, a well-constructed diphtheria pavilion should only have convalescent children stay in the wards together if they have spent over 15 days in the hospital. Every admission is suspect and must be isolated in a

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8. In ROUX Emile; YERSIN Alexandre. Contribution à l'étude de la diphtérie, 3<sup>e</sup> mémoire. *Annales de l'Institut Pasteur*, 1890, 7, 384-426. In his conclusion, Roux insists on the need to sterilise the rooms and steam bed sheets, all material used and belongings of patients. He insists as well on the painting the throat of recovering children with an antiseptic solution until complete sterilization, a common therapeutic act by that time, to avoid reversal of the loss of virulence. In 1894, just before his clinical essay on serotherapy, Roux mentions this treatment (glycerin and salicylic acid; washing with boric acid added to water) as being still in use, the only new element remaining, as far as he is concerned, the serum.

type of box which is closed, easy to disinfect, and located in such a way that the personnel cannot transport infections from patient to patient»<sup>9</sup>.

The full text of that note was reprinted (and depicted as a decisive step for the choices of the *Assistance publique* after 1895) in the Hygiene treatise coordinated by P. Brouardel and E. Mosny, published in 1907<sup>10</sup>.

Obviously, it is the multifactorial feature of the fight against diphtheria, the treatment against the bacterium (serotherapy) and the contextual treatment (the hospital) which led to a double-headed project: production of the serum (production site) and the designing of the anti-microbial circuit (the hospital for infectious diseases).

#### 4. The production site of the serum: Marnes-la-Coquette (Garches)

The buildings located in the park of Marnes-la-Coquette (often referred to as Garches) were adapted between 1884 and 1939 for housing the industrial production of sera and vaccines, particularly against tetanus and diphtheria, first in the context of that well-defined medical project: the serotherapy of infectious diseases.

Roux intended to provide an industrial-sized production. The buildings initially included stables for horses, a breeding centre for guinea pigs used in biological assays, and rooms for bleeding horses and for preparing and conditioning the sera. Temporary buildings for the production of the same reagents for the Army Health Service were added during the 1914-1918 World War, whereas new research and production buildings were constructed in 1935<sup>11</sup>.

It would be useful to provide some chronological data to put the facts in their context. The Institut Pasteur was established in the 15th arrondissement of Paris, rue Dutot (presently rue du Docteur Roux) thanks to a public subscription launched in 1886 by the *Académie des Sciences* for the

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9. ROUX, MARTIN, CHAILLOU, note 1, p. 661. For smoother reading, we have translated cited material.

10. MARTIN, Louis. Hygiène hospitalière. In: P. Brouardel et E. Mosny éditeurs (Eds.), *Traité d'hygiène*, Paris, Librairie J-B. Baillière, vol. 8, 1907.

11. A detailed study of the architectural history of the site is being carried out by the *Centre de recherches historiques* of the Institut Pasteur and the *École d'architecture de Paris-Val-de-Seine*.

construction of an institution for the prophylaxis of rabies. Under Roux's supervision, the Institut Pasteur was built in two years.

The announcement made in September 1894 at the Budapest Congress of Hygiene that anti-diphtheria serotherapy was a success is followed by the launching by the newspaper *Le Figaro*, of a subscription aimed at promoting anti-diphtheria treatment. Originally it was for the purchase of horses. The same year a *Service pratique de sérothérapie* headed by Roux was created at the Institut Pasteur. Garches (Marnes-la-Coquette or previously known as Villeneuve l'Etang) was part of the service. Roux was himself in charge of the animal centre and of the diphtheria service. Within the logic of an expanding institution, Roux provided the Institut Pasteur with a pharmaceutical and financial department.

After the decision made in 1907 by the board of directors to build new horse stables and a rotunda at Garches, the industrial future of the site was clearly stated. During WWI, participation in the war effort is manifested by an increase in production and a significant increase in the number of employees<sup>12</sup>.

In 1923-1924, the discovery of anatoxins and that of the efficiency of adjuvant for vaccination marked the beginning of an expanding industrial production of vaccines at Garches. In 1936, new laboratories are built and ware dedicated two years later.

The Institut Pasteur and its production installations constituted a model for numerous foreign visitors, particularly for Brazilians, resulting in the construction of a Serotherapeutic Institute in Manguinhos, Rio de Janeiro, later to become Institut Oswaldo Cruz in 1908, and for which reference to the Institut Pasteur was made<sup>13</sup>. F. Delaporte relates «*une visite à la section de préparation des sérums thérapeutique*»<sup>14</sup> by Oswaldo Cruz in 1898:

«The Institut Pasteur section devoted to the preparation of therapeutic sera is installed in a beautiful property in Garches (...) On 6 April, 1898, we visited this annex to the Institut Pasteur. We were honored by the presence

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12. Up until 1914 at least 25 people worked in Marnes. The number reached 100 in July 1914. The number of animals followed the same rate of growth, from 230 horses in July, and reaching 1500 animals during the war. Horses were also kept on other sites.

13. BENCHIMOL, Jaime (coord.). *Manguinhos de sonho à vida: a ciência na Belle Époque*, Rio de Janeiro, Fiocruz/COC, 1990.

14. *Brasil-Médico*, 1898, 285-286, quoted by DELAPORTE, François. *La maladie de Chagas*, Paris, Payot, 1999.

of professor Roux, who accompanied us in this excursion, and by Mr. Prévost, the establishment's director (...) The Institute of serotherapy arises in the center, surrounded by a vast carpet of green, which serves as a pasture for the horses destined for the production of sera»<sup>15</sup>.

## 5. The *Hôpital Pasteur*

The hospital, «*hôpital de recherche*» which will become an «*hôpital d'expérimentation*»<sup>16</sup> was located in Paris, inside the site of the present rue du Docteur Roux (formerly rue Dutot/Vaugirard) and was inaugurated in 1900. Its original vocation is defined without any ambiguity by Louis Martin (1864-1946), the first physician-director of the *Hôpital Pasteur*; it was created primarily to take care of children with diphtheria.<sup>17</sup> Cares and management were provided by members of a religious order, the *Sœurs de Saint-Joseph de Cluny*<sup>18</sup>.

Emile Roux, as already mentioned, is the initiator of the project, planned since 1894. It is organized logically, according to the already-admitted principles of a pavilion and an isolationist organization (both individual isolation and protection from the outside).

Thus, the ambition of the architectural program of the *Hôpital Pasteur* is to enable the gathering of research on infectious diseases and its therapeutic application together with the experiment of a new organization for a hospital<sup>19</sup> (fig. 1).

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15. DELAPORTE, note 14, pp. 26-27.

16. Archives Institut Pasteur (AIP), Box SUR, Bernard Sureau, document on life at the hospital, 6 nov 1988.

17. MARTIN Louis. Le fonctionnement de l'hôpital Pasteur. *Revue d'hygiène et de police sanitaire*, 1903, 25, 236-281.

18. AIP, box Hôpital, *Note sur la création de l'hôpital Pasteur*, no date. A contract is signed in 1896 associating Emile Duclaux, directeur de l'Institut Pasteur, and the Sisters of Saint-Joseph de Cluny.

19. Concerning a contextual history of the hospital and of the isolation of patients, I refer to the excellent study by KISACKY, Jeanne. Restructuring Isolation: Hospital Architecture, Medicine, and Disease Prevention. *Bulletin of the History of Medicine*, 2005, 79, 1-49.



Figure 1. *Hôpital Pasteur* today. Martin pavilion. Photo by the author.

### 5.1. *Financing*

The *Hôpital Pasteur* is built by the architect Florentin Martin on a 14 000 m<sup>2</sup> plot of land purchased by a then anonymous donor (Mme Lebaudy) in 1896. In order to permit the donor to remain anonymous, an intermediate financial society, *la Société d'applications des méthodes pastoriennes* is created for purchase of the land. Power is granted by the Assembly to Emile Duclaux (1840-1904), director of the Institut Pasteur from 1895 to 1904

«to accept, in the name of the Institut Pasteur, the stocks that the *Société d'applications des méthodes pastoriennes* might put at his disposal, and also to accept to substitute the *Société de l'Institut Pasteur* for all engagements which might be contracted by the *Société d'applications des méthodes pastoriennes* concerning the use of land belonging to this society, all the preceding under the formal condition that the maintenance of the hospital to be built on this



land be assured by the ressources of this hospital and at no moment, would obligate the Institut Pasteur to be responsible»<sup>20</sup>.

The hospital's expenses are sustained by Mme Lebaudy (Mme L) until 1920, the year of her death, and later according to her will, by the *Trustee Coutts* of London, which provides the necessary funds annually until 1940 (the final payment amounted to 14 million 350 thousand francs).

## 5.2. The order

The building permit, filed by Emile Duclaux, director of the Institut Pasteur, is delivered in 1898. The file includes a set of blue-prints, plans, cross-sections and elevations (fig. 2, 3, 4) prepared and signed by Duclaux et Fl. Martin, all entitled *Hôpital pastorien* and dated May 13, 1898 (Florentin Martin, Architecte, 18, rue d'Estrées, Paris).

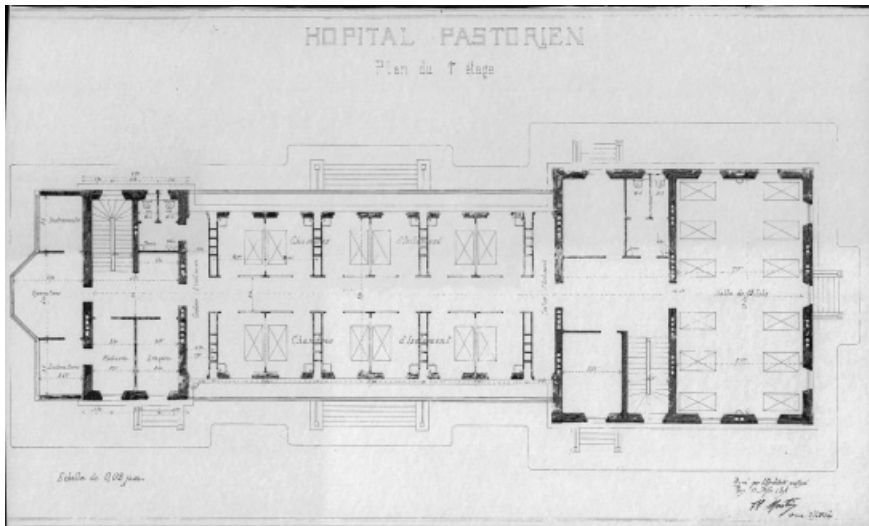


Figure 2. The hospital, 1st floor plan, Archives de Paris.

20. AIP, CA-REG 1, Registre I Conseils d'administration 1886-1908, Séance de l'Assemblée du 1<sup>er</sup> avril 1898

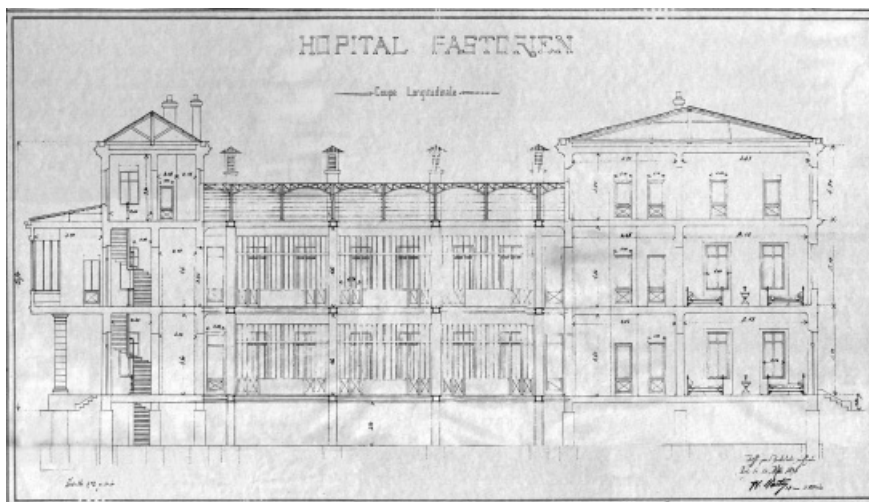


Figure 3. The hospital, longitudinal cross-section, Archives de Paris.

The authorization for a building permit concerning the second pavilion for patients is filed later, on September 1st, 1898<sup>21</sup> and also deals with a building permit for the pavilion for the Director, located at 205 rue de Vaugirard, along with a «*bâtiment à usage de dependances*»<sup>22</sup> (fig. 5).

The file includes a set of plans: a blue-print of pavilion n°2 of the hospital signed by Roux and Fl. Martin, dated September 1st 1898, several blue-prints and a request for hospital annexes, signed by Roux and Fl. Martin, dated September 1st, 1898 (parallel to the pavilion, housing the kitchen, refectory for men and women, sewing and laundry services on the ground floor and, in the basement, the storage for food, bread, dried vegetables, dish-washing equipment, cellars, drying oven, laundry and disinfection).

21. Archives de Paris, Série V 0<sup>11</sup> 3798, RF préfecture de la Seine Pièce n°2039, permission du 28 septembre 1898, n° 2984.

22. The director's apartment consists, at the 1st floor of the building, of an office, a small and a large lounge, a kitchen and a dining room. The permit for the construction of the consultation building and that for the staff situated at 213 rue de Vaugirard is signed by Duclaux and dated February 13, 1899. A series of blue-prints is associated with the file, including one entitled *Fondation de Maillefer Hôpital pastorien*, dated February 13, 1899, signed by Duclaux and Fl. Martin. The permit to build was granted on March 18, 1899 (Permission du 18 mars 1899 n° 561. Archives de Paris)

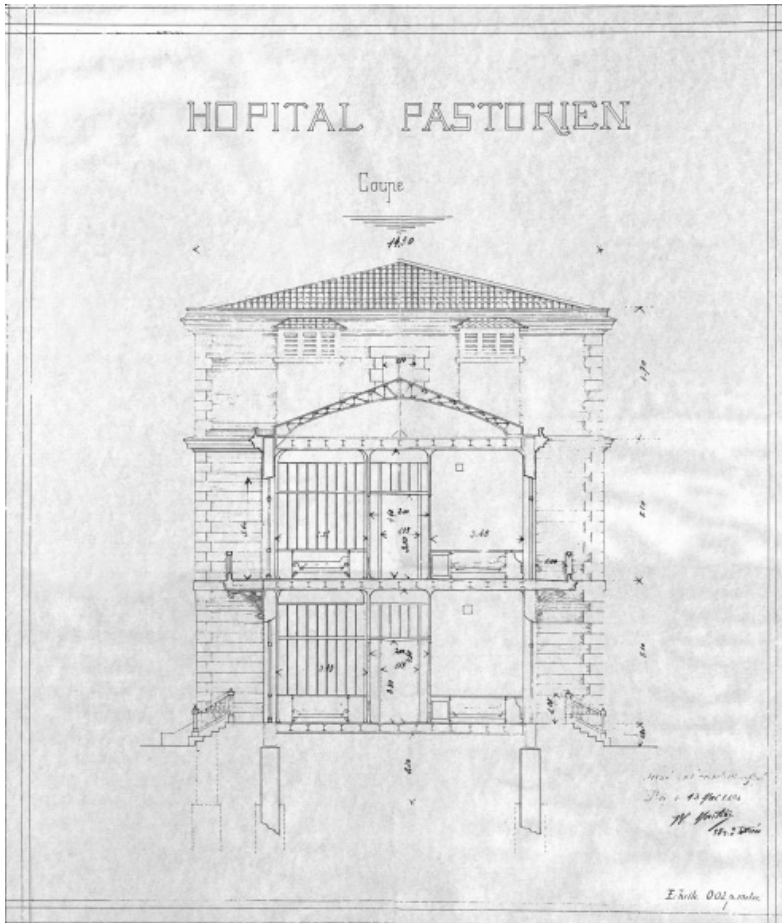


Figure 4. The hospital. Cross-section, Archives de Paris.

The first pavilion (presently named *Louis Martin*) is opened to medical activity by a prefectural order dated October 25, 1900, authorising its opening as an «établissement destiné au traitement des maladies microbiennes»<sup>23</sup>. The second pavilion (presently *Emile Roux*) is opened in 1902.

23. Archives de Paris, note 21.

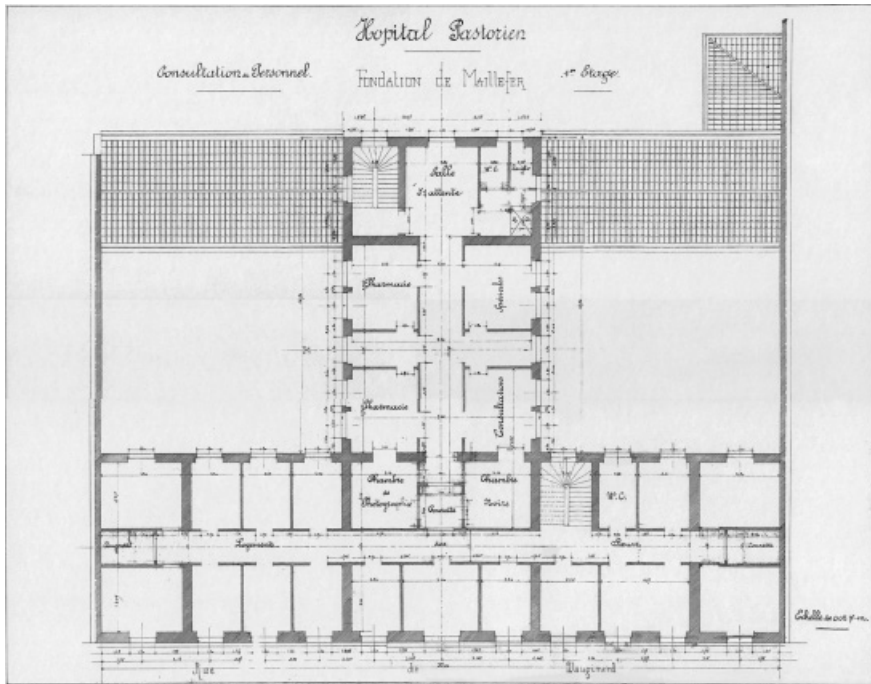


Figure 5. Clinic and personnel building, Archives de Paris.

### 5.3. The architect

Joseph Florentin Martin [5 (ou 30<sup>24</sup>) August 1867 at Le Puy (Haute-Loire)-22 January 1922], studied architecture at the *École des Beaux-Arts* in Paris, 1888, (as a student of Questel and Pascal) He received his diploma in 1899 (based on the project of the *Hôpital Pasteur*). The *Hôpital de l'Institut Pasteur* appears to be his main achievement<sup>25</sup>. Florentin Martin is a brother of Louis Martin.

24. Archives nationales, AJ52\* 244: Chronological record of architecture students 1819-1898 .

25. Among buildings of which he was the architect, were: the health houses for docteur Hartmann, bd Victor Hugo and rue des Dames Augustines in Neuilly-sur-Seine (1906), docteur Gosset's house, rue des Plantes and Antoine Chantin, in Paris (1912); a program of houses for workers built rue Guillemot in the Plaisance area in Paris for Miss Chaptal along with houses and apartments for large families —well ventilated, equipped with laundries with a system of washing and disinfection of clothes similar to that in use at the *Hôpital Pasteur*. Fl. Martin

#### 5.4. Description

As early as 1901, the architect, in an article published in the *Revue d'hygiène et de police sanitaire*, describes the hospital in great detail: distribution of space, inside fittings, paintings, construction materials, flow of fluids, heating systems, technical installations.

Two critical notions arise from the article, favouring hygiene and pastorian methods: hygiene, «the most hygienic as possible» and the support of pasteurian principles: «*l'Hôpital Pasteur, conçu et exécuté selon les idées du maître*»<sup>26</sup>. The hospital is a complex of buildings including<sup>27</sup>:

- To the north, at 213 rue de Vaugirard, a building for medical consultations and the housing of the staff; at 205, a house for lodging the resident physician and the administration.
- More to the south, the hospital itself, consisting of two main, identical, buildings, linked to one another by a third building, windowed and used as a green house, according to a U plan.
- The two buildings each consist of three bodies: a long one flanked at each end by pavilions<sup>28</sup> with a square plan (south) and a rectangular plan (north).
- The green house consists of an octagonal central rotunda flanked by two aisles commanding the south entrances to the two main buildings.
- An inside courtyard lined on three sides by the buildings and open on the north side. It is planted with two rows of trees along a cen-

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also built interest-bearing houses avenue de Saxe and de Breteuil, rue de Rome, a mansion for Denys Cochin with building, yard and garden, 50 rue de Babylone, 7<sup>e</sup>, (1911) as well as horse stables and annexes for the Institut Pasteur (62 rue d'Alleray, 15<sup>e</sup>, 1899). CURINIER, C-E (Dir.), *Dictionnaire national des contemporains : contenant les notices des membres de l'Institut de France, du gouvernement et du parlement français, de l'Académie de médecine...* Paris, Office général d'éd. de librairie et d'impr., [1899]-1919, vol. 3, pp. 86-87.

26. MARTIN, Florentin. L'hôpital Pasteur. *Revue d'hygiène et de police sanitaire*, 1900-1901, 12, 645.

27. See also L'hôpital Pasteur. *La construction moderne*, 1901 (juillet et août), pp. 510-511 and pp. 520-521, with plates by the architect.

28. The word pavilion is used here within the definition given by an architecture dictionary: «building or the main body of a building characterized by a more or less square plan». PEROUSE DE MONTCLOS, Jean-Marie. *Principes d'analyse scientifique, Architecture, vocabulaire*, Paris, Imprimerie Nationale, rééd. 1993.

tral alley. Secondary, perpendicular alleys cut out the flowerbeds according a rigorously symmetrical pattern.

- To the south of the complex, a building is devoted to the *service des morts* (morgue, later converted into the pharmacy and the hospital laboratory).
- These diverse buildings were all connected by a network of underground galleries.

The two buildings develop over two elevation levels for the central body and three levels for the two end pavilions. The hospital is built with a mixed material of brick and white stone. This results in a traditional Parisian polychromy: pavilions in red bricks, window frames in white stone (see hospitals Boucicault, Bretonneau and Trousseau), *chainage*, lintels and *moellons de meulière* for the foundations.

The entire medical complex extends over a surface of about 7000 m<sup>2</sup>.

### 5.5. *Inside distribution and circulation*

The inside distribution obeys the principles of individual isolation and separation of the clean from the waste circuits.

«Air circulation, both warm and cold, requires attention on the part of the conceptors. Warm air passes inside the hollow wall (similarly to the pipes for clean and dirty water and gas and the cables for electricity) as does the polluted air, which is evacuated towards the exterior by means of a shaft. Heating is by warm air. The air is captured in the basement, passes over a steamheated metallic battery, and rises inside the shafts in the walls thus heating each room».<sup>29</sup>

The circulation of persons, staff and patients, defined according to a precise scheme, is largely inspired by Grancher's anti-contamination circuits, themselves inspired by surgery wards. Bed to bed circulation is reduced to a minimum. As in the *Hôpital des Enfants-Malades*, the staff must adopt rigorous rules of asepsis when going from room to room: hand washing

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29. For a precise description of the human and fluid circuits, and of the heating system, see MARTIN, note 17.

with antiseptic<sup>30</sup> or changing of clothes. Sterilisation of the bed and room equipment is carried out after each patient's discharge.

The great difference with the *Hôpital des Enfants-Malades* is the strict application of Roux's theories about the layout. As there is an absolute need to isolate cases of pure diphtheria, diphtheritic anginas associated with streptococcus, diphtheria with measles or any associated pathology, individual rooms are necessary, in contrast to an organization based on common wards. Convalescent cases must be housed in a separate part of the pavilion. Human contacts, the main pathogenic source, are reduced to the minimum: a balcony is built up along the wall of the first level with a glass door to each room so that the visitors can see and talk to the young patient without any contact.

Non-infection is the very principle of the hospital, where the architecture is dominated by an absolute necessity for isolation, disinfection, and reduction of the furniture to the minimum. The strict and careful application of this principle carried out by the architect makes the *Hôpital Pasteur* a model, an *hôpital-pilote* adopted by many countries.

### 5.6. Influence and inspirations

The models of English hospitals, invoked as the source of inspiration for pavilion hospitals, are themselves inspired by the *Hôpital Lariboisière*, built in 1848 in Paris by M.-P. Gauthier.

Although the pavilion hospitals' programs developed in Great-Britain<sup>31</sup> are very probably the source of inspiration for *Hôpital Pasteur*, Florentin Martin, the hospital's architect, had not been sent to Great-Britain and elsewhere in Europe for that reason. It was rather to allow the young architect to get acquainted with the functions, and not the shape of the buildings, that the journey was undertaken, as underlined by Emile Roux, in a note sent to the *Société d'application des méthodes pastoriennes*: «The architect's trip was made not from the architectural point of view, but with the aim

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30. A special demand was made for the religious staff, the *Sœurs de Saint Joseph de Cluny*, for them to be allowed to wear shorter sleeves to ensure an even more hygienic procedure.

31. Concerning that very problem of the pavilionary system, see TAYLOR, Jeremy. *The Architect and the Pavilion Hospital, Dialogue and Creativity in England 1850-1914*, London and New York, Leicester University Press, 1997.

of acquiring an acquaintance with the most up-to-date hygiene practices abroad»<sup>32</sup>.

No document ascertains Florentin Martin's visit to Germany, particularly to Berlin. However, in *Les hôpitaux modernes au XIXe siècle*<sup>33</sup>, a book published in 1894 by Casimir Tollet, a civil engineer and historian, advocate of the pavilion hospitals, one can find the model of a diphtheria pavilion similar in all respects to the pavilions of the *Hôpital Pasteur*, identified by the author as «Berlin. Hôpital de l'Empereur et de l'Impératrice Frédéric (1888-1890)» (fig. 6). It actually is the *Kaiser —und Kaiserin— Friedrich-krankenhaus*, the first children's hospital inaugurated in Berlin in 1890<sup>34</sup>.

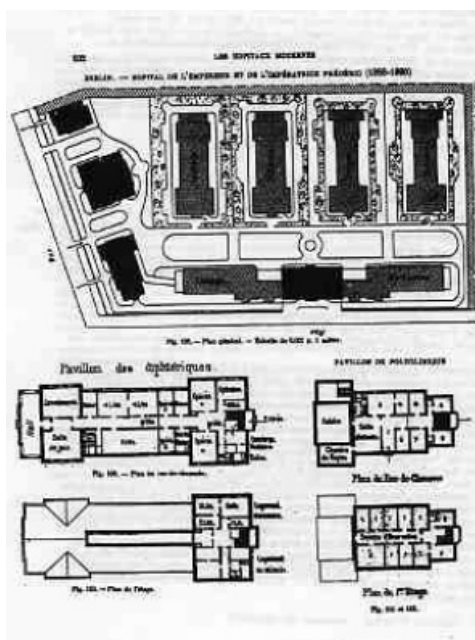


Figure 6. Berlin. Hospital of the Emperor and Imperatrice Frédéric (1888-1890), in Casimir Tollet, *Les hôpitaux modernes au XIXe siècle*.

32. AIP, Box DR DOS 3, file Institut Pasteur Direction 1888-1940, dossier Hôpital Pasteur, sd.

33. TOLLET, Casimir. *Les hôpitaux modernes au XIXe siècle: description des principaux hôpitaux français et étrangers les plus récemment édifiés, divisés en dix sections par contrées, études comparatives sur leurs principales conditions d'établissement*, Paris, l'auteur, 1894, p. 202.

34. I wish to thank Axel Hüntelmann, La Charité, Berlin and Institut für Medizingeschichte, Heidelberg, for the identification of the hospital.



One can suggest the hypothesis of a probable influence, or at least knowledge by the architect of that Berlin hospital, either *de visu*, or through Tollet's book, which it is hard to believe that Martin had not read.

The other hospital model, or at least a reference for functional rather than architectural aspects, is the Boucicaut Hospital built in 1897 by Legros, father and son. That hospital was critically reviewed in the *Revue d'hygiène et de police sanitaire* by Dr A.-J. Martin<sup>35</sup>. Upon reading about the circulation systems, although Boucicaut is a general hospital made up of 22 separate pavilions, thus a different scale than the *Hôpital Pasteur*, some analogies with the pasteurian distribution can be seen.

The principle of the organisation is based on the dispersion of the pavilions on the land and on the construction of an underground gallery which constitutes the physical link between the patients' pavilions and general services. A pavilion dedicated to the first observation of incoming patients, enables, as for the *hôpital Pasteur*, the washing and disinfecting of patients and their belongings and the admission only of clean patients in clean beds.

Particular attention is accorded to the circulation of air, adapted to the Tollet system. This system, which favours natural aeration and ventilation of the patients' rooms, is based on the principle of an ogival shape for the wards, with painted walls, lacking angles and corners, to preclude dust. Ventilation is assured by inlets, which are activated at certain points by gas burners and relayed by outlets which evacuate the polluted air by the roof.

A. J. Martin, however, has some reservations concerning the new hospital. He grants that the Legros, the architects of *Boucicaut*, were successful in their answer of the program requested, but remains quite reluctant as to what he considers a «luxury hospital». Martin questions the construction of the underground gallery, to which he pertinently objects that it is used both for circulation of persons and of waste matter, and thus at risk «of creating an environment that could easily become unhealthy and allow reciprocal contamination to occur»<sup>36</sup>. He also does not appreciate the numerous mechanical fittings and lifts, and overall, and that appears to have been the

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35. MARTIN, A.-J. L'hospitalisation moderne, le nouvel hôpital Boucicaut à Paris. *Revue d'hygiène et de police sanitaire*, 1898, 20, 135-154. A.-J. Martin, a homonym of Dr Louis Martin, director of the *hôpital Pasteur*, and of Florentin Martin, architect of the hospital, is a hygienist.

36. MARTIN, note 35.

most important point, he does not appreciate that the observation wards are at the same time isolation wards for patients proven to be contagious. Concerning that point, a very clear improvement is noted at the *Hôpital Pasteur*, where the patient's itinerary is set precisely. The patient is first taken to an isolation cabinet located on the ground floor of the consultation pavilion. If declared contagious, he is taken to a special room, called entrance room, and the isolation cabinet is immediately disinfected. The patient is later carried to the isolation room where he will undergo treatment. Roux's project, written as early as 1894, pointed to that sensitive point of isolation and circulation as ordered by the principle of *non-recontagion*.

Despite these reservations, A.J. Martin considers the *Hôpital Boucicaut* as having real qualities which ought to be a model to any conscientious hygienist and hospital director.

It is very likely that this article, published in 1898, attracted the attention of the designers of the *Hôpital Pasteur*, Roux and Martin. The hypothesis is acceptable. However, the anteriority of the principles edicted by Roux in that matter, rather suggests that the reservations made by A.J. Martin about Boucicaut only strengthen already well-admitted theories.

## 6. The *Hôpital Pasteur* as a model

The *Hôpital Pasteur* has been largely quoted as illustrating hygienic principles applied to the hospital environment as an execution of primary importance in the context of the fight against infections and in that of setting up the systems of circulation of people and of the air.

In the *Traité d'hygiène*, published in 1907 under the supervision of P. Brouardel, Louis Martin writes the part dealing with hygiene in hospitals, in which he describes the principles, the techniques and the rules of hospital hygiene, including sanatoria, mental asylums and old people's homes<sup>37</sup>.

The part devoted to hospitals for contagious patients<sup>38</sup> is actually a generalisation of the building and functioning of the *Hôpital Pasteur*, taken as a model after a six-year experimentation period. The iconography of that part of the chapter shows, with no mention of their origin, the patients'

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37. MARTIN, note 10.

38. MARTIN, note 10, pp. 77-99.

rooms, the equipment and the staff of the Pasteur hospital. The chapter is itself a development of the article written by Louis Martin on the functioning of the *Hôpital Pasteur*.

Photographs taken at the *Hôpital Pasteur* with no mention of origin, illustrate other sections of the book<sup>39</sup>. Other parts include frequent reference to the organisation, the functioning and the staff of the *Hôpital Pasteur*: detailed description of the heating system used, principles of ventilation of the rooms, floors and walls of the rooms and corridors, service tunnels and their fittings, equipment in common use in hospitals, members of charity orders working in hospitals, and techniques used to disinfect persons, rooms and equipment<sup>40</sup>.

The article confirms the idea that the *Hôpital Pasteur* is considered a reference in the domain of «infectiology» at the hospital, as well as concerning equipment in general.

At the end of the architect-hygienist cursus organized by the *École spéciale d'architecture de Paris*, headed by Emile Trélat, the program of the final competition of 1908 was the construction of «une maison de traitement chirurgical et dominical»<sup>41</sup>. In the terms of the proposal, Trélat refers to the *Hôpital Pasteur*, for which it constitutes a very model which should be observed by every hygienist. The difference remains in the purpose, «the customers», since this program aims at quite a well-off clientele<sup>42</sup>.

«Devoted exclusively to infectious diseases, the plan of the hospital (Pasteur) is to isolate the patients, who are treated in separate cells, where disinfection is carefully carried out according to the needs. Everyone is admitted into the establishment in order of registration, according to the space available, and treated free of charge. And the gratuity of treatment is a characteristic which shows to what point the establishment on rue Dutot distinguishes itself from the present idea (...) There is good reason above all to

39. Lift, p. 32; autopsy room, p. 60; service gallery, p. 65, bed-rolling system, p. 67; vidoir, p. 70; trolley for distribution, p. 25; system for collecting and washing dishes, p. 72-73; rolling trolley, p. 74; mobile bath, p. 29). The identification is based on the use of the same photographs in the texts of the *Soeurs Saint-Joseph-de Cluny*, in the 1903 article on the functioning of the hospital. It can also be inferred from inside fittings and tiled floor.

40. Once again illustrated by two photographs taken at the hospital Pasteur.

41. Concours de sortie de 1908, programme de composition architecturale, Archives de l'École spéciale d'architecture.

42. «L'installation à projeter répondrait aux exigences d'une clientèle de grande ou moyenne aisance». Concours de sortie, note 41.

refer to the Hôpital Pasteur and to ponder over all its scientific applications, for which it is the characteristic example of the moment»<sup>43</sup>.

In his presentation paper written in 1900, Florentin Martin emphasized this distinctive feature of *Hôpital Pasteur*: free access to medical care; the authors of the program given in 1908 to the architecture students were not concerned with this point, being more interested by the up-to-date «scientific» distribution theories of the hospital in order to adapt it to a high-standard establishment.<sup>44</sup>

In spite of this very different social purpose, what is to be kept in mind is the exemplary character of the *Hôpital Pasteur* as a place of excellence concerning the application of hygienist principles.

During the *Exposition universelle* held in Paris in 1900, class 111 is devoted to speaking for pasteurian theories in matters concerning hygiene<sup>45</sup>.

The Institut Pasteur was well present at the exhibition. The Pasteur lounge (*Salon Pasteur*) was on the ground floor of the *Palais de l'hygiène* along with the Instituts Pasteur of Paris and Lille and other European health administrations<sup>46</sup>. It was so named because the organization committee of class 111 intended to glorify Pasteur «in the name and to the charge of the French exhibitors of this class»<sup>47</sup>. In its centre, the Pasteur lounge exposed an octagonal display cabinet crowned by a “bust of Pasteur crowned by the genius of humanity” and showing instruments and items used by Pasteur for his discoveries.

The Pasteur lounge also included plans and models of the Pasteur Institutes of Paris and Lille and exhibitions specific to each of these institutes.

Group XVI of class 111 comprised Emile Roux and Albert Calmette (director of the Lille Institut Pasteur). The Institut Pasteur was thus *de facto* not eligible for competition *since* Roux and Calmette are jury members<sup>48</sup>.

43. Concours de sortie, note 41.

44. MARTIN, note 26, p. 646.

45. The classification for class 111 includes: laboratories and institutes of hygiene, health administrations, vaccination and disinfection, improvement of houses and towns, control of food, demographical statistics and mineral waters.

46. *Congrès international d'hygiène et de démographie*, Paris 1900, *Guide de l'hygiéniste à Paris*, Paris, Masson, 1900.

47. *Guide de l'hygiéniste*, note 46, p.13.

48. However, Pasteurian names are found among the collaborators of the exhibition who are rewarded. The *Grand Prix* is attributed to Dr Binot, Institut Pasteur, Paris, charged by Roux to organize the exhibition; a Silver Medal is granted to Prévost, Institut Pasteur, Paris. The

There was no gold medal for the hospital, contrary to what is often written (including within Pasteurian literature), which indeed was absent from the list of the gold medals. However, the rules of the exhibition were somehow circumvented, since the Institut Pasteur obtains the *Grand Prix* in class 112 (*Assistance publique*)<sup>49</sup>.

The 1900 universal exhibition was an extraordinary springboard for the dissemination of Pasteur's theories and for the glory of the *Institut Pasteur*. Thousands of visitors attended the Pasteur Lounge, and an abundant press widely described the exhibition. However nowhere is there mentioned in the articles a description of a model of the *Hôpital Pasteur*, as often said. It was only in 1904 that a very accurate description of the *Hôpital Pasteur* is given in the *Rapport du jury international de la Classe 111*, written by Dr A.-J. Martin, in a long paragraph devoted to the *Institut Pasteur* of Paris<sup>50</sup>. We consider that the journals' silence is due to the fact that there was neither a plan nor model of the hospital at the Exhibition. The *Hôpital Pasteur* did not get a medal, not for statutory reasons, but largely because it was not presented.

It could be concluded though that, due to a large public space of recognition, to the simultaneity of the end of the construction of the hospital (the first pavilion was dedicated in July 1900 and open in October the same year) and the presence of the Exhibition (April 15 to November 12), the dissemination of Roux's theories concerning hospitals was largely effectuated.

## 7. Contestation of the model. The *Hôpital Pasteur*: an expensive ideal

Roux's project is a paradigm of a policy of individual isolation of the contagious patient: individual isolated rooms, individual ventilation, a circuit for patients and staff precisely studied to avoid contamination from patient to

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names of Vialat and Jupille, also members of the Institut Pasteur, are mentioned. *Exposition universelle de 1900 à Paris, Liste des récompenses*, Paris, République française, Ministère du commerce, de l'industrie des postes et des télégraphes, 1901.

49. *Exposition universelle*, note 48, p. 1245.

50. *Exposition universelle de 1900 à Paris, Rapport du jury international. Classe 111 Hygiène, Rapport du Dr A.-J. Martin, Economie sociale, Hygiène, assistance publique*, Paris, République française, Ministère du commerce, de l'industrie des postes et des télégraphes, 1904, pp. 275-278.

patient by way of equipment and staff as well as during the natural course of the disease. What is questioned by other physicians and administrators is not the medical efficiency of the *Hôpital Pasteur* but the cost of its functioning. After three years of operation, the functioning of the *Hôpital Pasteur* was discussed by Louis Martin<sup>51</sup> at the April 22, 1903 session of the *Société de médecine publique*<sup>52</sup>. The *Hôpital Pasteur* appeared as a kind of health ideal, but certainly not as a model for hospital economy. Daily expenses for each patient amount to about 5 francs according to Grancher's own calculations, whereas medical results of similar quality presented by others are obtained elsewhere in France at a cost of 1.5 to 2 francs per bed, thus at a cost corresponding to the budget allowed for and imposed on public hospitals by regional councils, due to the use of pavilions for contagious patients and partial isolation.

Actually, hospital administration in general had perfected the organisation proposed by Grancher in 1890. His plan had been improved by the introduction of a pavilion for uncertain cases, in which the patients were isolated for a few hours before they were dispatched to the appropriate pavilion<sup>53</sup>. The organisation now proposed as a model for hospitals for infectious diseases that included boxed rooms closed by a glass door and separated from each other by a two-meter-high glass panel placed in such a way that air could circulate below and above it. Technical details were given: a floor oiled with paraffin, never swept but cleaned each day with linen soaked in an antiseptic solution, walls covered by using a varnished coating. The rules obeyed by the staff are the same as in 1890. The conclusion is that «the results are as excellent as in Mr. Grancher's service. The demonstration is evident, and it is heretofore a duty to adopt these measures in all civil and military hospitals»<sup>54</sup>.

Except for the door, considered useless by Grancher, that plan was adopted for the new boxed rooms of the *Hôpital des Enfants-Malades*.

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51. MARTIN, Louis. Le fonctionnement de l'hôpital Pasteur. *Revue d'hygiène et de police sanitaire*, 1903, 25, 256-281.

52. In *Revue d'hygiène et de police sanitaire*, Séance du 22 avril 1903 de la société de médecine publique. 1903, 464-467. Commentaries are those made by Médecin Inspecteur Général Drouineau.

53. VALLIN, E. *Revue d'hygiène et de police sanitaire*, 1900, 22, 843-845, commentary on Moizard's article: Le service des douteux à l'hôpital des Enfants-Malades. *Archives de médecine des enfants*, Juillet 1900, 414.

54. VALLIN, note 53.

The author admits that «it will provide the same service as the individual rooms of the pasteurian hospital».

During the Medical Congress held in Paris in 1900, Grancher develops that conclusion and reports his research on the *service antiseptique de médecine* proposed in 1890 and summarizes the results obtained<sup>55</sup>. He reminds other physicians that for ten years he has recommended the isolation of patients. The organisation adopted at the *Hôpital des Enfants-Malades* was not unique. Rooms with 2 or 4 beds have been arranged at the *Hôpital des Enfants-Assistés* in Paris starting from a large common ward subdivided into boxed rooms with glass panel, an arrangement considered efficient and less austere than the isolation rooms installed by Roux at the *Hôpital Pasteur*, often defined as an extreme position concerning isolation.

The first admission at the *Hôpital Pasteur* was made in September 1900. Despite the initial intention to devote the hospital to diphtheria patients, during the following year a large number of small-pox patients (actually due to visitors attending the Universal Exhibition) were admitted. During WWI, it is used for the treatment of soldiers affected by various infectious diseases: typhoid fever, intestinal diseases, tetanus, and infected wounds. Soldiers of the Orient Army suffering from malaria and some colonial troops suffering from sleeping sickness were also treated, and after July 1918, victims of the Spanish flu. After diphtheria was eradicated thanks to an efficient vaccination procedure (1923: Ramon's anatoxine), the hospital was used for other types of infectious diseases, particularly of tropical origin<sup>56</sup>.

The hospital rapidly evolved towards the status of a hospital for all kinds of infectious diseases, a status which it kept until its closure in 1999, for financial reasons.

Despite changes in its original purpose, the hospital was, still in agreement with Roux's project, used as an experimental hospital to improve vaccines (smallpox and diphtheria) and overall to run tests of pharmaceu-

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55. AIP, BIN/DOC 2. Dossier Jean Binet Documentation. J. Grancher. Un service antiseptique de médecine. Statistique de dix années. *Congrès de médecine de Paris 1900*. Printed paper, no mention of the journal.

56. Data on the hospital are unfortunately unavailable for this period, since the police registers of the hospital (admissions, death rates, patients' files) from 1900 until 1933 have disappeared. The only available material are the articles referenced in citations in this paper.

ticals synthesized in laboratories of the *Institut Pasteur* particularly in the therapeutic chemistry and organic chemistry laboratories<sup>57</sup>.

The example of a project, midway between industry and public health<sup>58</sup>, coupled to a research/application pole, remains quite unusual in the history of French medicine. The set up, however, remained efficient as such for 25 years, but because (or thanks to) the eradication of the original problem, diphtheria, the two main components progressively become autonomous, and the binome dissociated: Marnes became specialized in the industrial production of various serums and vaccines for France and its colonies; the Hospital Pasteur got closer to public administration of public health and specialized in the admission of patients suffering from infectious diseases, whatever the nature and the origin. Its last scientific and medical involvement before being closed, still sticking with Roux's ideas of coupling laboratory and hospital, concerned the opportunistic infections associated with AIDS, particularly mycoses.

The *Hôpital Pasteur* was set up as part of an apparatus, a well-thought-out system which fulfilled its functions and aims until the disappearance of the disease. This achievement revealed a major feature of the antidiphtheria fight, the absolute necessity for what we could call «hygienic ethics»: sterilization of the immediate environment, that is to say the throat, strengthened by the sterilization of the mediate environment, the hospital itself (rooms, bathrooms, corridors) kept as non-pathogenic as possible by the finely worked out human and non-human circuits. This stands as the real challenge of Roux's project: to give serotherapy a chance to be effective. Thanks to this policy, the tools were laid out for any infectious disease, and it is the reason for the effectiveness of the *Hôpital Pasteur* in the field of infectious diseases. ■

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57. DEBUE-BARAZER, Christine. When cultural admiration leads to therapeutic innovation: Ernest Fourneau. Communication at *EAHMH Conference 2005, Cultural history of health and beyond, Paris 7-10 september 2005*.

58. That project, in large part financed by a public subscription by *Le Figaro*, proved extremely profitable to the Institut Pasteur.