A study on the Thompson-Yates Laboratories and the development of Pathology on the Science, Utility and the Second City of the Empire

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INTRODUCTION

According to the article published in Sphinx in October 1898 to mark the opening of the Thompson-Yates Laboratories, experimental medicine, modern pathology and her daughter sciences of bacteriology arid serology, hygiene, veterinary science and agriculture, and the whole range of animal product, brewing, baking and food processing industries that they spawned, all depended on physiology for their 'scientific basest.0 At Liverpool, these various applications of physiology were pursued, not by Sherrington, but by the University' s Professor of Pathology, Rubert Boyce. This chapter sets out to illustrate the contrast between Sherrington's pure-science orientation to physiology and Boyce's applied-science approach to his pathology department. As with physiology, it also examines the reception that was afforded to Boyce's approach by the University and the city, and traces developments into the 1920s.

In 1898, Boyce reported that both he and Sherrington expected schools of pathology and physiology to emerge in the Thompson-Yates Laboratories, the department of physiology covering the physical and chemical physiology and histology of healthy organisms, and Boyce' s department dealing with the anatomy, histology and chemical pathology of disease. (2) Sherrington, as already argued, followed the model of the German and Cambridge laboratories and regarded his department as concerned with both undergraduate teaching and pure science research. Boyce adopted a wider view of his discipline. He intended that his department should step outside its accepted boundaries to pursue a comprehensive experimental medicine-style pathology that would Include both pure and applied science, and would incorporate as many ancilliary lines of work as possible to stimulate city Interest and support.

The pathology department would provide teaching and research in human morbid anatomy, histology and chemistry for undergraduate and postgraduate medical students, and courses in dental pathology f or students of University Colleg&s School of Dental Surgery. It would also cover experimental pathology as applied to clinical medicine after the practice of Rudolf Virchow, and comparative or veterinary pathology for students of public health and the City Health Department's meat inspectors, and would assist the School of Tropical Medicine with Its instruction in the pathology, parasitology and bacteriology of tropical disease. " The pathology department would also cater for the applications of physiology mentioned In the Sphinx article, offering teaching, research work, and diagnostic and analytical services in bacteriology, serology and public health, and food science.

In 1901, the government Treasury Inspectors reported that Boyce had created in the Thompson-Yates Laboratories a 'Pathology Institute' that 'brought Its students into contact with the practical applications of their science' and gave them the opportunity of 'undertaking original investigations for the purpose of improving the methods and solving the problems with which a growing science is constantly confronted. The development of the 'practical applications' of experimental pathology, comparative pathology and serology, and food science, and Boyce's contribution to tropical pathology and the Liverpool School of Tropical Medicine, are discussed elsewhere in this thesis; the

purpose of this chapter is to follow the pathology department's applied science activities as they related to bacteriology and public health.

BACTERIOLOGY: TEACHING. DIAGNOSTIC SERVICES AND PUBLIC HEALTH

Boyce continued the bacteriology course for medical students begun in 1892 by Alfredo Kanthack, Medical Tutor to the Royal Infirmary and Demonstrator in Bacteriology, who moved to the pathology department at Saint Bartholomew's Hospital in the following year. In 1906, forty-six undergraduate students attended Boyce's classes in pathology and bacteriology and by 1909, the number had risen to seventy-three. Boyce also extended his bacteriology classes to include general practitioners, students of veterinary medicine and hygiene, and the University School of Hygiene's Diploma of Public Health candidates, in 1906, R. Stenhouse Williams was appointed to take charge of the department's teaching responsibilities relating to the School of Hygiene, and instruction was provided for some forty Diploma students a year by 1911. In addition to their teaching function, Boyce's bacteriology laboratories were also involved in the provision of diagnostic and analytical services for local medical men, and for the city.

Continental advances in the discovery of the causative organisms of anthrax, tuberculosis, and diphtheria, and in improved methods for their cultivation and identification, were taken up only cautiously in England in the 1880s and early 1890s. CS) However, as Blancher pointsout, ' Herman Biggs' presentation of a paper to the British Medical Association meeting at Bristol in August 1894 on the work of his New York laboratories in the identification of tuberculosis from specimens of sputum and the diphtheria bacillus from throat swabs, appears to have exerted a catalytic effect. In the years immediately following Biggs' visit to England, the creation of bacteriology laboratories providing routine diagnostic services for public health authorities, general practitioners and hospitals, became a popular activity.

Laboratories were established by some local health authorities, by individual Medical Officers of Health like D, S. Davies at Bristol arid Rubert Boyce's close friend Arthur Newsome at Brighton,' 3 ' by the London hospitals and the Metropolitan Asylums Board which supervised the capital's infectious diseases hospitals, by research associations, and by commercial firms. However, it was the civic university colleges that really seized on the opportunity to claim this new area of scientific work as the particular property of their pathology departments. As with the new science of electrotechnics, the colleges were again in a pre-eminent position to offer their laboratory facilities and trained personnel in the provision of a more efficient and cost-effective service than the local community could provide for itself.

In Liverpool, the pathology department's bacteriology laboratories provided accommodation for the Pathological Diagnosis Society, created by Boyce in 1897. The Society supplied local medical practitioners with bacteriological and chemical diagnostic reports on sputum f or tuberculosis, throat swabs for diphtheria, blood serum for typhoid reactions, urinary deposits and tumours. Around 150 practitioners responded to Boyce's original invitation to join the scheme, and by 1900, membership had increased to 200, with each member paying an annual subscription of lOs Sd, and with nearly 1,000 investigations completed in the year.'" The bacteriology laboratories also provided reports for the Liverpool hospitals, and in 1900, Boyce offered to conduct regular examinations for the Royal Infirmary for a fee of £50 per annum.

In response to Boyce's proposal, the Hospital Medical Board rioted the 'difficulties of working without a bacteriology laboratory' and the fact that 'in this respect the Royal Infirmary Is lagging behind other major hospitals'. The Board favoured keeping control of the work by establishing a bacteriology laboratory in the hospital, but in view of the considerable initial outlay that this would involve, finally recommended to the Hospital Committee that Boyce's offer should be accepted. Microscopical and cultural examinations on

diseased post-mortem tissue, on tissue removed during surgery, on pus, blood, sputum and urine were provided, with a laboratory attendant despatched to the hospital each day to collect the specimens, (12)

Diagnostic investigations were also carried out for the city's Medical Officer of Health, and in 1898, in recognition of the important work that the bacteriology laboratories were doing, Boyce was officially appointed as City Bacteriologist for Liverpool, the first such municipal appointment in the country. In return for a fee from the City Council, Boyce agreed to add the systematic examination of water, milk and food samples to existing services, the tests to complement the chemical work already provided by the City Analyst. Like the Royal Infirmary, the City's Health Committee considered the advantages of keeping control of the work by opening its own laboratories, but again decided, on financial grounds, to make use of University College's facilities Instead.

In 1898, Boyce's bacteriology laboratories issued reports on 438 samples (sputa f or tuberculosis, throat swabs for diphtheria and Widal tests for typhoid, waters and milks, shellfish, tinned fish and meat products, condensed milk and other foodstuffs) at a cost to the city of £303. This sum, as Dr. Hope pointed out, was a fraction of what it would 1have cost the city to embark on its own testing services. 3' By 1900,

Boyce's department was processing some 2,300 City specimens a year. In 1903, the suggestion was raised by a number of City Councillors that the new University of Liverpool should provide a free municipal bacteriology service in return for its annual City Council grant. However, it would appear that most members of the Council and its Health Committee felt that Boyce was giving value for money, especially in view of the fact that in some years he did not bother to claim his own City Bacteriologist fees.

In October 1897, Deldpine reported to the Owens College Council on the benefits that had accrued to the College from his diagnostic bacteriology scheme in only the first two years of its operation. He maintained that the scheme had given the College Council the opportunity 'to take an active part in public matters of great importance to the health of the community'. The bacteriology laboratory, meanwhile, had gained a constant supply of material for study, and also the prestige that came with the general acceptance of its special scientific expertise as regarded the conduct of the work. Delépine himself had the satisfaction of knowing that, as a result of his department's work, he was now regarded by 'the medical profession at large' as 'the proper person to give an opinion on scientific matters' as they related to the health of the coxmnunity.'4

It was the anticipation of Just these benefits, along with the very welcome extra income, that lay behind the eagerness of the other university colleges and their professors to establish routine bacteriology laboratories. The college councils, anxious to generate goodwill and to demonstrate the usefulness and relevance of the colleges to their cities, were ready to add this service for the medical and public health communities to their existing commitment to medical education and the needs of local industry and commerce. The pathologists saw their opportunity to claim the new scientific specialism as one means of bolstering their status within the medical profession, and especially with regard to the powerful clinicians with whom they came into contact during their hospital work. The clinicians, in their turn, tended to greet the new science of bacteriology and the pathologists' advances with some caution.

Maulitz argues that bacteriology, while offering medical practitioners a new way of thinking about a patient's Illness, and new diagnostic and therapeutic tools, also presented them with something of a threat. As the most dramatic illustration of the infusion of the ideology of science Into medicine, the rise of bacteriology suggested that scientific values, with all their promises of enhanced efficiency and legitimacy, might remove the focus of medical practice from the bedside to the laboratory bench.dl English clinicians expressed their fears of the subversion of the 'art' of clinical medicine, based as it was on the careful observation and examination of the patient and the

centrality of the doctor-patient relationship, by 'mere' laboratory science. They complained of students trained In laboratory science and then preferring to rely on laboratory Investigations, rather than applying their scientific skills to the proper purpose of clinical observation; of pathologists promoting their brand of scientific medicine as a means of encroaching on the clinicians' territory; and all to the detriment of the essential quality of medical practice.

For Sir Dyce Duckworth, Physician to Saint Bartholomew' s Hospital, speaking at the Liverpool Medical Institution in October 1901 on the wave of enthusiasm surrounding the bacteriology of tuberculosis and its challenge to the older, but no less valuable, conception of the relation or predisposition of the host toward the intruding parasite, 'If we treat the diseases and not the patients we may be scientists but we are certainly not physicians.d h1 Similarly, T.R,Bradshaw, Physician to the Liverpool Royal Infirmary, while acknowledging that laboratory work had conferred 'incalcuable advantages' on medicine, and that 'at the present time the advance of medicine as a science lies through the laboratory', nevertheless remarked on the problems involved in 'the degree to which what may be not inaptly styled laboratory methods have come to supplement, maybe in some degree to replace, the strictly clinical examination of the patient.'

According to Bradshaw, when a practitioner 'who has to deal with the whole man' concentrated his attention on an investigation of one organ or bodily function, and especially when that investigation was carried out away from the bedside, 'the patient will probably suffer'.17' In 1905, Bradshaw also commented on what he considered to be the uselessness of the Widal serum reaction in the diagnosis of typhoid fever, due again to the essentially restricted nature of laboratory sciences compared to the multi-faceted richness of clinical medicine.

Bradshaw pointed out that the practitioners who came into contact with the suspected typhoid cases did not possess the necessary skills or facilities to perform their own Widal tests. The tests had to be carried out by specialist workers in a laboratory, divorced from the actual cases of the disease. In other words, 'the practitioner who sees the clinical signs is not able to do the test and the pathologist who does the test does not have the benefit of seeing the clinical signs'. Bradshaw argued that the many negative or equivocal results obtained from the Widal test in obvious clinical cases of the disease, demonstrated the inevitable problems arising from this situation, and made it clear that the laboratory scientists' special expertise could be, at best, of only limited value as far as medical practice was concerned. Other Liverpool clinicians, distrustful of what they saw as Boyce's attempts to involve the pathology department in their province of clinical medicine, were no less ready to report instancesof the fallability of the new bacteriological tests and the laboratory workers' scientific expertise, as compared to the tried and tested, and 'superior', methods of clinical observation and judgement.

The facts of bacteriology were also applied to the problem of tracing the sources of food poisoning outbreaks. One notable success was recorded as early as 1897, when an outbreak of typhoid that affected twenty seven children who had all attended a fair in Knotty Ash, was tracked down to an Italian ice cream and chipped potato seller, whose family had been ill for some weeks. On investigation, his shop was found to be in an extremely dirty condition. Professor Boyce examined a sample of his ice cream and found it 'teeming with bacteria, with growth on agar closely resembling forms obtained from samples of sewage'. The man and his family were also shown to give positive reactions in the Widal test, and with the backing of the bacteriological evidence, an appeal was made by the Health Committee for parliamentary powers to licence and supervise such itinerant food sellers. C25) The application of the facts of bacteriology also extended to the question of the disposal of the city's sewage, and to Dr.Hope's other major interest in infant mortality and its links to improper feeding and the need to provide the city with a pure milk supply.

With Dr. Hope's readiness to send an ever increasing number of specimens for analysis, and to commission various special investigations, Boyce's department developed a particular expertise in these two areas.

BACTERIOLOGY AND ITS APPLICATION TO PUBLIC HEALTH: SEWAGE DISPOSA

In Manchester, at the request of the City Rivers Committee, Henry Roscoe conducted a series of experiments on the purification of the effluent discharged from the Corporation sewage works at Davyhulme. He supplied reports to the City, and to the Royal Commission on Sewage Disposal appointed in 1898, and Commission members toured the Davyhulme site, Manchester University's chemists, with the best department in the country and a growing interest in microbial metabolic processes as a part of organic chemistry, continued to work on the biological filtration of sewage at Davyhulme. Their efforts culminated in the introduction of the activated sludge process of sewage disposal in 1914. In Liverpool, however,the weakness of University College's chemistry department and its narrower range of interests as compared to Manchester, combined with the excellence of the facilities provided in the Thompson-Yates Laboratories, Boyce' s work on the bacteriological analysis of water and the consequent decision of the Royal Commission on Sewage Disposal to make use of the Laboratories as a centre for experimental work, meant that sewage disposal became an issue for the College's bacteriologists, rather than chemists.

The Royal Commission provided Boyce' s department with an annual grant of £1, 200, C2 and out of this money, Charles Hill, Alfred NacConkey and Harriet Chick were appointed as Assistant Bacteriologists for the sewage disposal work.

At the request of Dr. Hope and the Health Committee, special beds were also set up in connection with the municipal Fazakerley fever hospital to provide a trial for the Thompson-Yates Laboratories' experiments on the disinfection of excreta, in an attempt to sterilise the Fazakerley effluent before it was discharged into the river.

In 1900, Professor Boyce reported that the working of the filter beds had Improved the sewage farm's effluent considerably, and that it was 'the subject of general remark that the River Alt had not been so lean for many years'. In terms of bacterial counts, the storm water filters were found to produce the best results and Boyce concluded that this was due to the fact that these filters obtained long periods of rest between treatments. The artificial beds, which were run continuously, were found to be prone to clogging. A year' s constant working was shown to reduce their capacity greatly. In June 1900, the extremely high bacterial counts recorded on the effluent indicated the extent of the problem, and it was decided that the beds must be allowed regular periods of rest if they were to be worked efficiently.

BACTERIOLOGY AND ITS APPLICATION TO PUBLIC HEALTH: MILK SUPPLY

Lewis has drawn attention to the conversion of the issues of maternal and child welfare and infant mortality from objects of private charity to matters of national concern, as part of the drive to improve the quality of the British population following the disasters of the Boer War and the publicity surrounding reports of the poor physical condition of the army recruits. She points out that the 1904 Report of the Interdepartmental Committee appointed to enquire into the physical deterioration of the British people, devoted considerable attention to the welfare of infants and school children as a matter of safeguarding the next generation.

Legislation concerning the provision of school meals and medical inspections followed, Lewis also points to the prevailing social attitudes towards questions of the sanctity of the family, the nature of poverty and the role of state intervention, that ensured that the mother and child services developed in the form of milk depots, clinics and home visiting with the emphasis on education and parental responsibility, rather than on any direct economic assistance for the mothers. CS1)

Concern for the quality of the race was also behind the creation of the Gouttes de lait in France in the 1890s to promote breast feeding, to provide modified cows' milk feeds where this was impossible, and to dispense advice on child care. The social ameliorators, committed members of the public health lobby like Arthur Neweholme, countered the eugenists with the argument that the high infant mortality rate constituted rather a waste of humanity that the nation could not afford. They maintained that this mortality must be prevented through the introduction of reforms that included the registration of midwives and the notification of births as well as the encouragement of breast feeding and the establishment of milk depots on the French lines. Buchanan concludes that the amount of money and energy invested in the public health movement over the years, and the strength of the vested interests involved, made it inevitable that the social ameliorators would prevail.

For the country's Medical Officers of Health, infant mortality constituted a serious problem requiring urgent attention, and obviously needing something more than the purely environmental approach that had succeeded in reducing the mortality rate among the adult population.

A contrary opinion held that the contamination was present in the milk due to pollution at the farm in the milkshop, or in the home. The milk depots established at St.Helens in 1899, and in various other towns throughout the country between 1901 and 1904, offered both sterilised ready bottled cows' milk feeds and education for mothers on hygienic habits. As Lewis points out, this educational function became increasingly prominent as Medical Officers of Health came to regard the pollution of milk in the home by dirty or negligent mothers as the most significant factor, and as the expense involved in supplying the bottle feeds was realised. CS3)

In 1885 and 1887, Dr.Hope set out the results of his enquiries into the circumstances surrounding the fatal cases of infantile diarrhoea that had occurred in the city from 1883, Hope recorded a correlation between the weather conditions and the incidence of the disease, with an excess of cases during hot and dry weather in the summer months. He also noted the presence of filth in some form in connection with many of the cases, the fact that most of the cases occurred among the poor, and the obvious carelessness shown by many of the mothers in their domestic arrangements.

With regard to the action that should be taken to prevent the pollution of the milk given to the city's infants, Hope argued for a combined environmental and personal approach. Environmentally, the municipal Health Department must increase its street cleaning activities in hot and dry weather to remove accumulated filth.

This instruction would be provided at the milk depots, and by means of home visits conducted by the City's Female Sanitary Inspectors who had been touring the poorer districts of Liverpool since 1897, impressing upon the inhabitants the evils of sloth, drunkenness and improvidence, and the advantages of cleanliness and healthy habits. Dr.Hope regarded this work as a logical extension of the City's existing commitment to the provision of improved sanitation, pure supplies of water and food, and public education, and justified his recommendations in these terms. Over the years, while other Medical Officers of Health increasingly emphasized the educational aspects of the work, Hope with the active assistance of Rubert Boyce, continued to insist that both the environmental and personal elements must be retained.

The Liverpool Health Committee opened its first milk depot in Netherfield Road in 1901, and encouraged by the demand shown for the service, established another three centres in Cazeneau Street, Earle Road and Park Road two months later. The milk used in the depots was subjected to testing by the City Analyst and by Boyce, whose laboratory looked for evidence of faecal contamination and also for the presence of the tubercie bacillus. At the depots, the milk was 'humanised' by the addition of cream and sugar, and then bottled and sterilised. The feeds were supplied in nine bottles in a

basket, with each bottle containing sufficient milk for one feed, at a cost of is 3d, payment in advance.

The disadvantage of this arrangement, In terms of maintaining adequate supervision over both the shopowners and the mothers, was recognised, however, Mothers were encouraged to bring their babies to the depots for regular weighing and consultation with the Female Superintendents, and while superstitious beliefs surrounding the practice of weighing kept many women away, a 'satisfactory' number did comply.

By December 1903, 6,295 infants had been fed and Dr. Hope was able to report that the mortality rate of the depot infants stood at 78 per 1,000 as against 159 for the whole city, with the city figure including breast-fed as well as artificially-fed infants. In 1903, the milk depots also recorded a deficit of £2,029 and Dr. Hope was obliged to defend their work against those critics who argued that the rate-payers' money could be better spent In some other way. Hope based his defence on the educational importance of the personal contact with the mothers that the depots achieved.

The professors received 295 samples of milk derived from Liverpool and the surrounding countryside, and 5. 2% of the city produced samples and 13. 4% of the country samples were recorded as containing tubecle bacilli. Further investigations carried out by Professor Boyce over the next two years produced similar figures. In 1899, Boyce's bacteriology laboratories conducted a search for the tubercie bacillus in samples of butter and margarine taken from city shops, and also carried out a trial of the tuberculin test in a cowahed at West Derby, This test, recommended by the Royal Commission in the previous year, identified infected cows by the rapid rise in temperature that followed the injection of tuberculin, a substance extracted from the tubercie bacillus by Robert Koch in 1890. Professor.

Boyce found the test to be extremely sensitive, detecting tubercie disease in the absence of any other signs, and concluded that it presented the City Health Department with a reliable and relatively simple means of identifying and removing infected animals.

The Liverpool Corporation had taken on the responsibility of ensuring a pure supply of water for the city, and Boyce was convinced that it must do the same in the case of the milk. He maintained that intelligent supervision of the production and distribution of milk was required, and that if the producers and sellers would not undertake this supervision themselves, the municipal authorities must do it for them. (42)

Close examination of the city cowsheds by Dr.Hope's Inspectors did produce an improvement in the conditions of sanitation and ventilation in which the cattle were kept, with a corresponding improvement in the state of the milk. As regarded the country supply, however, the Liverpool Sanitary and Veterinary Inspectors were presented with the virtually impossible task of attempting to control the production of milk over large areas of Cheshire, Shropshire and North Wales, and the contamination rates for country milk remained substantially higher than those for the city.

The pathology laboratory which, like bacteriology, had maintained a good research output up to 1913, was faced with similar problems. By 1919, Glynn's department had issued 24,691 reports to the North Western Command, and from 1916 onwards had examined an annual average of 6,000 specimens of faeces from the dysentery arid enteritis convalescents. The military work again decreased rapidly from 1919, but the hospital bacteriology, and especially the venereal disease work for the Royal Infirmary, continued to take up a great deal of the department's time. In 1920, 3, 722 Wassermann reactions and 4, 169 examinations for the gonococcus and spirochaetes were carried out for the Royal Infirmary, with 787 pathology and bacteriology reports also issued to the hospital.

388 reports were prepared for the Children' s Hospital in the year, and pathology and bacteriology work f or the Women's Hospital was also begun. In the following year, 608 specimens of cerebro-spinal fluid were subjected to routine examination as part of a joint project carried out with the pathology laboratory at the Rainhill Asylum and the Northern Hospital's

neurological department. c82) The department' s research work was confined to an investigation of pneumonia for the Medical Research Council.

Again as at Manchester, returning students compounded the problem. The pathology department found it necessary to duplicate its practical classes to accommodate the increased student numbers, putting a heavy burden on the staff, and from 1923, the systematic teaching of special veterinary pathology was added to the department's duties. Student numbers for hygiene and public health classes also increased dramatically.

Dr. Hope catered for eighty students attending the MB classes in hygiene in 1921 as compared to eighteen in the 1912-1913 session. From 1923, in addition to his Diploma in Public Health, Diploma in Veterinary Hygiene andB, Veterinary Science teaching, Professor Beattie also provided instruction for science students working for the Honours BSc in Bacteriology, the Fellowship of the Institute of Chemistry, and for other general purposes.

CONCLUSION

In the 1890s, bacteriology was a new area of scientific activity that could be claimed as the province of University College's pathology department by virtue of that department's special facilities and trained personnel. Over the years, the pathology laboratory maintained its monopoly on the science (with the exception of the activities of the Runcorn-based Evans Sons pharmaceutical company from 1913, (see chapter seven) and set itself to cater for what proved to be the prevailing city demand for routine service work and practical instruction. For the School of Hygiene, the provision of higher technical education brought theadvantages of a recurrent grant from the City Council, and many extra City payments for the purchase of equipment and other special purposes. It also provided a healthy student intake from the ranks of both municipal and voluntary sector workers.

By the early 1920s, the increasingly heavy routine workload1 and onerous teaching duties, were swamping the time available for research, When the routine work and student numbers began to settle down somewhat from 1924, research was able to recover slightly. Glynn's department covered work on pulmonary tuberculosis, the morbid anatomy of the pancreas, blood groups, and the Medical Research Council pneumonia enquiry. The bacteriology laboratories conducted studies of complement fixation in the Wassermann reaction, the biology of stretococci, the nutrition of bacteria with special reference to the 'Bacillus influenzae', and experimental tuberculosis and its treatment with naphthalein emulsions.

However, the pathology and bacteriology departments, and the School of Hygiene, were unable to return to anything like their pre-war levels of research activity. The routine diagnostic work and the practical teaching found favour with the city, but Boyce' s seemingly appropriate approach to research work in the Liverpool context, and his institutional school of applied research, for all its promising local support, had ultimately proved no more enduring than Sherrington's pure science. The 'failure' of Boyce' s applied research programme does not seem to have been connectedwith his death. From February 1904, when he took part in his first overseas expedition, Boyce had involved himself increasingly with the School of Tropical Medicine, By the end of 1910, he had conducted five expeditions for the School, and was practically a full-time government consultant on the subject of tropical disease (see chapter eight). The running of the pathology department had been largely in the hands of Ernest Glynn for some years before 1911, and continuity was assured with his appointment as Professor. It would seem, rather, that the 'failure' was due to the etfect of the War years in increasing the demand for routine diagnostic work, the heavy teaching load of the 1920s, and the absence of funding to support a revival of research work in the post-war years. By 1920, local and central government contributions were directed primarily towards routine work, and in the difficult post-war years of inflation and economic depression, the University Council was generally concerned to use its embatt led resources in support of teaching, rather than research, and to

economise and retrench whenever possible, rather than expand.

Some expansion was found to be possible, notably in oceanography and industrial chemistry with the endowment of chairs by Professors Herdman and Campbell Brown, and in engineering with the establishment of chairs in Thermodynamics of Heat Engines, Refrigeration, Strength of Materials, and Metallurgy, with funding from the Liverpool business community. For pathology, and for physiology, however, the local demand f or routine services, and the University's need for teaching, had proved themselves stronger than the city's concern for research work in either pure or applied science. And as the following chapter will show, in Liverpool University' s pioneering Johnston Laboratories, biochemistry, serology and experimental medicine were subject to this same gradual ascendency of teaching and routine diagnostic functions over research.

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