in these theories and of extending the results by bringing in more of the modern methods of mathematics, but that is not the present subject of discussion. What I wish to emphasize now is the need of logistic studies which will make it possible to say more definitely than is yet possible in this field what is assumed, what is proved, and how the group of theorems and definitions hang together. Incidentally, I would propose that the number of undefined terms be made large, rather than as small as possible, for whenever we introduce a new undefined term we separate off a group of theorems in which this term appears. Thus the undefined terms should be so chosen as to subdivide the science into divisions which are convenient both for mathematical and for physical purposes.

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PASTEUR, THE MAN[1]

Pasteur has told us that scientific understanding comes to the "prepared mind." In reading the splendid "Life of Pasteur" written by his son-in-law, Vallery-Radot, as well as the more recent tributes by Duclaux and by Descour, one is impressed by the lack of detail as to how Pasteur's own mind became "prepared." The story has lately been told in greater detail by Marc Tiffeneau.[2] Pasteur, as everybody knows, was the son of a tanner who had been a soldier under Napoleon. Pasteur entered the École Normale at Paris when he was twenty-one years old, and graduated three years later in 1846. He became a demonstrator (agrégé préparateur) in chemistry, a position which had just been established in order to allow young men to continue their laboratory researches instead of exiling them to provincial professorships. About the same period, in the year 1845, Auguste Laurent left the chair of chemistry at the University of Bordeaux, which he had occupied since 1838, because he did not find there sufficient opportunity for research. Arriving in Paris, he accepted the offer of a new laboratory in the École Normale, and it was not long before Laurent recognized the exceptional character of his young assistant, Pasteur, an ardent worker and a brilliant thinker. Laurent was at this time thirty-eight years old. He was the son of simple French peasants; he was born, lived and died poor. When twenty-two years of age he graduated as engineer of mines and later became the assistant of Dumas, who taught him the principles of organic analysis. His doctor's thesis considered the doctrine of chemical substitutions, which is one of the pillars of the atomic theory, and the thesis described specifically the action of chlorine on organic compounds. He and his inseparable friend, Gerhardt, were the real founders of the atomic theory. Laurent now suggested to Pasteur the subject of his thesis, which also involved the then great controversy of chemical substitutions. On August 23, 1847, Pasteur presented for his doctorate a paper entitled "Research into the saturation capacity of arsenious acid. A study of the arsenites of potash, soda and ammonia." Pasteur herein writes regarding Laurent that he had been "enlightened by the kindly advice of a man so distinguished both by his talent and by his character."

And on another occasion he says, "Laurent's lectures are as bold as his writings, and his lessons are making a great sensation among chemists." For Laurent, in 1846, gave the first course on "chemical anatomy" under the Faculty of Medicine of Paris to crowded classrooms, and here for the first time enunciated the atomic doctrine before medical students.

Laurent, having been trained as a mining engineer, had a remarkable knowledge of crystallography, and in 1845, according to Tiffeneau, had shocked his colleagues by declaring that substances which were isomeric could crystallize in different systems.

When Laurent left the laboratory in 1847 Pasteur was already the master of his technic. Shortly thereafter Pasteur became interested in the relation between chemical structure and the power to rotate polarized light, from which arose his celebrated studies upon the molecular dissymmetry of tartaric acid published in 1848.

To Biot, an old man of seventy-four who

1 An address delivered on the centenary of the birth of Pasteur on December 27, 1922, before a meeting of the Federation of Societies for Experimental Biology held at Toronto, Canada.

2 Tiffeneau, M.: *Bull. Soc. française de la histoire de médicine,* 1921, 15, 46.

had first applied the polariscope in the study of the rotation of glucose solutions, he demonstrated that by picking out right and left-handed hemihedral crystals of tartaric acid and making of them separate solutions, these solutions were respectively dextro- and levo-rotary. Pasteur relates the outcome in these words, "Then, very visibly affected, the illustrious old man took me by the arm and said, 'My dear child, I have loved science so much all my life that this makes my heart throb.'"

In one of his letters Pasteur exclaims, "I, who did so love my crystals."

It has seemed worth while to consider how the youthful, highly receptive mind of Pasteur struggled out of its native environment to receive the endowment obtained in Paris from intellectual association with the best the world had to offer. While inheritance from good germinal protoplasm may be an essential factor of intellectual power, yet in science the training of the mind at the hands of a master, so that the fruitful knowledge of the time is sown in younger and not yet worn-out mental soil, is the secret of advance from generation to generation. Pasteur himself sowed this seed in the minds of Calmette, Chamberland, Roux and Metchnikoff. A colonial dependency of Great Britain having half the population of the present city of New York produced Benjamin Franklin and Benjamin Thompson at the same time that it produced Washington, Alexander Hamilton and John Jay. But the minds of Franklin and Thompson were stamped with manifold European contacts.

The scientific mind is more than a good intellectual inheritance, more than that a great master has had it in charge, and Pasteur has thus described it: "The illusions of an experimenter form a great part of his power. These are the preconceived ideas which serve to guide him. Many of them vanish in the long path which he must travel, but one fine day he discovers and proves that some of them are adequate to the truth. Then he finds himself master of facts and of new principles, the application of which sooner or later bestows their benefits."

United with this imaginative power went prodigious industry. Pasteur was not one of those who sat all day at his desk and expected others to accomplish the physical work of the laboratory in the execution of his thoughts. This man at least did not seek to avoid physical drudgery in the simple surroundings of the humble French laboratories of his day. Reflecting on the huge sums spent on the Opéra, he writes to the official *Moniteur,* "I implore you take some interest in those sacred dwellings meaningly described as laboratories." The lesson taught by the consecration of his life to a life of labor in a laboratory is that the true laboratory worker is a laborer and not a loafer.

Pasteur shows his character in writing a wonderful tribute to Claude Bernard at a time when the latter was very ill, causing Bernard to remark that the article "paralyzed the vasomotor nerves of my sympathetic system and caused me to blush to the roots of my hair." One academician wrote of this affair, "The public will learn, among other things, that the eminent members of the academy admire and love each other, sometimes with no jealousy."

Pasteur, as the world knows, was convinced that the process of alcoholic fermentation was bound up in the life of the yeast cell, a doctrine violently combatted by Liebig "with a vigor and obstinacy characteristic of the man and inversely proportional to the strength of the argument" (F. J. Moore). The discovery later by Buchner that a zymase could be expressed from yeast which would produce alcoholic fermentation, does not invalidate Pasteur's thesis, for Rubner has shown that ninety-five per cent. or more of the activity of yeast is actually due to the metabolism of glucose within the living cell.

A very human characteristic develops in the story of the life of Pasteur when we are told of his dismay and distress to find, after the death of his true and trusted friend Claude Bernard, some notes which threw doubt upon Pasteur's interpretation of alcoholic fermentation! How often this human weakness occurs! I have sat next to a member of the Federation of Societies for Experimental Biology at a time of the dismemberment of one of his theories at the hands of another member and heard the agonizing cry, "I thought X was a friend of mine." Heart-breaking and human though this be, it is logically absurd to build friendship upon the basis of a similarity of intellectual metabolism.

It is not necessary here to refer to Pasteur's services to the world in the subjects of bacteriology and immunology. Suffice it to say that they have saved to France alone many times the cost of the Franco-Prussian war of 1870. And this transforming work of Pasteur may be contrasted with an early statement of Liebig, expressed in 1845, "As to the opinion which explains putrefaction of animal substances by the presence of microscopic animalcules, it may be compared to that of a child who would explain the rapidity of the Rhine by attributing it to the violent movements of the numerous mill-wheels at Mayence."

Finally, let it be remembered that Pasteur was a deeply religious man. On Armistice Day, 1918, the London crowd at first instinctively surged to Buckingham Palace, where lives the king, and then instinctively to St. Paul's Cathedral. Pasteur puts it thus: "The idea of God is a form of the idea of the Infinite. As long as the mystery of the Infinite weighs on human thought, temples will be erected for the worship of the Infinite, whether God is called Brahma, Allah, Jehovah or Jesus; and on the pavement of those temples men will be seen kneeling, prostrated, annihilated in the thought of the Infinite."

He himself lived a life closely approaching the infinitely valuable.

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SCIENTIFIC EVENTS

THE PAN-PACIFIC SCIENCE CONGRESS

ON the representations of the Australian National Research Council, it has been decided to hold the next Pan-Pacific Science Congress in Australia in 1923. The meeting will commence at Melbourne on August 13 and terminate at Sydney on September 3. The event will be an important one in the history of Australian and Pacific science. The commonwealth government through its prime minister, Mr. W. M. Hughes, has decided to extend its support to the meeting, and has agreed to provide the sum of £5,000 towards the cost. Invitations to send representatives have been issued by the commonwealth government to the various countries bordering the Pacific or having interests therein, while the Australian National Research Council is inviting a large number of leading scientific men who are interested in Pacific matters to attend and take part in the proceedings.

The first Pan-Pacific Science Congress was held in Honolulu in August, 1920, and the work accomplished on that occasion served to show the great value and importance of such meetings between representatives in and around the Pacific. It is proposed that these congresses so successfully inaugurated at Honolulu should be continued triennially. In addition to the benefit arising from the interchange of scientific thought, a mingling of leaders of science will tend to the bringing about of a better understanding between the peoples of the Pacific.

Among the office bearers are the following:

Australian National Research Council: Professor Orme Masson, The University, Melbourne, *president;* R. H. Cambage, Royal Society, Sydney, *honorary secretary-treasurer;* Professor A. C. D. Rivett, The University, Melbourne, *joint honorary secretary.*

Pan-Pacific Committee: Professor Sir Edgeworth David, The University, Sydney, *chairman;* E. C. Andrews, Mines Department, Sydney, *honorary secretary.*

The tentative list of subjects for papers and discussion is as follows:

A. *Agriculture and Veterinary Science:* Soil problems, climate in relation to crops, plant pathology and plant breeding. Diseases of livestock in the Pacific region: Methods of eradication and control.

B. *Anthropology and Ethnology:* Polynesian and Melanesian races, Australian aborigines, totems, languages, folk-lore, anatomy.

C. *Biology:* General plant distribution in the Pacific; floras of island groups and of individual islands. Insects harmful to the planter and farmer. Role of insects in transmitting disease and the control of weed pests. The distribution of animals. Fisheries.

D. *Geography and Oceanography:* Marine currents, continental shelves, charting in the Pacific.

E. *Geology:* Coral reefs, glaciation, structure of the Pacific region, Carboniferous and Permian problem, correlation of Cretaceous and Kainozoic sediments in Pacific, mineral resources, vulcanology, geological surveys.

F. *Hygiene and Climatology:* Mining hygiene, ventilation, dust prevention. Tropical diseases,