MERIT RESEARCH JOURNALS
www.meritresearchjournals.org

Merit Research Journal of Medicine and Medical Sciences (ISSN: 2354-323X) Vol. 3(6) pp. xxx-xxx, June, 2015
Available online http://www.meritresearchjournals.org/mms/index.htm

Review

The University of London, the scientific birthplace of Jenner and Fleming who saved and still saving millions of people throughout the world

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Abstract

The University of London, founded by Royal Charter in 1836. For 60 years the university concerned itself solely with holding examinations. It did not become a university in the fullest sense of the word until the reconstruction of 1900 brought a number of institutions in London into a federal relationship as its colleges or schools. The University admitted women to its degrees, the first university in the United Kingdom to do so. A large number of notable people have passed through the University of London, either as staff or students including monarchs, presidents or prime ministers, Noble Prize laureates, Grammy winners, Oscar winner, Olympic gold medalists, discoverers, authors, inventors, political figures, novelists, and artists. But, of the paramount importance has been the British physicians Jenner and Fleming's responsibility for the introduction of preventive inoculation for smallpox and the discovery of the first antibiotic, penicillin. Some years later, a British group led by Australian pathologist Walter Florey, and Ernst Boris Chain naturalized English biochemist followed Fleming's lead, and isolated and purified penicillin whose major advantage is its Safety. Fleming, Florey, and Chain were awarded the Noble Prize of 1945 for medicine or physiology for the discovery of penicillin.

Key words: The University of London, Jenner, smallpox, Fleming, Florey, Chain, penicillin.

INTRODUCTION

The University of London is one of the oldest and largest universities in the United Kingdom. Through its colleges, re-search institutes and associated institutions, the University of London offers the widest range of higher education opportunities in Britain, with over 1500 degree courses and unparalleled facilities for advanced research. The purposes of it are to pursue excellence in teaching, research and scholarship (The author of this paper was a WHO's fellow (Nasser O. Eslami) (1966-1967) at London school of Hygiene and to tropical Medicine); and to offer through its federal structure of Colleges, institutes and other facilities, unsurpassed range of opportunities for education and training to all those able to benefit. The purposes of the University of London are also to enhance public welfare, prosperity and culture by encouraging applications of learning and research; and to secure and administer resources to achieve the aims effectively.

The History of the University of London

The University of London (informal referred to as London University) has its origins in the 1820s and 1830s with the cre-ation of University College Bloombury and King's college in the Strand. The only two English universities in existence at that time- Oxford and Cambridge- limited entrance to communicant members of the Church of England. In contrast, the founders of University College set out to provide an institution open to all, irrespective of race and creed or political belief. But in reaction to the

Figure 1. The University of London's Coat of Arm.

Figure 2. The University of London as drawn by T.H. Shepard (published in 1827/1828), is now part of University College London.

foundation of University College, a group of "Establishment" figures set up King's College. Both University College and King's College petitioned for the Royal charter which would allow them to award degrees to their graduates. (Figure 1)

To solve its dilemma, the government compromised by creating a third body- The University of London- to examine students of both Colleges and grant degrees. The University of London was given its Royal Charter in 1836. The University has expanded and changed over the last 179 years but it has maintained its founding principles which, in the words of its Charter are "to hold forth to all classes and denominations, both in the United Kingdom and elsewhere without any dis-tinction whatsoever, an encouragement for pursing in a regular and liberal course of education; to promote research and advancement of science and learning."(Figure 2)

Chancellors

The Chancellors of the University of London since its founding (1836):

- William Cavendish, the second Earl of Burlington (1836-1856).
- Granville Leveson- Gower, the second Earl Granville (1856-1891).
- Edward Stanley, the 15th Earl of Derby (1891-1893).
- Farrer Herschell, the first Baron Herschell (1893-1899).

• John Wodehouse, the first Earl of Kimberley (1899-1902).
• Archibald Primorse, the 5th Earl of Rosebery (1902-1929).
• William Lygon, the 7th Earl Beauchamp (1929-1931).
• Alexander Cambridge, the first Earl of Athlone (1932-1955).
• Queen Elizabeth, the Queen Mother (1955-1981).
• The Princess Anne (The Princess Royal from 1987) (1981-).

Colleges and Institutes

Colleges and Institutes of the University of London are as Follows:
Birkbeck College, from Birkbeck's foundation in 1823.
British Institute in Paris, founded in 1894.
British Postgraduate Medical Federation (BPMF).
Centre For Defence Studies, one of the university of London's institutes for advanced studies.
Charring Cross and Westminster Medical School, was established in 1984 as a result of the amalgamation of two schools of University. Charring Cross Hospital Medical School found in 1815, and Westminster Medical School (estab-lished in 1834) moved to new building designed especially for teaching medicine and the care of the sick in 1939.
Goldsmiths College, was founded in 1891 in South East of London, by the Worshipful Company of Goldsmith, and has been part of the University of London since 1904.
Heythrop College, a specialist school for student of theology and philosophy was incorporated by Royal Charter in 1971.
Imperial College of Science, Technology and Medicine (Incorporating St Mary's Hospital Medical School), was establish by Royal Charter in 1907. Its purposes are, in the words of the College's Charter: "to give the highest specialized instruction, and to provide the fullest equipment for the most advanced training and research in various branches of science, espe-cially in its application to industry."
Institute of Advanced Legal Studies, was established in 1947.
St Mary's Hospital Medical School (Imperial College), was founded in 1854.
Institute of Cancer Research, is associated with the Royal Marsden Hospital and comprises the Chester Beatty Labor-atories and other research departments.
Institute of Child Health, is the Medical School of the Hospital for Sick Children, Great Ormond Street, and the Queen Elizabeth Hospital for Children, Hackney Road.
Institute of Classical Studies, was established in 1953.
Institute of Commonwealth Studies, was establish in 1949.
Institute of Dental Surgery, which is associated with the Eastman Dental Hospital.
Institute of Education, was first established in 1902, transferred to the control to the University of London in 1932 and became a school the University in 1987.
Institute of Germanic Studies, is recognized as a national focus for advanced study and research in the field.
Institute of Historical Research, is the University of London's center for advanced work in history.
Institute of Latin American Studies, that promotes and co-ordinates research and postgraduate teaching on Latin America in the social sciences and humanities.
Institute of Neurology, that promotes teaching and research in neurology and the neurosciences.
Institute of Ophthalmology, is closely associated with Moor fields Eye Hospital.
Institute of Psychiatry, is associated with the Bethlem Royal and Maudsley Hospital.
Institute of Romance Studies, was founded in 1989.
Institute of United States Studies, was founded in 1965.
Institute of Zoology, the Zoological Society was founded in 1826 and incorporated by Royal Charter in 1829.
Jew's College, founded in 1885, is the largest college of its type in Europe and the oldest in the world.
King's College London (incorporating King's College School of Medicine and Dentistry), founded in 1829, is one of the oldest and most prestigious colleges of the University of London. Figure 3.

King's College School of Medicine and Dentistry, founded in 1931. The Medical School was re- unified with King's College London to form the King's College School of Medicine and Dentistry in 1983.
London Business School, established in 1965, and in 1986, was granted a Royal Charter in recognition of its national and international structure.
London Hospital Medical College, was founded in 1740; the Medical College was built in 1785, and the Dental School was opened in 1911.
London School of Hygiene and Tropical Medicine, established by its own Royal Charter is the university of London's major resource for postgraduate and research in public health and tropical medicine and is the leading postgraduate medical institution in these subjects in Europe.
Marine Biological Station, Millport, is an institution of the Universities of London and Glasgow (Scotland) and provides marine biological research and teaching support for both these universities.
National Heart and Lung Institute, together with the Royal Brompton National Heart and Lung Hospital form Britian's premier postgraduate center specializing in all aspects of heart and lung diseases, integrating clinical practice, research and teaching.
Queen Mary and Westfield College (QMW), is one of the four largest colleges of the University of London.
Royal Academy of Music, was founded in 1822.
Royal College of Music, was founded in 1882.
Royal Free Hospital School of Medicine, found in 1874, and was granted a Royal Charter in 1938.

Figure 3. Archibald Primorse, the 5th Earl of Rosebery, the Chancellor of the University of London (1902-1929).

Royal Postgraduate Medical School, incorporated by Royal Charter, in 1931, is housed on the site of Hammersmith Hospital.

Institute of Obstetrics and Gynecology, Royal Medical School is associated with the Department of Obstetrics and Gynecology at Hammersmith Hospital and with Queen Charlotte's and Chelsea Hospital.

Royal Veterinary College of London, formed in 1691, received its first Charter of incorporation from Queen Victoria in 1875.

St Bartholomew's Hospital Medical College, was founded in 1123, the first formal reference to students dates from 1662.

St George's Hospital Medical School, found in 1751, was moved in October 1976 from Hyde Park Corner into its new buildings at Tooting.

St Mary's Hospital Medical School, see Imperial College of Science, Technology and Medicine.

School of Oriental and African Studies (SOAS), is the major center in Europe for the study of Asia and Africa.

School of Pharmacy, founded by the Royal pharmaceutical Society of Great Britain in 1842, was granted a Royal Charter in 1952.

School of Slavonic and East European Studies, founded in 1915.

Trinity College of Music. Founded in 1872, and was closely associated with the University of London since 1876. (Figure 4)

United Medical and Dental Schools of Guy's and St Thomas's Hospital (UMPS), occupy sites at Guy's Hospital at London Bridge and at St Thomas's Hospital by Westminster Bridge, over hooking the Thames. Medical students from Guy's and St Thomas's were taught jointly in the eighteenth century and in 1982 the two hospital re-established these links.

University College London. Founded in 1826, is the oldest and largest college of the University of London (University of London Guide, London, 1905).

Ten Largest Colleges, are: King's College London; University College, London, Birckbeck, Goldsmiths; the London Business School, Queen Mary, Royal Holloway, SOAS, and the London School of Economics and Political Science.

Its specialist colleges include: Hythrop College, specializing in philosophy and theology; St George's College, specializing in medicine; and imperial College London was formerly a member of the University of London before it left the university in 2007.

The Notable People, who have passed through the university of London, either as staff or student, including

Figure 4. London School of Hygiene and Tropical Medicine.

at least four monarch, 52 president or prime minister, 74 Noble Prizewinners, six Grammy winners, two Oscar winner, three Olympic gold Medalists.
Contributors to a number of significant and important scientific advances and discoveries including:
Henry Gray: Author of Gray's Anatomy.
Francis Crick, Maurice Wilkins, and Rosalined Franklin: DNA.
Tommy Flowers: the invention of modern electronic computer.
William Henry Bragg and Charles Glover Barkla: the development of X- ray technology.
Anne O'Garra: Discovery of the mechanism of action.
James Clerk Maxwell: the formulation of the theory electro magnetism.
Louis Essen: the determination of the speed of light.
Joseph Lister: the development of antiseptics.
Charles K.Kao: the development of fiber optics.
Alexander Graham Bell: the invention of telephone.

The Notable Political Figures, who have passed through the University of London include: Muhammad Haji Ibrahim Egbal, Romano Prodi, Junichiro Koizumi, Aung San Suu Kyi, (Archbishop) Desmond tutu, Taro Aso, Walter Rodney, Nelson Mandela, John F. Kennedy, Dr.B.R. Ambedkar, and Mahatma Gandi.

The novelists produced by the University of London are: Malcolm Bradbury, G.K. Chesterlon, H.G. Wells, Thomas Hardy, Arthur C. Clarke, J.G Balard, John Keats.

Also many artists, outstanding musicians, and conductors have been associated with the University of London (En.Wikipedia.org/wiki/University of London).

An Epitaph on the Tombstone of Smallpox by Jenner

We do not know whether groups of prehistoric men were wiped out by swiftly spreading disease, but probably they were. Certainly, diseases which kill large numbers of people have been recorded ever since humans could write. One of the great scourge of the world 3000 years ago was smallpox (and the other was leprosy).
The fight against smallpox, "the appalling, loathsome killer and known as speckled monster" is a real success story. Smallpox was probably rife in 10000 years BC, and mummy of Rameses V Pharaoh of Egypt in 1160 BC, shows pock marks on his skin (Cochrane, Jennifer. An Illustrated History of Medicine. Tiger Books International, London, 1996, p.76). This acute and often highly fatal virus disease has occurred in epidemic form throughout the world since ancient times. One of the earliest known accounts is of an epidemic in China in 1122 BC. Figure 5

Rhazes (c. 850-932) Persian physician who practiced medicine in Iran and Baghdad, was the first to distinguish between smallpox and measles (Rhazes (c. 850-932), outstanding Persian physician who described diabetes mellitus, pregnancy, the sex organs, and advised dietary regime, first described and differentiated smallpox and measles. He also had some understanding of blood circulation (more than 700 years before William Harvey (1957-1578) who discovered the circulation of the blood). Al-Razī (Rhazes) generally recommended simple treatments, such as nutritious food rather than complex drugs. He wrote al- Ḥāwī and more than 230 medical works. (Lee, H.S.J. Medical Millennium, p. 86.) Smallpox is an acute exanthematous disease by infection with pox virus variolae. Although the wide eradication of smallpox was officially announced in 1979, it is too soon to give up discussion of this disease in medical texts, and it is treated here as though is still existed). Galen (129-200) famous Greek doctor and prolific writer, claimed he was driven out by his fellow competitors in medicine- others suspect cowardice in the face of the impending plague of smallpox- only to turn in 169 as doctor to the emperor

Figure 5. Mummified head of the Pharaoh Rameses V, 1160 BC, showing lesions thought to be those of smallpox.

Figure 6. Confluent smallpox with massive number of lesions, all in the same stage of development, confluence of many.

Marcus Aurelius Antoninus (Porter, Roy. The Cambridge Illustrated History of Medicine. Cambridge University Press, 1998, p. 62.) (Roman Emperor: 161-180). Long prevalent in Africa and in the East during the Middle Ages, smallpox was apparently widely spread by soldiers returning from the Crusades. The disease reached to the Western Hemisphere during the sixteenth century probably brought from central Africa by Negro slaves.

One of the striking features in the history of this appalling and loathsome disease, and «speckled monster» has been the marked variation in mortality rates in different epidemics. While it is true that factors such as nutrition, population immunity, and medical care may affect survival, many feel that differences in strain of smallpox virus called alastrim, or variolae minor, is found in Africa, south of the Sahara and in Central America and the West Indies. (Figure 6)

The virus is quit resistant to drying and may be air borne or be carried on skin, clothing, and eating utensils. The organisms are believed to enter through the upper breathing passages. The incubation period ranges from 8 to 14 days. The disease begins with fever, vomiting, and headache and backache. A brief red rash may appear on the trunk before the characteristics raised rash of smallpox develops. The latter usually occurs about the third of fourth day, first on the inside of the mouth, the face, and forearms and later spreading widely over the body. Itching may be intense. The skin lesions fill with a clear fluid which changes within a few days into the thick pus with crusting.

In severe cases death may occur three to four days of the onset, even before the rash appears. In nonfatal cases recovery takes place with two to three weeks, usually with two considerable scarring, but leaving the victim with an active immunity against second infection (Encyclopedia International, 1975).

Figure 7. Edward Jenner the British Lifesaver.

Figure 8. These pictures of infected people come from a twelve- volume compendium of Aztec history and culture complied by a Catholic missionary scholar called Fray Bernardino de Sahagún (c. 1499-1590).

In the past, 20 to 30 percent of the afflicted with severe Asian strain died. Survivors were permanently scarred and sometimes blinded. There is no specific treatment for smallpox.

Before vaccines, everyone was susceptible to smallpox. The disease spread in any climate, anywhere. Smallpox, the loathsome, and devastating disease, repeatedly altered the course of history. Brought by Cortés to the New World, it eventually killed an estimated 3.5 million Indians and contributed to the collapse of the Inca and Aztec civilizations. De-cimation of North American Indians paved the way for European settlement.

In Europe the problem was no less severe. Lord Macaulay wrote of its effects in 17th century England: "That disease… was then the most terrible of all the ministers of death… smallpox was always present, filling the churchyards with corpse… and making the eyes and cheeks of the betrothed maiden objects horror to the lover (Henderson, 1978).

Prevention and Control. The Chinese inoculated against smallpox, using pus from a mild case and putting it into a scratch on a healthy person. Inoculation was used widely in Turkey in the early eighteenth century. Then, Lady Mary Wortley Montagu (1689-1762) English letter writer, upon her return in 1718 from Constantinople, where her husband had been ambassador, she introduced to England the Turkish practice of inoculation of smallpox (Encyclopedia International, 1975).

The inoculation became fashionable in Britain! This

Figure 9. Jenner's Temple of Vaccina.

Figure 10. This horn belonged to a cow used by Jenner to provide cowpox infected fluid to vaccinate people against small-pox, an appalling disease.

worked well if the smallpox stayed as a mild strain, but it could kill the inoculated person if anything went wrong. Edward Jenner (1749-1823), an English country doctor solved this problem in 1798 (Cochrane, Jennifer. An Illustrated History of Medicine. P. 76). He observed that person who had been exposed to the cattle disease cowpox did not contract smallpox. Jenner in 1796 vaccinated a small country boy and afterward tried to infect him with smallpox, but the child resisted the infection. Two years later in 1798, he published his results in a small book entitled "An Inquiry into the Causes and Effects of the Variolae Vaccinae." Within a few years the technique of vaccination spread throughout the world and succeeded in virtually eliminating smallpox where it was introduced (Parliament expressed the gratitude of the nation by voting Jenner f 10000 in 1802, and 20000 in 1807) (Encyclopedia International, 1975). Figure 8

Not until the 1940's were Europe and North America rid of smallpox. In developing countries it remained epidemic, and cases were often exported in smallpox-free areas. Health officials feared it as no other diseases.

In all countries vaccination program continued, quarantine inspector tried to enforce the international edict that all travellers be vaccinated. In 1959 an initial attempt by WHO to eradicate smallpox was begun, but the effort failed. Most countries had too few resources and WHO could offer little help. Soon after WHO started and continued the campaign in country after country. Most were begun by 1969 and all by 1971. Until 1969 mass vaccination had been the standard strategy, but even when 95 percent were vaccinated, the disease would sometimes continue to spread. Figure 10

By 1970 the number of countries smallpox was endemic, or continuously present, had dropped from 33 to 17, by 1973 to only six countries. But among this were India, Bangladesh, Pakistan, and Nepal with more than 700 million people.

Eventually, in 1974 the last case occurred in Pakistan; in 1975 in Nepal and India; and on October 16, 1975, Rahima Banu, a three- year- old Bangladesh girl, contracted he last case of the severe Asian strain of smallpox. She survived.

As 1976 began, Ethiopia alone remained infected by a far milder strain of smallpox. However the logistics were all but insuperable. Ethiopia was torn by civil war, by famine, and by heavy summer rains. To civil war was added a war with Somalia. WHO's surveillance teams

Figure 11. One October 16, 1975, Rahima Banu, a three year- old Bangladesh girl, contracted smallpox, the last case of the severe Asian, but she survived.

were kidnapped by guerrillas and vanished for days to weeks at a time. Their heli-copters were hit by rifle fire, and one was blown up by a grenade. Some staffers were wounded and a few were killed. But a determined Ethiopian and WHO staff was not to be denied. In August 1976 the last known case occurred in an encampment in the Ogaden desert.

Now the victory finally was at hand. But at the time of last cases in Ethiopia, smallpox was imported into previously uninfected Somalia. Tragic delays hampered the efforts. More than three thousand were stricken, but by early October 1977 only two cases remained. It was from them that Ali Maalin was infected. (Figure 11)

Smallpox no longer afflicts humanity, and remaining virus be confined to a few laboratories under high security.

Produce Dictates Vaccine Storage: Routine Vaccinations will be stopped everywhere, but can we abandon our first and oldest vaccine? Are we sure there is no animal reservoir? Might not old scabs be a risk? All outbreaks in smallpox- free areas have been traced to a source than a decade; all have been traced to a source in a known infected area. No “spontaneous” cases or outbreaks have ever been detected.

Finally there remains the chance that smallpox or other biological agents might be used in warfare, an unlikely possibility with smallpox since it spreads slowly and can be contained with vaccination. As insurance, WHO and many governments are storing vaccine, which at low temperatures retains its potency for decades. The chances of another outbreak are remote, but we are ready. For the first time, children are being born in smallpox- free world. I am confident their children and grandchildren will enjoy that freedom.

For this, the credit belongs to the tens of thousands of health workers from around the world and to the WHO staff that, again and again, devised ingenious solutions to never ending, almost impossible problems. Figure 12

The Final Chapter. Somali cook Ali Maow Maalin developed smallpox on October 26 1977. Since then no other cases have been detected in the field.

Victory in the finest international mobilization and battle, where all the combatants can be called heroes await the final dispatch: without a hiding place in nature apart from man, an ancient enemy vanquished (National Geographic. Ibid, pp. 798-805.).

Eventually, the WHO’s campaign to conquer smallpox was successful chiefly through vaccination. The disease was declared eradicated in 1979 (Parker, Steve. Eyewitness Science Medicine. Dorling Kindersley, London, New York, Stuttgart, Moscow, p. 63.)

Fleming the Father of Antibiotics

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The ability of various microorganisms, especially bacteria and fungi, to inhibit the growth of other microbes had been known since the latter part of the 19th century, and attempt were made to utilize the products of such microorganisms in the treatment of various infectious diseases. Although some success was achieved with substances prepared from certain bacteria and fungi, the result were not sufficiently impressive to justify great

Figure 12. Lady Mary Worthley Montagu who ordered the embassy surgeon, Charles Maitland, to inoculate her 15-year- old son.

Figure 13. Somali cook Ali Maow Maalin developed smallpox on October 26, 1977. Since then no other cases have been detected throughout the world.

hopes for antibiotic therapy. Alexander Fleming (1881-1955) British bacteriologist, in 1928, demonstrated that culture of a green mold, later identified as “Peni-cillium notatum” (A steady stream publications appearing in the late 19th and early 20thcenturies indicated that the higher bacteria, mold, and fungi also destroyed certain bacteria. Westling named one such effective mold “Penicillium notatum” in 1912. (Lyons, Albert S. Medicine. An Illustrated History. P. 590) produced a substance that inhibited the growth of staphylococci and certain other bacteria. Figure 13

Several attempts to isolate this substance in pure form failed (Encyclopedia International. Vol. P. 463 and vol. 14, p. 159). More than ten years elapse until a British group led by Howard Water Florey (1898-1968) Australian pathologist and Ernst Boris Chain (1906-1979) naturalized English biochemist followed Fleming lead and extracted, purified, and mass- produced penicillin for large scale medical use. In 1945, Fleming, Florey, Fleming, Flory, and Chain were awarded Noble Prize of physiology or medicine for the discovery and development of the antibiotic that has saved thousands of lives and played an important role in destroying some diseases (Cochrane, 1996).

In 1929, Alexander Fleming reported in the “British Journal of Experimental Pathology” his observations on the antibacterial action of penicillium, with the suggestion that the mold culture could be used to inhibit bacteria as a help in obtaining their cultural isolation. In 194, Howard Florey and Ernst Chain, made studies which convinced them that penicillin had great therapeutic potential. The main difficulty was that penicillin could not be made in

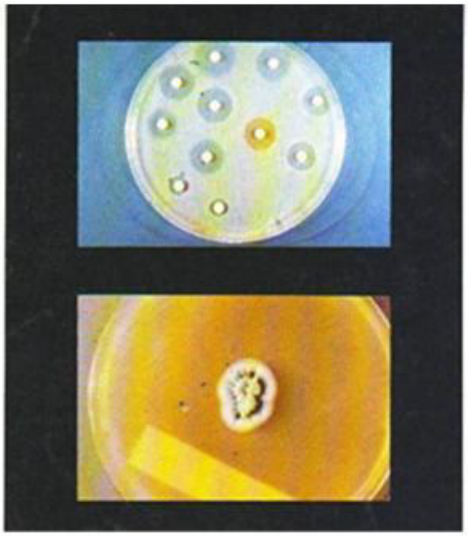

Figure 14. Above: Test of organism sensitivity to antibiotics. Bellow: Penicillin culture.

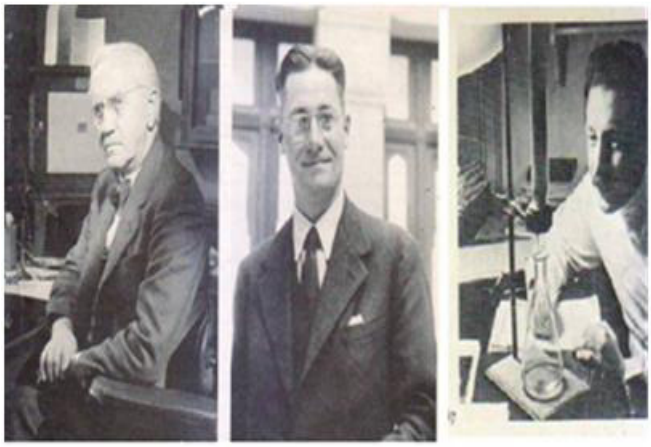

Figure 15. From left to right: Alexander Fleming, the discoverer of penicillin, in his laboratory, in 1951; Howard Florey who, with Ernst Chain led the Oxford team that successfully isolated and purified penicillin successfully; and Ernst Boris Chain whose studies with Howard Florey established the great therapeutic properties of penicillin.

quantity in the laboratory, but it was solved by cooperation between the government of the United States and pharmaceutical manufacturers within two years after Florey and Chain had transferred their work to U.S.A (Lyons, Albert S. Medicine, An Illustrated History. Abradale Press, New York, 1978, p.59.).

Infection eventually Conquered by Fleming's great discovery, penicillin. Figure 14, 15

CONCLUSION AND IMPACT

Today's people, especially children and olds no longer die of smallpox and infectious diseases that were fatal before the revolutionary medical and physiological innovations, descriptions, and discoveries. Why? Because contrary to the animal Kingdom humans traced the enquiring of knowledge through trial and error, research, and through the ability to hand the information on from one generation to the next. The University of London which has a long established reputation for excellence in teaching, research, and attracting students from all parts of the United Kingdom and from across the world, and the like have played a great part in this regard. For instance, Edward Jenner (1749-1823) British physician whose alma mater was "St George's, the Univ-

ersity of London, and University of St Andrew introduced vaccination against smallpox and wrote “An Inquiry into the Cause and effects of the Variola Vaccine.” Alexander Fleming (1881-1955) a Scottish bacteriologist who received his education at Kilmarnock and later qualified as a surgeon from St Mary’s Hospital in Padington discovered the first, best known and most widely used of the antibiotic, penicillin.

To fight against diseases and to decrease the morbidity and mortality rates and to increase the “average age at birth” there are two important weapons: one is improved public health including clean water, disposal of rubbish and sewage, and vaccination against communicable diseases specially smallpox; the other was the discovery of antibiotics. The impact of Jenner and Fleming’s discovery is obvious: they saved and saving millions of lives.

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