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Review

Stamping through scientific advances in medicine and genetics

Renad I. Zhdanov[1, 2, 3*], Ipek Cetinkaya[3] and Svetlana I. Zhdanova[4]

[1]Institute of General Pathology and Pathophysiology, Moscow 125315 Russian Federation. [2]Alexander von Humboldt-Stuftung, Jean-Paul-Strasse 12, Bonn D-53173 Germany. [3]On leave from Department of Genetics and Bioengineering, Yeditepe University, Istanbul 34755 Turkey. [4]Chair of Pediatrics, Kazan State Medical University, Kazan, Republic of Tatarstan, 420021 Russian Federation.

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There are large numbers of postage stamps related to scientific and medical advances around the world. These stamps are mostly devoted to great scientists and physicians and their discoveries and accomplishments in science. This article discusses some of the most important for the public cases of these achievements based on considering postage stamps worldwide. It is apparent that these postage stamps represent a respond from the society to professional activity of scientists and medical doctors. This being the issue, it can be said that even if the stamps are fading away, it is a fact that they leave a historical commemoration to famous crucial points in science and medicine. The relationships between the postage stamps mentioned in this article and pharmacology, genetics, and bioengineering are discussed. An input of science into world culture and the impact of nations into modern science, medicine and technology are estimated and evaluated via analyzing and comparison of philatelic materials worldwide. Although more than 80 philatelic items worldwide are presented and discussed in the paper, an attention is paid mostly to the contributions from the United Kingdom (27 stamps), the United States of America (24 stamps), the U.S.S.R. and Russia (17 stamps), Germany (7 stamps), and France (5 stamps) . Presentation and considering of the stamps and stamp blocks is organized around a few topics of the most public interest: medicines (insulin, antibiotics, and hormones), DNA & gene medicines, and genetics and bioengineering as well. A special attention is paid in the paper to the Great scientists and physicians worldwide and their discoveries: G. Mendel, F. Banting, A. Fleming, N. Vavilov, P. Julian, J. Watson, F. Crick, B. McClintock, and the first physician-astronaut in space B. Egorov, MD as well. The article is based on the philatelic collection of the authors, one of the largest in scientific and medical philately containing about 4,000 science and medicine related philatelic items: stamps, blocks, envelopes, cancellations. This paper has been prepared in order to inspire young minds on scientific philately, which are commemorations on important impacts in scientific world.

Keywords: Modern medicines, DNA double helix, nations' impact on science and medicine, medical genetics, bioengineering.

INTRODUCTION

A large number of postage stamps, issued by the postal authorities in many countries worldwide the last decades, are devoted to pharmaceutical and medical themes that include the most important discoveries and achievements in these fields from a public point of view. This article is aimed to reveal to the scientists and medical doctors - physicians, pharmacologists, pharmacists - the significance of the results of their work *via* postage stamping as a cultural view and a reflection of their professional activity by the Society. The first review of scientific and medical philately was published by the British Medical Bulletin in 1949 (Douglas, 1949). Due to the use of Internet and mobile phones for communication between people along with the stamping machines seem to be excluding the handling postage stamps, which are

*Corresponding author email: zrenad@gmail.com; Phone: ++7.937.527.2800; Fax: +7.495.151.1756

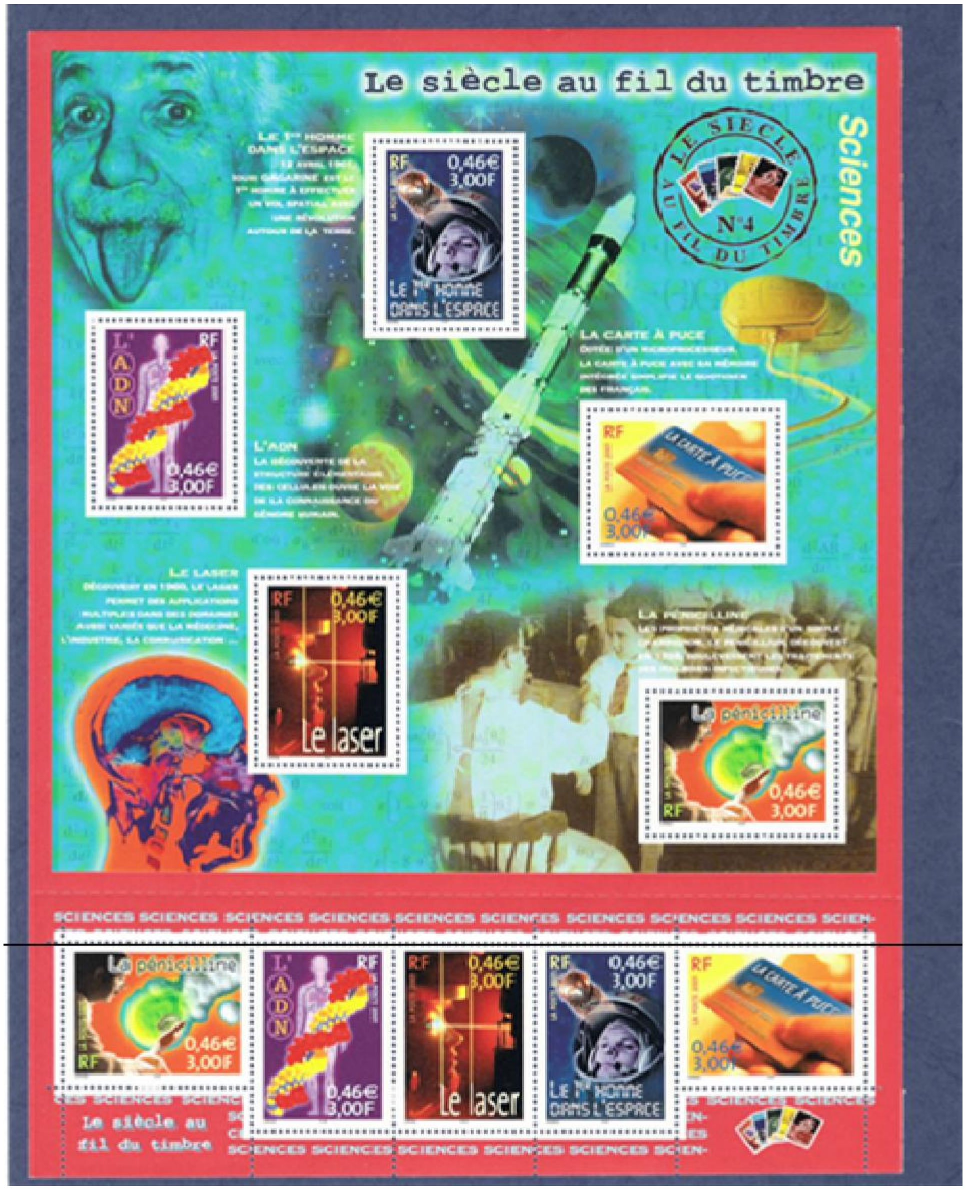

Figure 1. Stamp block (France, 2000, 5 stamps x 0.46 Euro) devoted to the greatest scientific, medical and technological achievements of the twentieth century.

gradually disappearing, becoming a part of the art and culture (Pearn, 1982; Wilson, 2001; Heilbronner and Miler, 2004; Zhdanov, 2009b). Considering postage stamps presented in the article, we concluded the following concern. Although the British Empire was disassembled after the World War II, the great inputs of British institutions and people to the World culture, science and medicine have been significantly remaining since then. This issue came out not because of postage stamps were pioneered in the United Kingdom, but it is resulted from analyzing philately over the World. Furthermore, in the great extent, the modern science and medicine were shaped by the physicians and scientists educated in the former British Empire and Commonwealth dominions, and later on - from Germany and United States of America (and partly from Russia, since Russian science is mainly of German origin). Therefore, British, German and U.S. societies and creators seem to be responsible for preserving medicinal philatelic culture worldwide.

To examine our proposition on an impact of nations on the modern science and technology,let's pay an attention to the French block of 2000 presented in Figure 1.The five postage stamps of this block (stamps I-V, bottom row) are devoted to the greatest scientific and technological achievements of the twentieth century, issued by French Postal service. These stamps (of 0.46 Euro value each) commemorate: I) discovery of penicillin and antibiotics-based medicines; II) discovery of DNA structure and DNA-based technologies; III) developments of lasers and masers, being originally developed in the former U.S.S.R. and, partly, in U.S.A., and their numerous applications in science and technology; IV) the first space flight of man (the Soviet cosmonaut Yuri Gagarin); and V) microprocessors as memory elements for computers and beyond (French invention). Considering that two innovations, the Ist and the IInd,of these five achievements (DNA double helix's and penicillin discoveries) arose from the British Empire (and two ones, the III^{d} and the IVth, are originated in the U.S.S.R.), it is stoutly perceptible that contribution of British scientists into the modern science and medicine became substantial. It is also important that this evaluation was proposed by French officials and scientists. This article is based on and composed of the philatelic collection of the author (R.Z.), one of the largest in scientific and medical philately containing more than 4,000 science and medicine related philatelic items collected worldwide during research staying abroad (Germany, Canada, Italy, Turkey, Japan) (Zhdanov, 1987, 1988a-d, 2009a,b; Zhdanov and Jdanov, 1999, 2000).

Medicines

Six postage stamps (Figure 2) show insulin discovery and related items, which are connected with Canada, at the time of British dominion. The three stamps (Figure 2:1-3) are devoted to the 50th anniversary of the insulin discovery by Canadian scientist Professor Frederick Banting (1891- 1941) and his student Charles Best (1899-1978) in 1921 issued in Canada, 1971, Belgium, 1971, and Uruguay, 1971. The Belgian postage stamp (Figure 2:2) depicts the primary structure of proinsulin (composed of black and empty circles) with 3 S-S bridges. There are fine structural features of proinsulin at the stamp miniature: C-peptide chain - the black one at the bottom, B-chain should be deleted due to processing in the body - the chain composed of empty circles; A-peptide chain - the black one in the middle, is necessary for biological activities of the hormone. Due to this important discovery, Professor F. Banting was rewarded with the Nobel Prize in Physiology and Medicine by 1923. He shared the prize with Professor John McLeod (1876-1935). Professor F. Banting initially wanted to reject the Prize, as he believed that his assistant Charles Best (1899-1978), who had not even had a M.D. diploma at that time, should also be included in the decision of the Nobel Prize Committee. Later, he accepted the Prize, but shared half of his remuneration with C. Best, while J. McLeod gave half of his part to J.B. Collip, who had helped them to purify the insulin preparations. Professor F. Banting tragically died in an airplane crash at Newfoundland Island in 1941. The Canadian postage stamp of 1967 (Figure 2:4) was dedicated to the 100th anniversary of Toronto city, where insulin was discovered. The Institute of Banting and the Institute of Best are currently located at the campus of the University of Toronto. A Chinese postage stamp of 1976 (Figure 2:5), which belongs to a series of stamps devoted to the five-year plan for economic development of China (P.R.C.) (1972-1976), shows a three-dimensional structure of the insulin synthesized for the first time by Chinese scientists. Finally, by 1979, an Austrian postage stamp (Figure 2:6) was devoted to the 10th World Congress of the International Diabetes Federation in Vienna, and depicts diabetic angiopathy. As a background, it shows a microphotograph of vascular retina affected by retinopathy, as an example of diabetic angiopathy.

The three stamps of: Nicaragua and San Marino, 1983; and Mexico, 1981 (Figure 2:8-10) are dedicated to Professor Alexander Fleming (1881-1955) who discovered the penicillin, the first antibiotic medicine, which has saved millions of lives. There are also postage stamps depicting portraits of Fleming partners with whom he shared the Nobel Prize in Physiology and Medicine in 1945. They are: Howard Florey (1898- 1968), who overcame all the difficulties for transportation of Fleming's strain to the U.S.A. and organized the large-scale production of penicillin by U.S. pharmaceutical companies; and Ernest B. Chain (1906-1979), who revealed the chemical structure of penicillin (not shown). Postage stamp of *Principate* of Monaco, 1974 (Fig. 2:7), was dedicated to the 100th anniversary of the French physician Ernest Duchesne (1874-1912). According to French sources, he seems to have observed for the first time, the antibiotic properties of the mold *Penicillium glaucum*.

The U.S. stamp block composed of the four same postage stamps with coupons (1992) is shown in Figure 2:11. These stamps depict the portrait of the American chemist Perci Lavon Julian (1899-1975), who had performed the steroid hormone synthesis based on bile acids or plant sterols. At the caption in the stamp "Black Heritage" means that he was the first Afro-American chemist admitted into the U.S. National Academy of Sciences and into National Inventors Hall of Fame. These fourth block stamps seem like as if they were the same, but it can be seen that they are not identical after all according to their coupons containing different captions. Being a chemist on education, P. Julian had been used natural compounds with preformed cyclopentaphenantrene backbone in his syntheses. The most appropriate and useful approach to total steroid synthesis was proposed by the Russian chemist Igor Torgov (1912-2007) such as estrone synthesis - Torgov reaction (Zhdanov and Corey, 2009). I.V. Torgov developed a reaction sequence for total synthesis of

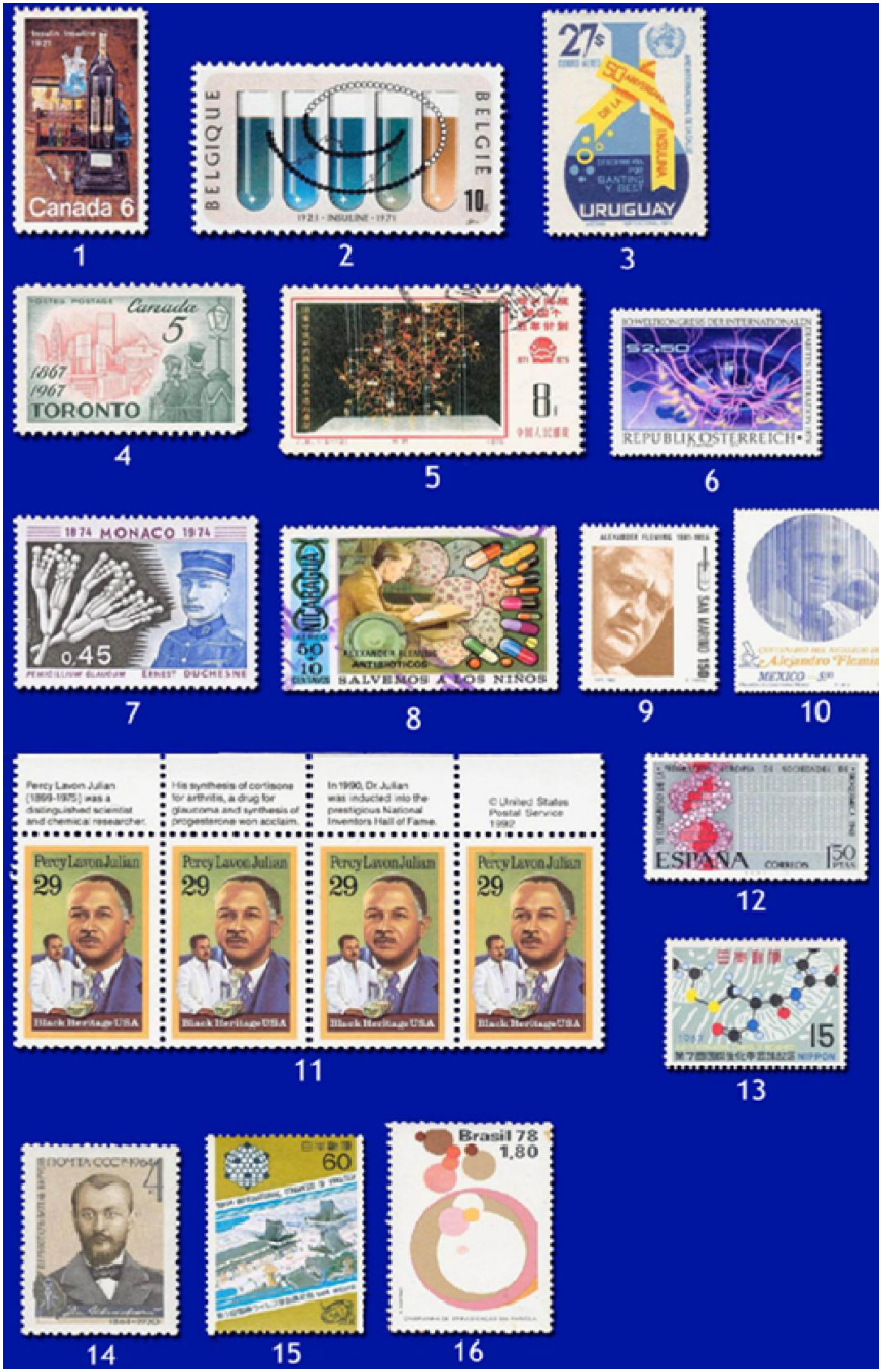

Figure. 2. 16 Postage stamps commemorating development of medicines in the twentieth century: insulin, penicillin, steroid hormones, DNA and antiviral medicines.

steroids after discovering a reaction for the steroid nucleus formation. The famous Torgov reaction became remarkably short. Additionally, Torgov's total steroid synthesis was highly regarded by Nobel Laureates Sir Alexander Todd, Sir Derek Barton, Leopold Ruzhichka and Elias Corey.

In pharmacology and medical practice, antiviral medicines have gained a great importance. Thus, the U.S.S.R postage stamp of 1964 (Figure 2:14) celebrates the 100th anniversary of the Russian physician Dimitry Ivanovsky (1864-1920), who had pioneered the study of viruses. In addition to his portrait, the stamp also includes a picture of a glass vessel, apparently, to filter out virus preparations. Viral vectors based on a variety of viruses: adeno -, adeno-associated -, herpes simplex, retro -, lenti -, and even HIV virus, are extensively used for targeted delivery of therapeutic genes to specific tissues for the purposes of gene therapy of a variety of diseases (Le Doux, 2008). The stamp that commemorates the 6th International Congress of Virology in Sendai, Japan in 1984 is shown in Figure 2:15. It depicts a scheme of a virion (upper left corner), a stylized view of typical Japanese city with pagoda temples (at the center), and the logo of the Congress - an infectious viral particle (right corner at the bottom). The Brazilian postage stamp of 1978 (Figure 2:16) is directly connected with year of 2009 and schematically features a viral infection via production of the famous influenza A/Brazil/11/78 virion particles (circulating 50 years ago in Portugal and in South America). This viral infection seems to be similar to the current influenza A (H1N1) virus appeared in Mexico in 2009 (Nakajima et al., 1981). The Japanese postage stamp of 1967 (Figure 2:13), is dedicated to the VIth International Congress of Biochemistry in Tokyo, and contains a schematic representation of a peptide bond (the black circles represent the carbon atom, red - oxygen, light blue - hydrogen, blue - nitrogen, and yellow - sulfur) with a pattern of cellular organelles (probably, mitochondria) as a background.

DNA and gene medicines

The most famous chemical structure of the twentieth century - DNA double helix - represents now both an encyclopedia of human genome (because it encodes proteins and their relationships); and at the same time, a medicine, because gene medicines are prepared to be widely used in pharmacology. A Spanish postage stamp of 1969 (Fig. 2:12) commemorating the VIth FEBS Congress (Federation of European Biochemical Societies) in Madrid, displays a model of the DNA double helix (B-DNA, on the left) and a table (on the right) containing the 64 triplets of the genetic code common to all living organisms - the key events of the molecular biology and the genetic engineering. Several postage stamps (Figure 3) as those of Cuba in 1975 that depicts the double helix of DNA, Cuba, 1975 (Figure 3:2); Czechoslovakia, 1962, that shows the replication fork (Figure 3:3); and Turkey, 1987 (Figure 3:4), that represents the B-DNA double helix of which hydrogen bonds are constructed with pharmaceutical pills commemorating the Turkish pharmaceutical industry. Israel postage stamp (Figure 3:5) commemorates the 15th Congress of Chemotherapy in 1964 and contains the non-natural DNA helix (misleading left-hand twist) which seems closer to its Z-form. The Bulgarian postage stamp (Figure 3:6) also depicts Z-DNA image, like the Israel stamp aforementioned, and commemorates the VIth FEBS Congress in Varna in 1971.

A series of four Swedish postage stamps of 1989 (Figure 3:1, first row) were issued in an honor of Nobel Prize Laureates and their discoveries related to DNA and genetics. These discoveries had a great impact and a powerful impulse on the development of medical genetics, genetic engineering and pharmacogenetics. The first stamp is devoted to the genetisist T.H. Morgan and Nobel Prize of U.S. in 1933 and to his work, where he verified the Mendel laws on the genetics of the fruit fly, *Drosophila melanogaster*. It depicts male and female fruit fly species and a scheme for genetic diversity by the crossing-over mechanism. The second stamp of the series (Figure 3:1, first row) is devoted to F. Crick (1916-2004), J. Watson (born 1928) and M. Wilkins (1916-2004) Nobel Prize laureates, for the discovery of the structure of the DNA double helix, and its role in storage and transfer of genetic information. The stamp depicts a model of B-DNA double helix and the R. Franklin's X-ray diffraction image of DNA (Chudley, 2000). The third one is devoted to the discovery of restriction enzymes by W. Arber, D. Nathans and H.O. Smith and their 1978 Nobel Prize. The fourth stamp in the series commemorates the U.S. geneticist Barbara McClintock's 1983 Nobel Prize for her genetic studies on maize and the discovery of "jumping" genes – transposons, DNA fragments that are able to move around the genome. Professor B. McClintock (1902 - 1992) can also be seen on the U.S. postage stamp of 2005 (Figure 4:10). The stamp features one of the transposable elements, showing her name in bold and the word "geneticist" as her profession.

The last line of Figure 3, two French postage stamps of 1969 commemorate to the 100th anniversary of the famous writer Alphonse Daudet (1840-1897) publication "Letters from my Mill" (Figure 3:7,8). These stamps depict alchemists. The matter is that one of the persons depicted on both stamps seems not to be an alchemist, but the character - monk Father Pere Gaucher from his story "L'elixir du reverend pere Gaucher" who prepared a famous "elixir" (Heilbronner and Miler, 2004). Alchemists were doing their experiments trying to prepare the "homunculus" a kind of human being synthetically developed *in vitro*. The last stamp at the bottom row, a German postage stamp of 1979 (Figure 3:9) reproduces the 1616 woodcut. It depicts Dr. Faust – a lead character

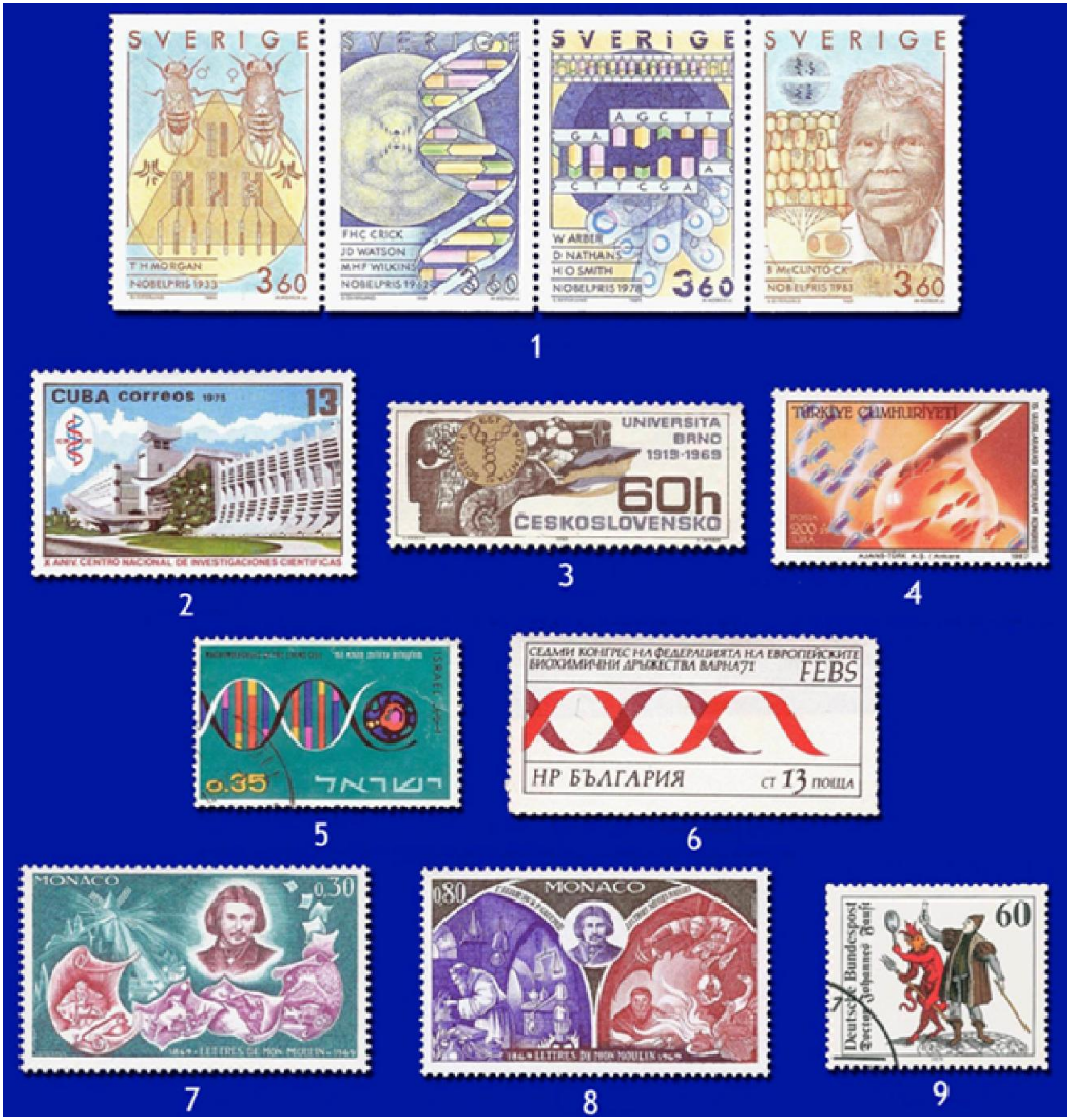

Figure 3. Postage stamps (9) illustrating discoveries related to DNA structure and function.

of the I.W. Goethe poetry, showing to Mephistopheles a glass vessel containing "homunculus" - an ancient dream of alchemists. Faust protects himself from a devil's spell with an alchemical circle. Currently, it is believed that "this project" - cloning of animals and human beings - is very close to being fulfilled, but with a limited and unpredicted success.

Furthermore, there are several postage stamps containing the DNA double helix images which are devoted either to the 50th anniversary of DNA structure, biotechnology or to millennium. Very interesting DNA stamps are combined into a fourth block of Macau (former colony of Portugal on the territory of China (PRC) of 1999 (Figure 4:4). The image of each light blue stamp features a nucleotide heterocyclic base forming hydrogen bonds with the corresponding nitrogen-containing heterocyclic base at the neighbor stamp: guanine (G, pink - purine) forms three hydrogen bonds with cytosine

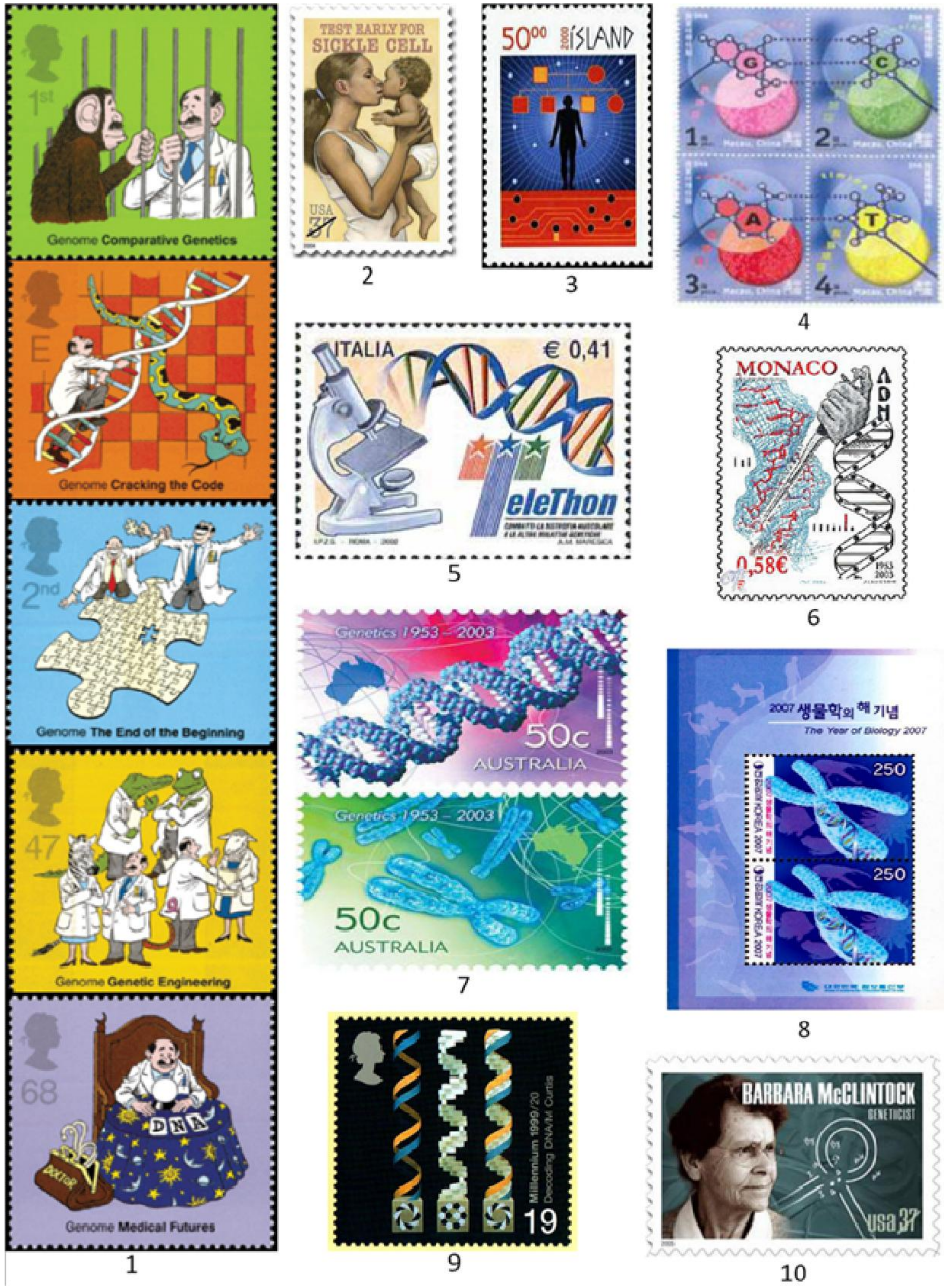

Figure 4. Postage stamps (19) devoted to human genome and genetics studies.

(C, green - pyrimidine), and adenine (A, red- purine) forms two hydrogen bonds with thymine (T, yellow-pyrimidine). Two Australian stamps (2003, 50 cents) (Figure 4:7) commemorate DNA double helix's discovery (upper) and the Australian achievements in genetics (lower) showing kangaroo's chromosomes; they are devoted to the World Congress to commemorate the 50th anniversary of DNA in Sydney. The UK postage stamp (Figure 4:9) commemorates the decoding of genomic DNA nucleotide sequence, also features three DNA double helices and sculpture of M. Curtis, as it is said on the postage stamp itself. The Monaco postage stamp of 2003 (Figure 4:6) commemorates the 50^{th} anniversary of the DNA structure discovery. It features a simplified molecular model of DNA double helix (right) with network of electronic orbital around carbohydrate-phosphate backbone (left) showing an automatic pipetting device (Monaco, 2003). Republic of Korea's stamp block of 2007 (Figure 4:8) commemorates "The Year of Biology" declared by the Government to promote biological sciences in the country. It features typical chromosome structure with a DNA molecule inside, and with profiles of a variety of biological species - animals, plants, fish are used as a background.

A series of U.K. postage stamps (2003) (Figure 4:1) is a commemoration to human genome sequencing and its applications, which were issued for the 50^{th} anniversary of DNA structure discovery. First stamp in Figure 4:1,1^{st} refers to the small difference between genomes of human beings and his closest relatives, being devoted to the comparative genomics. The second stamp in Figure 4, E (refers to the cracking the code of DNA, as the footnote highlights. Third stamp of this block (Figure 4:1,2^{nd}), named “The End of the Beginning”, is an illustration that reveals that the complete sequence of the human genome is only the beginning. It will be part of a bigger puzzle, since the majority of human genome sequence does not code protein genes: genome is still closed "book", but also even "sealed" one. The next stamp of this series (Figure 4:1,47p) features "a part of the art" of the current genetic engineering applications in an illustrative way, where the people are half-animal and half-human. Fortunately, as it was demonstrated in 2008 (Armstrong, 2008), human-animal hybrids cannot survive even two weeks. In the same line of thinking, from the authors' point of view, religious the Holy Books could be considered to be the primary "textbooks" also for scientists and bioengineers that are specialized in the field of genetically modified organisms. The last stamp (Figure 4:1,68p) with a doctor on a fortune-teller desk depicts that the future of the medical applications of DNA will be a big question mark, since almost every day a new medical approach is developed when it comes to the genetics, and many ethical questions are raised (see, e.g., Lewis and Zhdanov, 2009).

Genetics and Bioengineering

DNA sequence is also used as a basis for gene diagnostics and counseling, and for medical genetics cures as well. U.S.A. postage stamp of 2004 (Figure 4:2) suggests an early genetic test for diagnostics of the sickle cell disease. It is a hereditary genetic disease more common to people from Mediterranean origin, since it offers immunity to malaria in their countries of origin (USA, 2004). Iceland postage stamp of 2000 (Figure 4:3) celebrates the genetic advancements of the millennium, depicting a family pedigree and computer circuits around a man. Iceland is the country where human genetics is highly developed, with a database of entire population. The Italian stamp of 2002 (Figure 4:5) features the TeleThon logo, which is an Italian foundation for the study of muscular dystrophy and other genetic diseases, contains a DNA molecule model depicting gene therapy as a treatment for these diseases, incurable today. The molecule has a misleading left-hand twist, as shown in some stamps (Figure 3:3,5,6), but natural genomic DNA is a right-hand helix.

Long before the discovery of the DNA double helix, Johann Mendel was born in Heinzendorf bei Odrau, Silesa, Austrian Empire (now Hyncice, Czech Republic) in 1822, and took the name Gregor after he was ordained priest. He died in Brno in 1884. Mendel conducted more than 10,000 genetic experiments involving pea plants, and published his data – Mendel’s Laws of Genetics: law of segregation and law of independent assortment - in Germany in 1865. As he established the basic laws of genetics he is known at present time as the father of genetics. The first stamp shown in Figure 5:1 is part of a set devoted to scientific research, and the last issue of Free State of Danzig (Gdansk) before the German invasion by Hitler in 1939. The second stamp (Figure 5:2) commemorates Mendel's discoveries, and shows a pea plant and a replicating double helix. Since the details of DNA replication were not clarified at that time, the drawing is inaccurate. The last two stamps on the 1^{st} row (Figure 5:3,4) are also devoted to Mendel – in commemoration of the centenary of his death. These stamps show the results obtained from one of the crosses he made with the pea plant (Vatican City, 1984). The next stamp of Germany, 1984 (Figure 5:5), describes the Mendel’s second law (Law of Independent Assortment), with a crossing of the genotypes *RR, Rr, rr.* The Austrian stamp of 1984 (Figure 5:6) also commemorates a centenary of Mendel’s death, depicting Mendel’s first law (Law of Segregation) crossing results.

Soviet and Russian postage stamps commemorate two famous plant geneticists academicians V.A. Komarov (1869-1945), the U.S.S.R. stamp of 1969 (Figure 5:7) and N.I. Vavilov (1887-1943) (Figure 5:8,9): the U.S.S.R. stamp of 1977, and Russian stamp of 1987. Vladimir

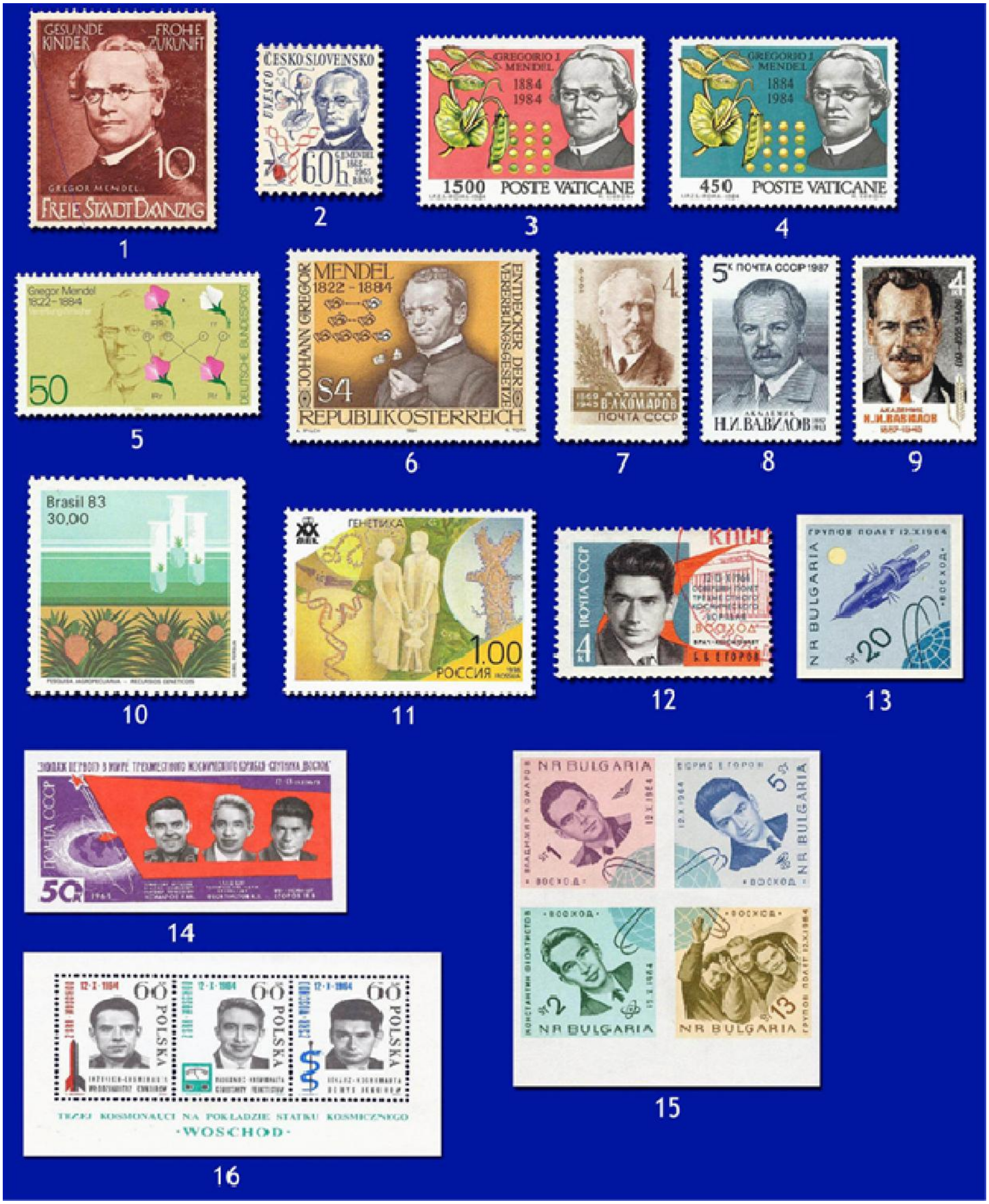

Figure 5. Genetics and genetic engineering postage stamps (16).

Komarov became famous because he was an outstanding botanist and served for many years as President of the U.S.S.R. Academy of Sciences (1936-1945); and Nikolai Vavilov is best known for having identified the centers of origin of cultivated plants (cereal crops) and established the famous law of genetics: law of homologous series in variation. Nobel Prize laureate Hermann J. Muller who demonstrated mutagenic effects of X-rays worked for three and half years in Vavilov's laboratory in Leningrad, later in Moscow (1934-1937) (he was even elected as a corresponding member of the U.S.S.R. Academy of Sciences during his stay in Moscow) . N. Vavilov died in jail during the World War II because he was kept under terrible conditions. Figure 5 presents also Brazilian (1983) and Russian (1998) postage stamps. Brazilian stamp (Figure 5:10) celebrates outstanding achievements of the country in biotechnology, genetic engineering and genetically modified plants. The Russian postage stamp (Figure 5:11) celebrates the state of the art of the twentieth century science in the field of human genetics: the background shows the profile of a young family - mother, father and daughter, and four circled images of DNA replication fork, scheme of meiosis, genomic DNA and a typical chromosome. Soviet cosmonaut, Boris Egorov, MD was the first physician in the space (Figure 5:12-16). Long time after his flight in October 12-13, 1964 jointly with the pilot-engineer V.M. Komarov and the PhD K.P. Feoktistov, Dr. B.B. Egorov became Director of National Institute for Medicinal Biotechnology in Moscow, where biotechnology- and genetic engineering-based medicinal preparations were produced. The U.S.S.R. postage stamp (Figure 5:12) and philatelic blocks of U.S.S.R. (Figure 5:14), Bulgaria (Figure 5:13,15) and Poland (Figure 5:16) commemorate the first flight of 3-seats - space aircraft. Dr. Boris Egorov, MD (later, he defended PhD and DSc Theses), can be seen on the Soviet stamp (Figure 5:12). Other stamps and block show portraits of cosmonauts (astronauts), schemes of space-crafts, and hypothetical space orbital around our planet earth.

Conclusions

This article discusses some of the most important for the public scientific and medical achievements based on considering postage stamps worldwide. Even if the stamps are fading away due to the use of Internet, mobile phone, stamping machines and, it is a fact that they leave a historical commemoration to famous crucial points in science and medicine. An input of science into world culture and an impact of nations into modern science, medicine and technology are estimated and evaluated *via* analyzing and comparison of philatelic materials worldwide. Although more than 80 philatelic items worldwide are presented and discussed in this paper, an attention is paid mainly to the contributions from the United Kingdom (27 stamps), the United States of America (24 stamps), the U.S.S.R. / Russia (17 stamps), Germany (7 stamps), and France (5 stamps). Presentation and considering of the stamps and stamp blocks is organized inside a few topics of the most public interest: medicines, DNA & gene medicines, and genetics and bioengineering as well. It is apparent that these postage stamps represent a response of the society to professional activity of scientists and medical doctors. Nevertheless, this presentation may inspire young minds, in one hand, and recall good reminiscences in experienced and wise ones, in another hand.

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REFERENCES

Armstrong L (2008). Newcastle University. Hybrid human-animal embryo research approved in the UK. Science Daily.

Chudley AE (2000). Genetic landmarks through philately - Crick, Watson and Wilkins: the scientists behind. Clin. Genet.. 57: 26-28.

Douglas G (1949). Medical and scientific philately. Br. Med. Bull. 6:88-95.

Heilbronner E, Miller FA (2004). A Philatelic Ramble through Chemistry, Wiley-VCH: Weinheim.

Le Doux J.M., ed. (2008). Gene Therapy Protocols, vol. I and II, Humana Press.

Lewis R, Zhdanov R (2009). Centenarians as stem cell donors. Am. J. Bioethics. 9:1-3

Nakajima S, Cox NJ, Kendal AP (1981). Antigenic and genomic analyses of influenza A(H1N1) viruses from different regions of the world, February 1978 to March 1980. Infection and Immunity 32: 287-294.

Pearn J (1982). Paediatrica philatelica. J. Paediatr. Child Health. 35:232-236.

Wilson R (2001). Stamping through mathematics. Springer, Berlin.

Zhdanov R (1987). Great geneticist Nikolai Vavilov. Science in the U.S.S.R. 6: 102.

Zhdanov R (1988a). Polymer formula on postage stamp. Science in the U.S.S.R. 1: 33.

Zhdanov R (1988b). Vladimir Vernadsky and his bio- and noospheres. Science in the U.S.S.R. 2: 44.

Zhdanov R (1988c) Radist of the 1st Polar expedition. Science in the U.S.S.R. 4: 84.

Zhdanov R (1988d). Great chemists from Kazan State University. Phil. Chim. Phys.10:167-169.

Zhdanov R, Jdanov A (2000).Medicine and pharmacy in philately. Khim.-Pharm. Zhurnal. Rus. Chem.Pharm.Bull.1: 46-53.

Zhdanov R, Corey E (2009). In memorium Igor Torgov. Torgov's way to total steroid synthesis. Steroids. 74: 723-724.

Zhdanov R, Jdanov A (1999).Pharmacology and medicine on postage stamps. Khim.-Pharm. Zhurnal Rus. Chem. Pharm.Bull.4: 50-55.

Zhdanov RI (2009a). Scientists on Turkish banknotes will inspire young minds. Nature. 457: 956.

Zhdanov RI (2009b). A Toast to Mendeleev who merits more than periodic order. Nature. 462: 985.