History of genetics

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When ?

History: Spontaneous generation and fixity of species

- Initial belief was that there is no need of transfer of biological material between generations (for at least mid 18^th century).
- Leeuwenhoek (1632-1723) observed spontaneous appearance of flies from refuse (small infusoria “arising” from apparently clear infusions of hay)
- Redi’s and Spallanzani’s (1621-1697 and 1729-1799) experiment questioned this doctrine of “spontaneous generation”. They showed fly larvae would not develop if adult flies are excluded from laying eggs on meat.
- They sealed boiled the flasks and inferred on the non-appearance of tiny “animalcules” observed by Leeuwenhoek. However, they did left the possibility, citing their experiment of “tainted” (heated, in their sense of words) air, that whether unheated air could generate new organisms.

- Seventeenth and eighteenth centuries marked the beginnings of systematics. Linnaeus (1707-1778) mostly contributed to the knowledge.
- According to him, there was a “fixity of species”.
- Two doctrines – spontaneous generation and fixity of species – were difficult to reconcile with each other.
- Both theories were put to rest by Pasteur (1822-1895) and by Tyndall (1820-1893) who showed that putrefaction of organic matter only occured under conditions that permitted solid particles to enter a nutrient culture. (These solid particles were identified to be microbes, later.)
- Consesus was that “every living thing from a living thing” (*Omne vivum e vivo*).

History: Preformationism and epigenesis

- Originally aristotle had proposed that an organism formed through sexual reproduction receives the “substance” of the female egg and a contribution of “form” by the male seminal fluid.
- The idea (generated by biologists during 17th and 18th century) that one of the sex cells, or gametes, either sperm or egg, contained within itself the entire organism in perfect miniature form (*preform* - ationism).
- Wolff advanced the idea that organisms develop from uniform embryonic tissues, idea of *epigenetics*, and later his successor von Baer (1792-1876) proposed the view that gradual transformation of increasingly specialized tissue make up an organism during development, and not the *de novo* appearance of organs.

History: Pangenesis and the history of acquired characters

- Charles Darwin (1809-1882) believed that very small, exact, but invisible copies of each body organ and component (gemmules) were transported by the bloodstream to the sex organs and there assembled into the gametes.
- This doctrine of “pangenesis” provided attraction for believers of evolution.
- According to this theory, the excess use or disuse of organ would alter its gemmules and consequently lead to a changed inheritance in the decendents – inhertance of acquired characters take place.
- Most popular proponent was Lamarck (1744-1829).
- Work during later part of 19th century and beginning of 20th set the stage for characterization of source of heredity.

History: Modern history of genetics

- Developments in cytology in the 1800s had a strong influence on genetics. Building on the work of others, Matthias Jacob Schleiden (1804–1881) and Theodor Schwann (1810–1882) proposed the concept of the cell theory in 1839. Biologists began to examine cells to see how traits were transmitted in the course of cell division.
- Charles Darwin (1809–1882), one of the most influential biologists of the nineteenth century, put forth the theory of evolution through natural selection and published his ideas in On the Origin of Species in 1859.
- Walther Flemming (1843–1905) observed the division of chromosomes in 1879 and published a superb description of mitosis. By 1885, it was generally recognized that the nucleus contained the hereditary information.
- Near the close of the nineteenth century, August Weismann (1834–1914) finally laid to rest the notion of the inheritance of acquired characteristics. He cut off the tails of mice for 22 consecutive generations and showed that the tail length in descendants remained stubbornly long.
- Weismann proposed the germplasm theory, which holds that the cells in the reproductive organs carry a complete set of genetic information that is passed to the egg and sperm.

History: Towards the end of 19th century and further

Table 1: History of modern genetics

Year	Event
1865	Gregor Mendel showed that traits are controlled by discrete factors now known as genes.
1869	Friedrich Miescher isolated DNA from the nuclei of white blood cells.
1903	Walter Sutton and Theodor Boveri hypothesized that chromosomes are the hereditary elements.
1905	William Bateson introduced the term “genetics” for the study of inheritance.
1908	G. H. Hardy and Wilhelm Weinberg proposed the Hardy–Weinberg law, the foundation for population genetics
1910	Thomas H. Morgan demonstrated that genes are located on chromosomes.
1913	Alfred Sturtevant made a genetic linkage map of the Drosophila X chromosome, the first genetic map.
1918	Ronald Fisher proposed that multiple Mendelian factors can explain continuous variation for traits, founding the field of quantitative genetics.
1931	Harriet Creighton and Barbara McClintock showed that crossing over is the cause of recombination.
1941	Edward Tatum and George Beadle proposed the one-gene—one-polypeptide hypothesis.
1944	Oswald Avery, Colin MacLeod, and Maclyn McCarty provided compelling evidence that DNA is the genetic material in bacterial cells.
1946	Joshua Lederberg and Edward Tatum discovered bacterial conjugation.
1948	Barbara McClintock discovered mobile elements (transposons) that move from one place to another in the genome.
1950	Erwin Chargaff showed DNA composition follows some simple rules for the relative amounts of A, C, G, and T.
1952	Alfred Hershey and Martha Chase proved that DNA is the molecule that encodes genetic information.

Table 2: History of modern genetics (...continued)

Year	Event
1953	James Watson and Francis Crick determined that DNA forms a double helix.
1958	Matthew Meselson and Franklin Stahl demonstrated the semiconservative nature of DNA replication.
1958	Jérôme Lejeune discovered that Down syndrome resulted from an extra copy of the 21st chromosome.
1961	François Jacob and Jacques Monod proposed that enzyme levels in cells are controlled by feedback mechanisms.
1961-1967	Marshall Nirenberg, Har Gobind Khorana, Sydney Brenner, and Francis Crick "cracked" the genetic code.
1968	Motoo Kimura proposed the neutral theory of molecular evolution.
1977	Fred Sanger, Walter Gilbert, and Allan Maxam invented methods for determining the nucleotide sequences of DNA molecules.
1980	Christiane Nüsslein-Volhard and Eric F. Wieschaus defined the complex of genes that regulate body plan development in Drosophila.
1989	Francis Collins and Lap-Chee Tsui discovered the gene causing cystic fibrosis.
1993	Victor Ambrose and colleagues described the first microRNA.
1995	First genome sequence of a living organism (Haemophilus influenzae) published.
1996	First genome sequence of a eukaryote (Saccharomyces cerevisiae) published.
1998	First genome sequence of an animal (Caenorhabditis elegans) published.
2000	First genome sequence of a plant (Arabidopsis thaliana) published.
2001	The sequence of the human genome first published.
2006	Andrew Fire and Craig Mello win the Nobel prize for their discovery of gene silencing by double-stranded RNA.
2012	John Gurdon and Shinya Yamanaka win the Nobel prize for their discovery that just four regulatory genes can convert adult cells into stem cells.