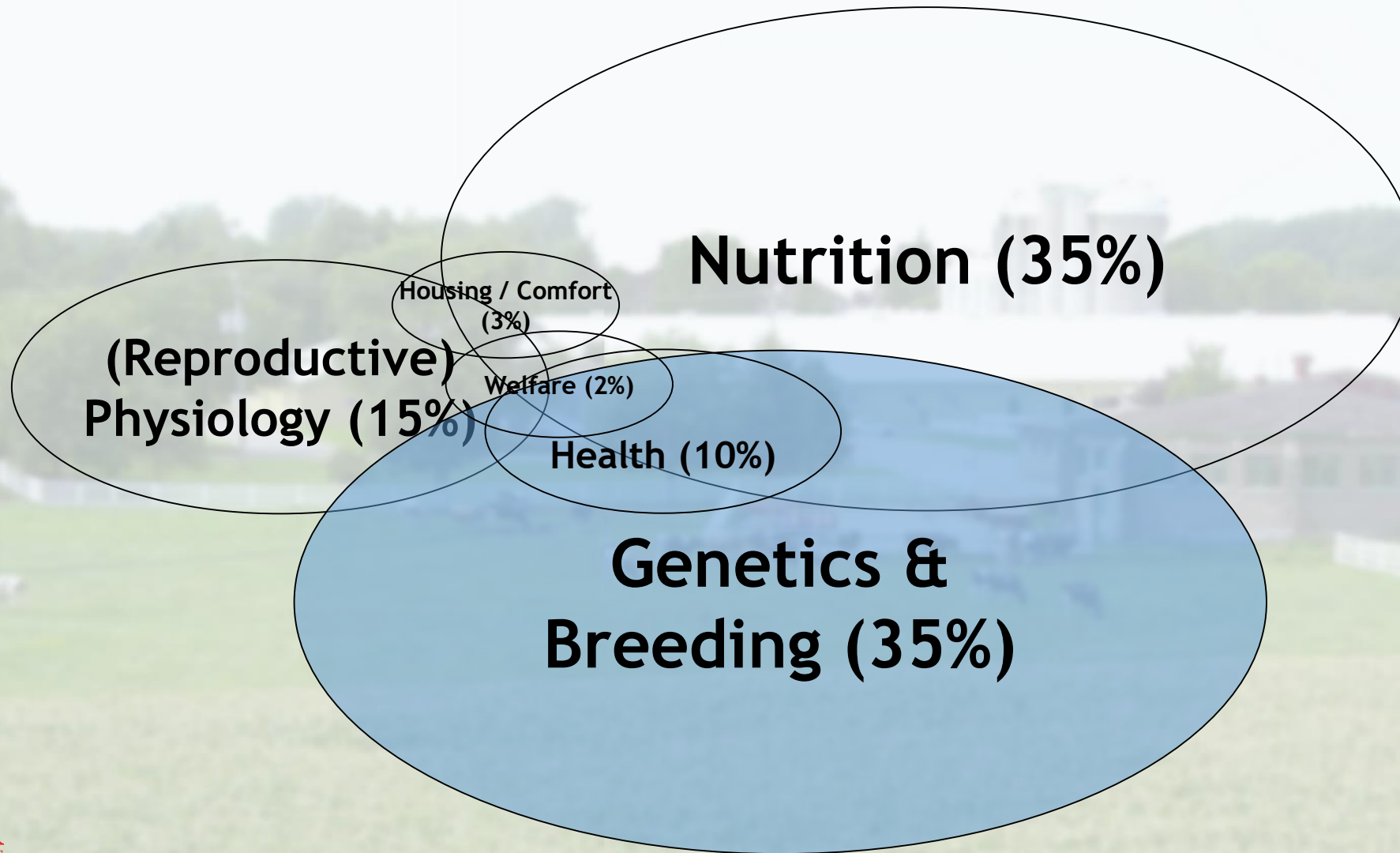
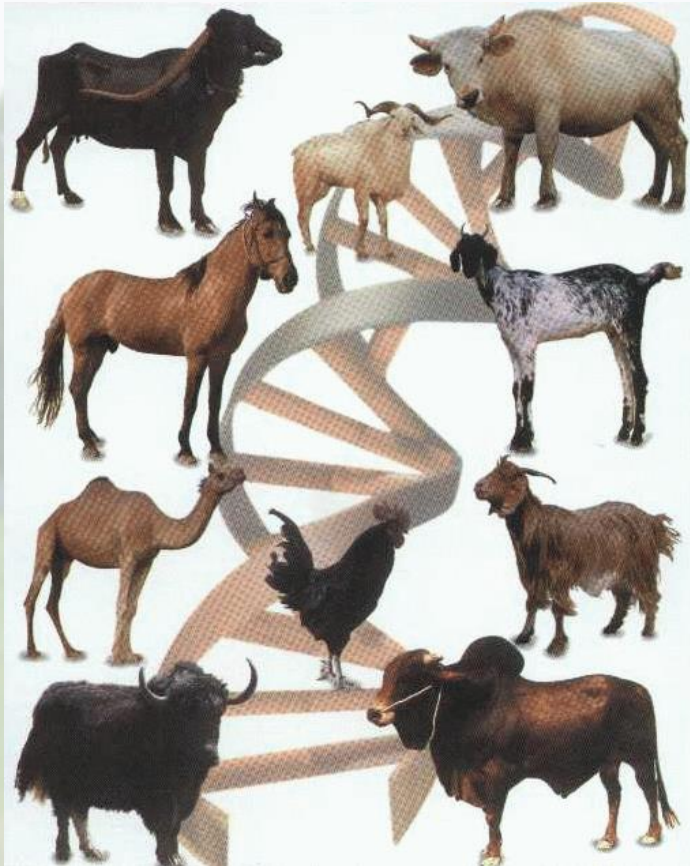


Improving Animal Production



Animal Genetics



“that branch of biology which deals with **genes** and their **transmission** from **one generation to the next** and their effect on external traits and characteristics”

“the science dealing with **heredity** and **variation** seeking to discover laws governing similarities and differences in individuals related by descent”

William Bateson, 1906



"A chicken is just an egg's way of making more eggs!"

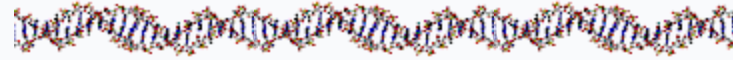
Page 11...

"I shall argue that the fundamental unit of selection, and therefore of self-interest, is not the species, nor the group, nor even, strictly, the individual. It is the gene, the unit of heredity."

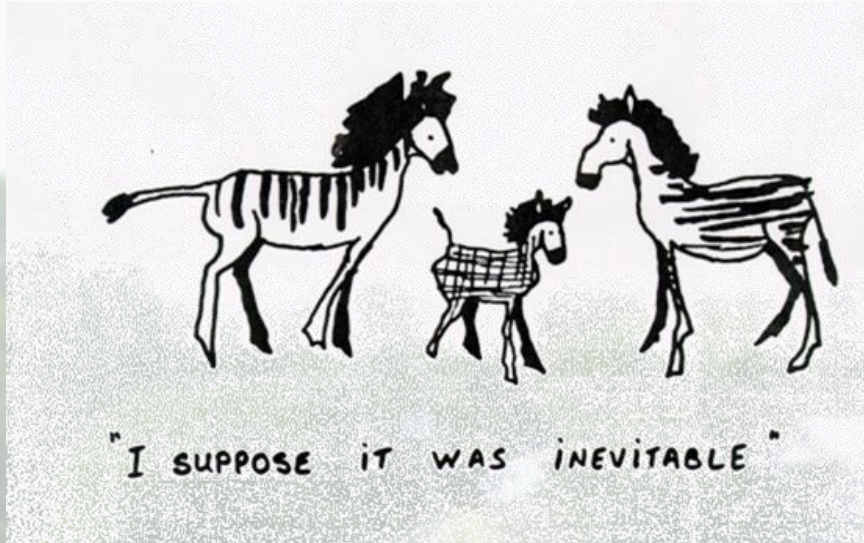
(Dawkins, 1976)

"We are influenced – not controlled – by our genes"

History



● *Blending Theory*



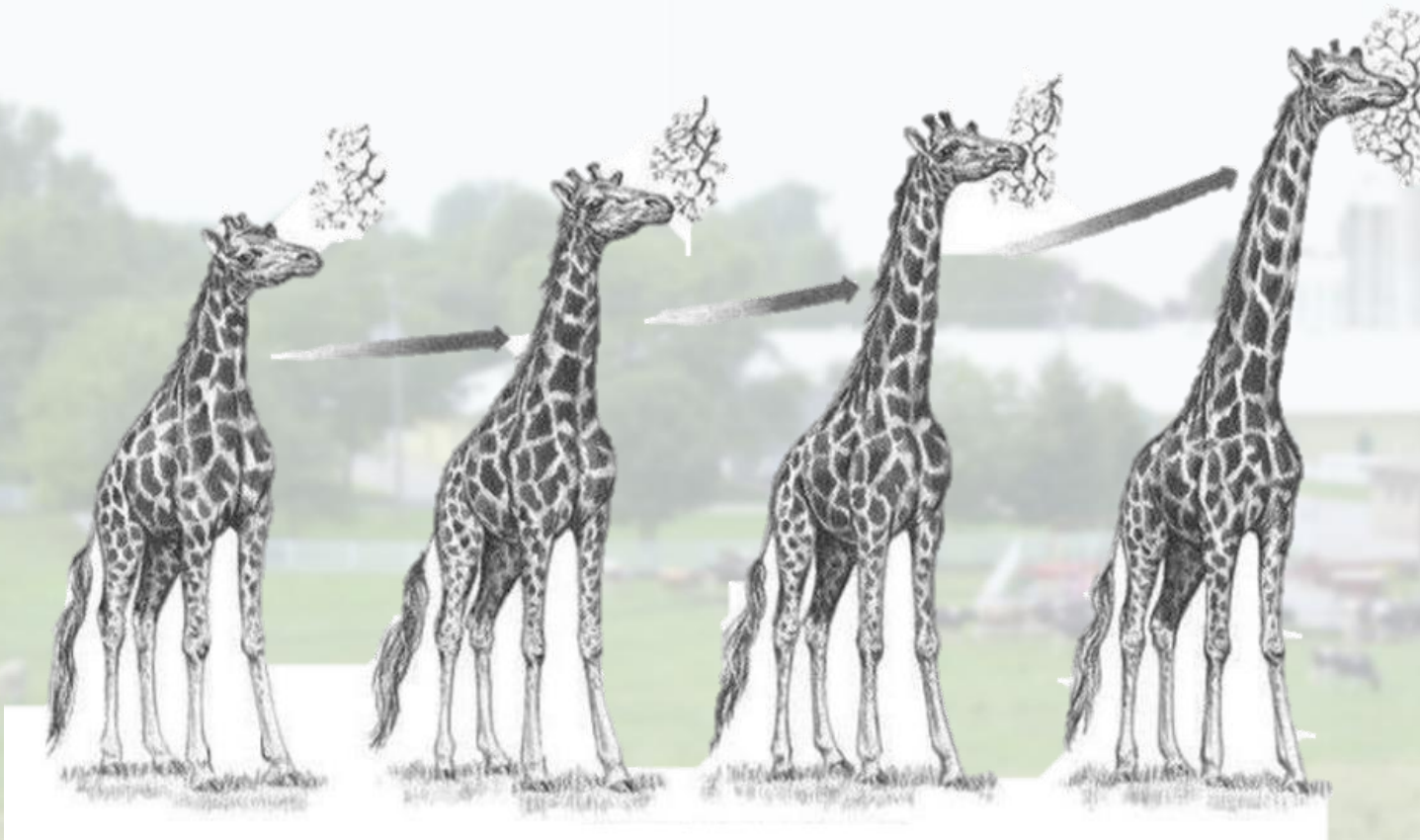
● *Acquired Characteristics*

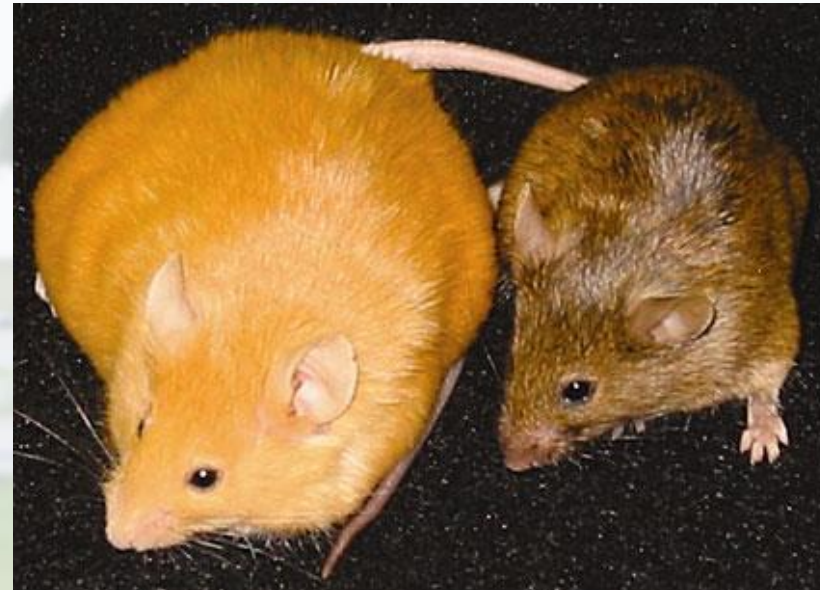


Jean-Baptiste de Lamarck, 1744-1829, a French physician and ex-military man, founded the modern study of animals without backbones and coined the term invertebrates to describe them as a group. When his battle wounds forced him to take up a new career, he studied botany and published a study of French plants. He later turned to invertebrates, and between 1815 and 1822 published the classic *Histoire naturelle des animaux sans vertèbres*. He applied his vast knowledge of living invertebrates to paleontological work, greatly enhancing the knowledge of fossil invertebrates. Lamarck was also an evolutionary theorist, and he believed that a single characteristic acquired by an animal during its lifetime could be passed on to its descendants by heredity (modern genetic theory was unknown at that time). He saw that evolution must have taken a long time to occur, and he supported the principle which has since become known as uniformitarianism.



LAMARCKS THEORY

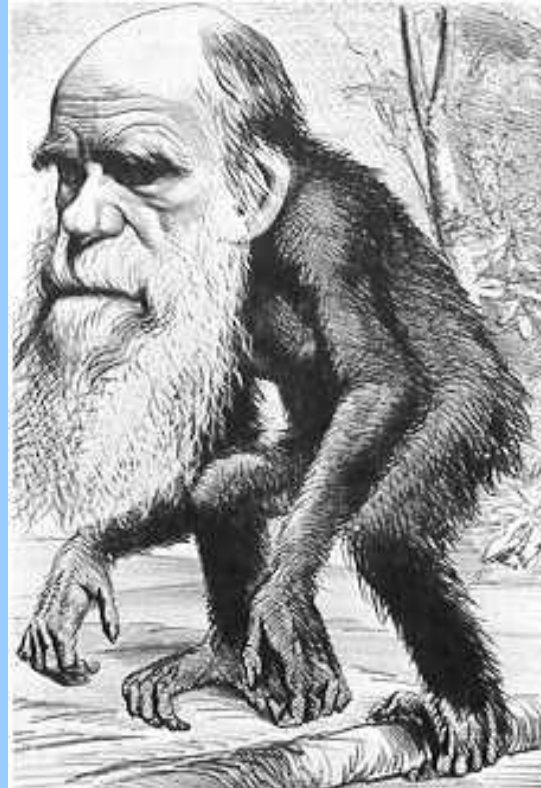
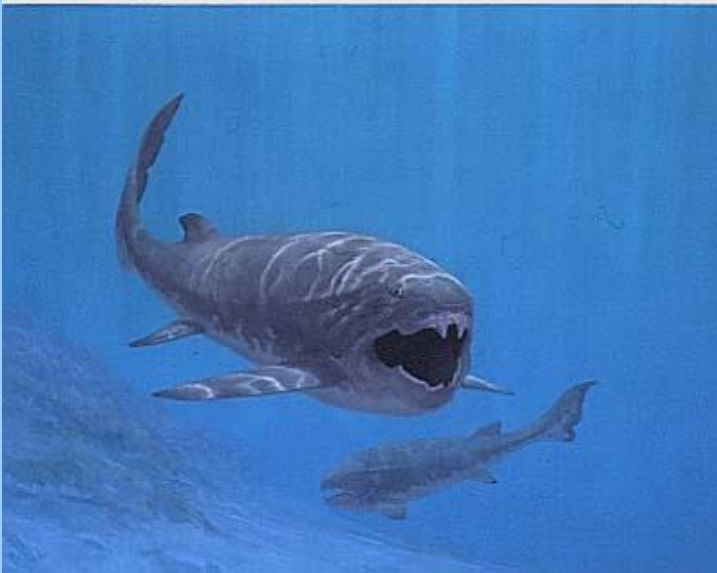




● Theory of Evolution

Charles Darwin

1809 - 1882



Evolution...
Natural Selection...
Survival of the Fittest...

Culling and replacement rates in dairy herds in Canada

This page represents the main culling and replacement rates in Canada

Number of herds enrolled on a milk recording program

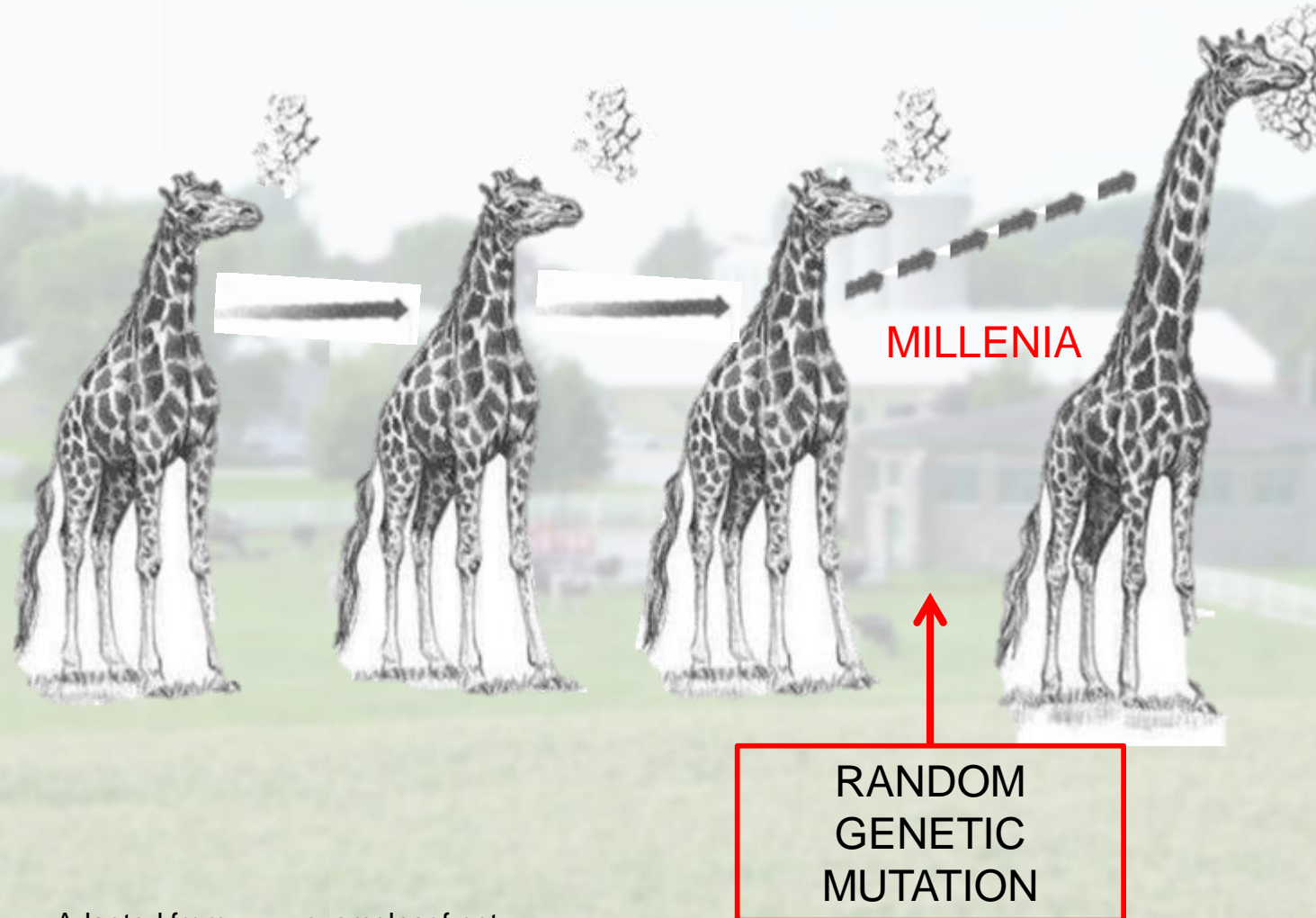
Cows	2014	2015	2016	2017	2018	2019
Number of herds enrolled on a milk recording program	9,039	8,585	8,299	7,827	7,246	6,787
Number of cows	696,737	694,265	691,743	703,143	661,638	621,509

Culling Reasons

Other Reasons

Culling Reasons	2014 Number of cows	2014 Total (%)	2015 Number of cows	2015 Total (%)	2016 Number of cows	2016 Total (%)	2017 Number of cows	2017 Total (%)	2018 Number of cows	2018 Total (%)	2019 Number of cows	2019 Total (%)
Reproductive	47,689	17.4%	44,016	17.1%	42,251	16.6%	39,772	16.9%	44,646	16.8%	39,993	15.9%
Mastitis	30,569	11.2%	29,151	11.3%	27,708	10.9%	24,695	10.5%	27,562	10.4%	23,832	9.5%
Feet and leg problems	19,666	7.2%	18,833	7.3%	17,643	6.9%	16,084	6.8%	17,861	6.7%	16,151	6.4%
Low milk production	19,159	7.0%	18,870	7.3%	17,650	6.9%	16,174	6.9%	19,785	7.5%	18,872	7.5%
Sickness	13,171	4.8%	12,677	4.9%	12,140	4.8%	11,841	5.0%	11,352	4.3%	10,521	4.2%
Injury to udder/teats	11,564	4.2%	11,123	4.3%	10,801	4.2%	7,655	3.3%	10,799	4.1%	10,063	4.0%
Injury/Accident	9,768	3.6%	9,667	3.8%	9,414	3.7%	9,161	3.9%	9,134	3.4%	8,321	3.3%
Old age	5,199	1.9%	5,088	2.0%	4,785	1.9%	4,498	1.9%	5,334	2.0%	5,006	2.0%
Difficult calving	1,754	0.6%	1,508	0.6%	1,520	0.6%	1,438	0.6%	1,434	0.5%	1,367	0.5%
Bad temperament	2,197	0.8%	1,847	0.7%	1,758	0.7%	1,501	0.6%	1,784	0.7%	1,902	0.8%

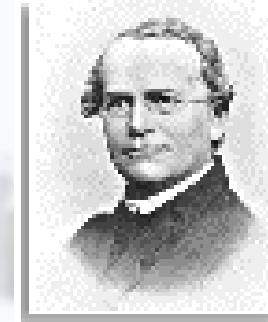
DARWIN'S THEORY OF NATURAL SELECTION

















● Mendelian Genetics

In 1865, Gregor Mendel published his findings on the inheritance of seven different traits in the garden pea. Prior to Mendel, inheritance was considered to occur through blending of traits. Mendel concluded that each parent contributes “particles” to the offspring.

We now call them genes. A gene is a stretch (piece) of DNA.



Character	Dominant trait	Recessive trait	Character	Dominant trait	Recessive trait
Seed shape	 Spherical	 Wrinkled	Flower position	 Axial	 Terminal
Seed color	 Yellow	 Green		 Tall	 Dwarf
Flower color	 Purple	 White			
Pod shape	 Inflated	 Constricted			
Pod color	 Green	 Yellow			

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● Biometrical Genetics

ARTHUR CHARPENTIER - WELFARE, INEQUALITY AND POVERTY

Regression ?

Galton (1870, galton.org, 1886, galton.org) and Pearson & Lee (1896, jstor.org, 1903 jstor.org) studied genetic transmission of characteristics, e.g. the height.

On average the child of tall parents is taller than other children, but less than his parents.

“I have called this peculiarity by the name of regression”, Francis Galton, 1886.

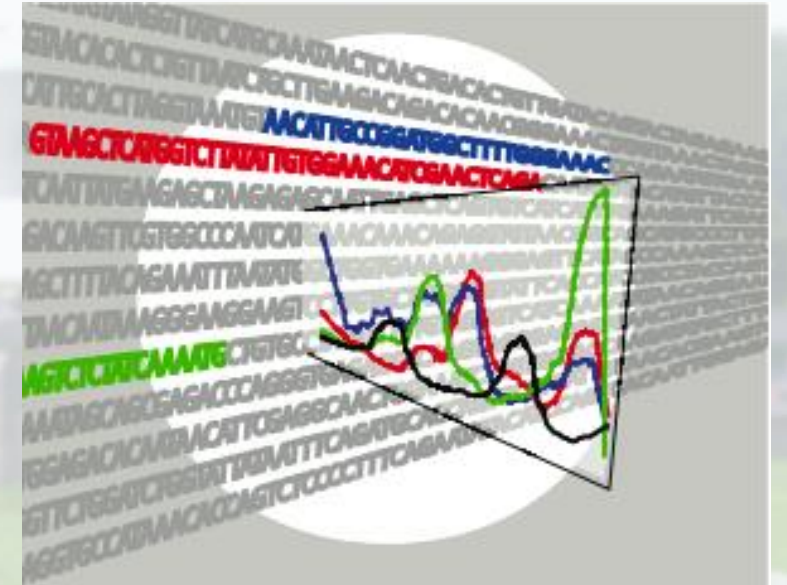
REGRESSION towards MIDNIGHT in HEREDITARY STATURE.
By FRANCIS GALTON, F.R.S., &c.

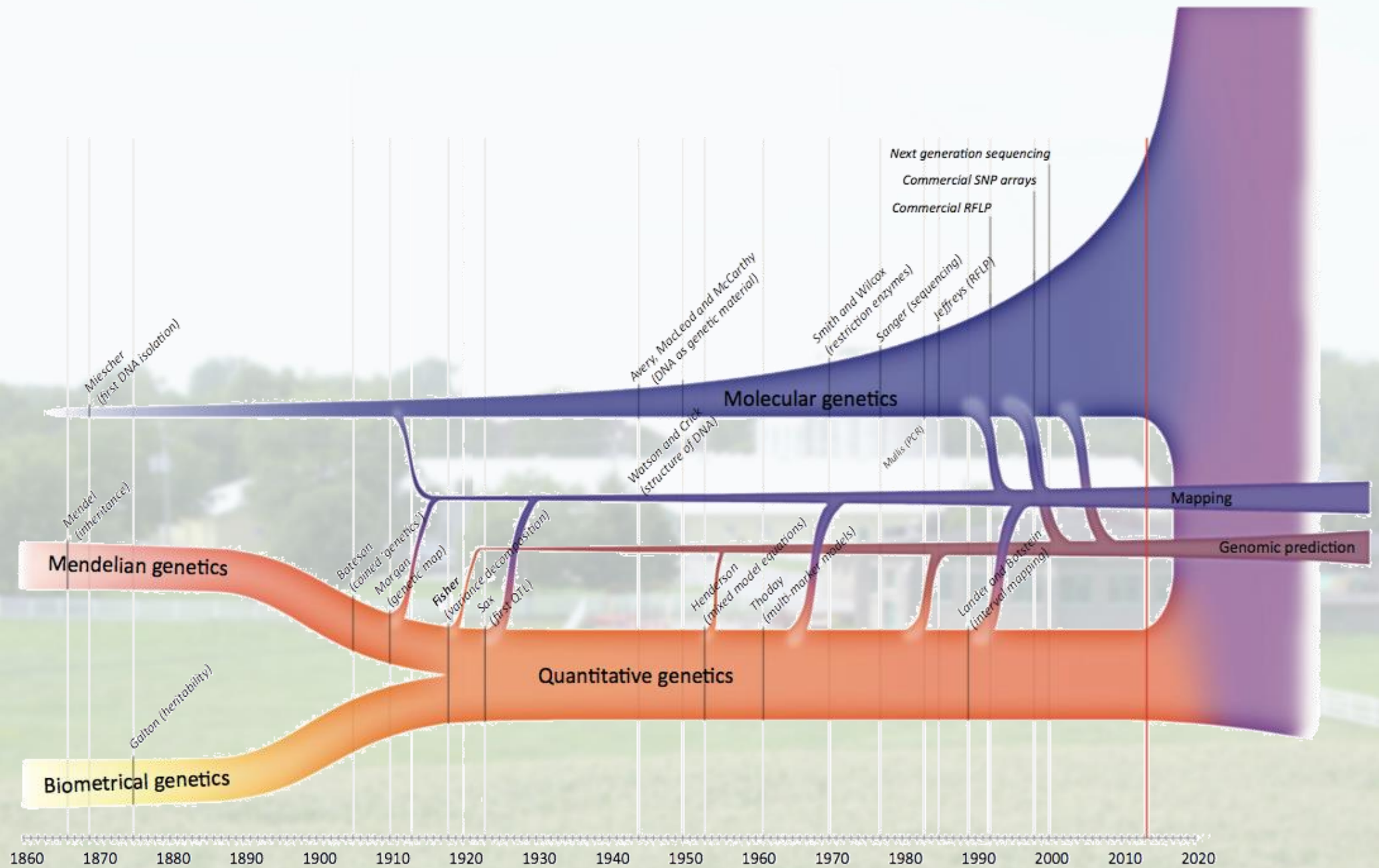
Table 1. Galton's 1886 presentation of 1013 father-son pairs of 1886 regression to mean height and their inheritance height.

Height of father	Height of the father (in)										Total no. of sons	Mean height
	5' 0"	5' 1"	5' 2"	5' 3"	5' 4"	5' 5"	5' 6"	5' 7"	5' 8"	5' 9"		
5' 0"	1	1	1	1	1	1	1	1	1	1	10	5' 0"
5' 1"	1	1	1	1	1	1	1	1	1	1	10	5' 1"
5' 2"	1	1	1	1	1	1	1	1	1	1	10	5' 2"
5' 3"	1	1	1	1	1	1	1	1	1	1	10	5' 3"
5' 4"	1	1	1	1	1	1	1	1	1	1	10	5' 4"
5' 5"	1	1	1	1	1	1	1	1	1	1	10	5' 5"
5' 6"	1	1	1	1	1	1	1	1	1	1	10	5' 6"
5' 7"	1	1	1	1	1	1	1	1	1	1	10	5' 7"
5' 8"	1	1	1	1	1	1	1	1	1	1	10	5' 8"
5' 9"	1	1	1	1	1	1	1	1	1	1	10	5' 9"
5' 10"	1	1	1	1	1	1	1	1	1	1	10	5' 10"
5' 11"	1	1	1	1	1	1	1	1	1	1	10	5' 11"
5' 12"	1	1	1	1	1	1	1	1	1	1	10	5' 12"
5' 13"	1	1	1	1	1	1	1	1	1	1	10	5' 13"
5' 14"	1	1	1	1	1	1	1	1	1	1	10	5' 14"
5' 15"	1	1	1	1	1	1	1	1	1	1	10	5' 15"
5' 16"	1	1	1	1	1	1	1	1	1	1	10	5' 16"
5' 17"	1	1	1	1	1	1	1	1	1	1	10	5' 17"
5' 18"	1	1	1	1	1	1	1	1	1	1	10	5' 18"
5' 19"	1	1	1	1	1	1	1	1	1	1	10	5' 19"
5' 20"	1	1	1	1	1	1	1	1	1	1	10	5' 20"
5' 21"	1	1	1	1	1	1	1	1	1	1	10	5' 21"
5' 22"	1	1	1	1	1	1	1	1	1	1	10	5' 22"
5' 23"	1	1	1	1	1	1	1	1	1	1	10	5' 23"
5' 24"	1	1	1	1	1	1	1	1	1	1	10	5' 24"
5' 25"	1	1	1	1	1	1	1	1	1	1	10	5' 25"
5' 26"	1	1	1	1	1	1	1	1	1	1	10	5' 26"
5' 27"	1	1	1	1	1	1	1	1	1	1	10	5' 27"
5' 28"	1	1	1	1	1	1	1	1	1	1	10	5' 28"
5' 29"	1	1	1	1	1	1	1	1	1	1	10	5' 29"
5' 30"	1	1	1	1	1	1	1	1	1	1	10	5' 30"
5' 31"	1	1	1	1	1	1	1	1	1	1	10	5' 31"
5' 32"	1	1	1	1	1	1	1	1	1	1	10	5' 32"
5' 33"	1	1	1	1	1	1	1	1	1	1	10	5' 33"
5' 34"	1	1	1	1	1	1	1	1	1	1	10	5' 34"
5' 35"	1	1	1	1	1	1	1	1	1	1	10	5' 35"
5' 36"	1	1	1	1	1	1	1	1	1	1	10	5' 36"
5' 37"	1	1	1	1	1	1	1	1	1	1	10	5' 37"
5' 38"	1	1	1	1	1	1	1	1	1	1	10	5' 38"
5' 39"	1	1	1	1	1	1	1	1	1	1	10	5' 39"
5' 40"	1	1	1	1	1	1	1	1	1	1	10	5' 40"
5' 41"	1	1	1	1	1	1	1	1	1	1	10	5' 41"
5' 42"	1	1	1	1	1	1	1	1	1	1	10	5' 42"
5' 43"	1	1	1	1	1	1	1	1	1	1	10	5' 43"
5' 44"	1	1	1	1	1	1	1	1	1	1	10	5' 44"
5' 45"	1	1	1	1	1	1	1	1	1	1	10	5' 45"
5' 46"	1	1	1	1	1	1	1	1	1	1	10	5' 46"
5' 47"	1	1	1	1	1	1	1	1	1	1	10	5' 47"
5' 48"	1	1	1	1	1	1	1	1	1	1	10	5' 48"
5' 49"	1	1	1	1	1	1	1	1	1	1	10	5' 49"
5' 50"	1	1	1	1	1	1	1	1	1	1	10	5' 50"
5' 51"	1	1	1	1	1	1	1	1	1	1	10	5' 51"
5' 52"	1	1	1	1	1	1	1	1	1	1	10	5' 52"
5' 53"	1	1	1	1	1	1	1	1	1	1	10	5' 53"
5' 54"	1	1	1	1	1	1	1	1	1	1	10	5' 54"
5' 55"	1	1	1	1	1	1	1	1	1	1	10	5' 55"
5' 56"	1	1	1	1	1	1	1	1	1	1	10	5' 56"
5' 57"	1	1	1	1	1	1	1	1	1	1	10	5' 57"
5' 58"	1	1	1	1	1	1	1	1	1	1	10	5' 58"
5' 59"	1	1	1	1	1	1	1	1	1	1	10	5' 59"
5' 60"	1	1	1	1	1	1	1	1	1	1	10	5' 60"
5' 61"	1	1	1	1	1	1	1	1	1	1	10	5' 61"
5' 62"	1	1	1	1	1	1	1	1	1	1	10	5' 62"
5' 63"	1	1	1	1	1	1	1	1	1	1	10	5' 63"
5' 64"	1	1	1	1	1	1	1	1	1	1	10	5' 64"
5' 65"	1	1	1	1	1	1	1	1	1	1	10	5' 65"
5' 66"	1	1	1	1	1	1	1	1	1	1	10	5' 66"
5' 67"	1	1	1	1	1	1	1	1	1	1	10	5' 67"
5' 68"	1	1	1	1	1	1	1	1	1	1	10	5' 68"
5' 69"	1	1	1	1	1	1	1	1	1	1	10	5' 69"
5' 70"	1	1	1	1	1	1	1	1	1	1	10	5' 70"
5' 71"	1	1	1	1	1	1	1	1	1	1	10	5' 71"
5' 72"	1	1	1	1	1	1	1	1	1	1	10	5' 72"
5' 73"	1	1	1	1	1	1	1	1	1	1	10	5' 73"
5' 74"	1	1	1	1	1	1	1	1	1	1	10	5' 74"
5' 75"	1	1	1	1	1	1	1	1	1	1	10	5' 75"
5' 76"	1	1	1	1	1	1	1	1	1	1	10	5' 76"
5' 77"	1	1	1	1	1	1	1	1	1	1	10	5' 77"
5' 78"	1	1	1	1	1	1	1	1	1	1	10	5' 78"
5' 79"	1	1	1	1	1	1	1	1	1	1	10	5' 79"
5' 80"	1	1	1	1	1	1	1	1	1	1	10	5' 80"
5' 81"	1	1	1	1	1	1	1	1	1	1	10	5' 81"
5' 82"	1	1	1	1	1	1	1	1	1	1	10	5' 82"
5' 83"	1	1	1	1	1	1	1	1	1	1	10	5' 83"
5' 84"	1	1	1	1	1	1	1	1	1	1	10	5' 84"
5' 85"	1	1	1	1	1	1	1	1	1	1	10	5' 85"
5' 86"	1	1	1	1	1	1	1	1	1	1	10	5' 86"
5' 87"	1	1	1	1	1	1	1	1	1	1	10	5' 87"
5' 88"	1	1	1	1	1	1	1	1	1	1	10	5' 88"
5' 89"	1	1	1	1	1	1	1	1	1	1	10	5' 89"
5' 90"	1	1	1	1	1	1	1	1	1	1	10	5' 90"
5' 91"	1	1	1	1	1	1	1	1	1	1	10	5' 91"
5' 92"	1	1	1	1	1	1	1	1	1	1	10	5' 92"
5' 93"	1	1	1	1	1	1	1	1	1	1	10	5' 93"
5' 94"	1	1	1	1	1	1	1	1	1	1	10	5' 94"
5' 95"	1	1	1	1	1	1	1	1	1	1	10	5' 95"
5' 96"	1	1	1	1	1	1	1	1	1	1	10	5' 96"
5' 97"	1	1	1	1	1	1	1	1	1	1	10	5' 97"
5' 98"	1	1	1	1	1	1	1	1	1	1	10	5' 98"
5' 99"	1	1	1	1	1	1	1	1	1	1	10	5' 99"
5' 100"	1	1	1	1	1	1	1	1	1	1	10	5' 100"

From the above table it is seen that the mean height of the sons of fathers of height 5' 0" is 5' 0", and that of the sons of fathers of height 5' 100" is 5' 100". The mean height of the sons of fathers of height 5' 50" is 5' 50". The mean height of the sons of fathers of height 5' 51" is 5' 51". The mean height of the sons of fathers of height 5' 52" is 5' 52". The mean height of the sons of fathers of height 5' 53" is 5' 53". The mean height of the sons of fathers of height 5' 54" is 5' 54". The mean height of the sons of fathers of height 5' 55" is 5' 55". The mean height of the sons of fathers of height 5' 56" is 5' 56". The mean height of the sons of fathers of height 5' 57" is 5' 57". The mean height of the sons of fathers of height 5' 58" is 5' 58". The mean height of the sons of fathers of height 5' 59" is 5' 59". The mean height of the sons of fathers of height 5' 60" is 5' 60". The mean height of the sons of fathers of height 5' 61" is 5' 61". The mean height of the sons of fathers of height 5' 62" is 5' 62". The mean height of the sons of fathers of height 5' 63" is 5' 63". The mean height of the sons of fathers of height 5' 64" is 5' 64". The mean height of the sons of fathers of height 5' 65" is 5' 65". The mean height of the sons of fathers of height 5' 66" is 5' 66". The mean height of the sons of fathers of height 5' 67" is 5' 67". The mean height of the sons of fathers of height 5' 68" is 5' 68". The mean height of the sons of fathers of height 5' 69" is 5' 69". The mean height of the sons of fathers of height 5' 70" is 5' 70". The mean height of the sons of fathers of height 5' 71" is 5' 71". The mean height of the sons of fathers of height 5' 72" is 5' 72". The mean height of the sons of fathers of height 5' 73" is 5' 73". The mean height of the sons of fathers of height 5' 74" is 5' 74". The mean height of the sons of fathers of height 5' 75" is 5' 75". The mean height of the sons of fathers of height 5' 76" is 5' 76". The mean height of the sons of fathers of height 5' 77" is 5' 77". The mean height of the sons of fathers of height 5' 78" is 5' 78". The mean height of the sons of fathers of height 5' 79" is 5' 79". The mean height of the sons of fathers of height 5' 80" is 5' 80

● *New Approaches*





How are traits inherited anyway?

