SBL100-Lecture

Introduction to genetic engineering part II

What is genetic engineering?

- Genetic engineering is deliberate addition, deletion, or intentional mutation of an organism’s DNA sequence to produce a desired result.

- Genetic engineering means manipulation or alteration of DNA sequences.

- Genes, mostly from other, often totally unrelated species are inserted in the genetic "master program".

- Genes from e.g. fish, scorpions, bacteria and viruses have been inserted into food plants in genetic engineering projects.

- Questions and concerns?

- How can apply our understanding of DNA to manipulate specific genes to produce desired traits?

- How can we use genetic engineering practice to address current problems facing humanity?

- What are moral and ethical problems related to its implementation?

Genetic engineering is so new and astonishing that people are still trying to figure out the pros and cons. (advantages and disadvantages).

Genetic engineering

Genetic

Genes

DNA

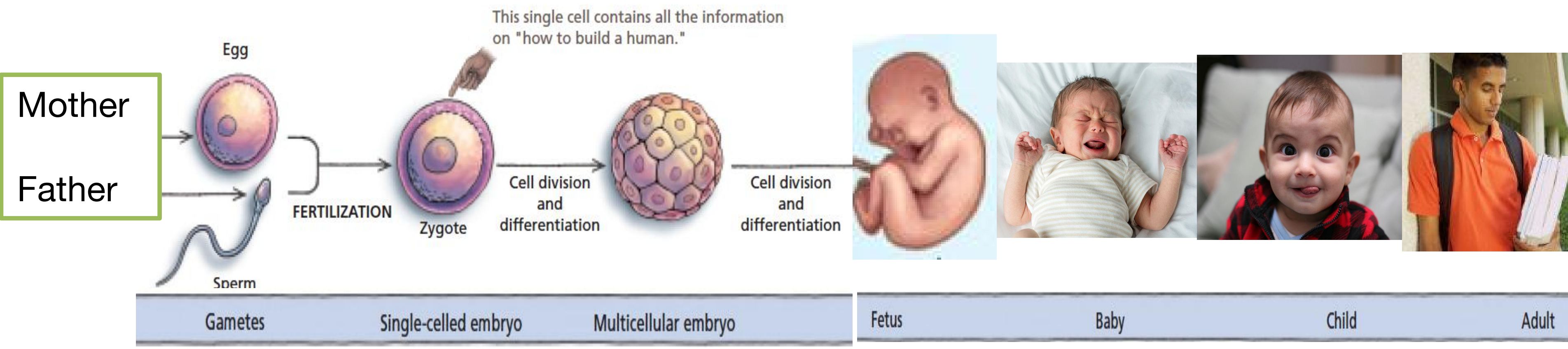
Genetics

The Inheritance of Traits

- Most of us recognize similarities and resemblances between our birth parents and among members of our family.

- In order to understand how our parents' traits were passed to us among siblings, we need a basic understanding of the human life cycle.

A life cycle is a description of the growth and reproduction of an individual.



- All human being are produced from the fusion of a single sperm cell produced by the male parent, and a single egg cell produced by the female parent.

- After the egg and sperm, or gametes , fuse at fertilization the resulting single, fertilized cell (the zygote) divides dozens of times to produce daughter cells .

- Each of these daughter cells also divides dozens of times.

- The cells in this resulting mass then differentiate into specialized cell types, which continue to divide and organize to produce the various structures of a developing human.

- We are made up of billions of individual cells, all of them the descendants of that first product of fertilization.

- Each normal sperm and egg contains information about "how to build a human."

- A large portion of that information is in the form of genes —segments of DNA that contain specific pieces of information about the traits of a human.

A Special Case—Identical Twins

•Occasionally two children of the same set of parents share 100% of their genes.

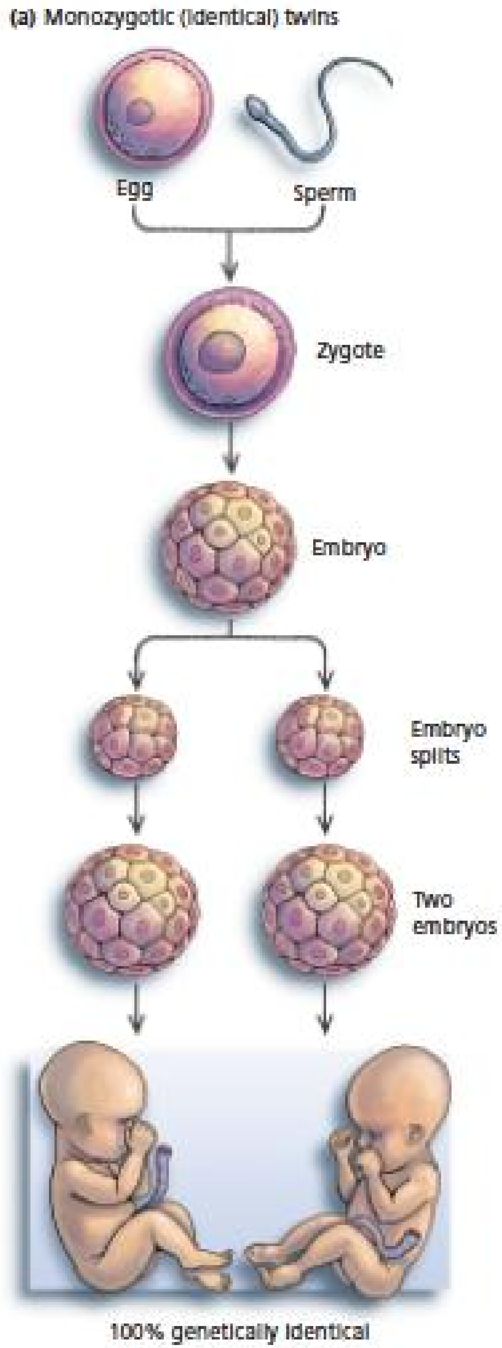
•Identical twins are the result of a single fertilization event—the fusion of one egg with one sperm giving rise to two offspring.

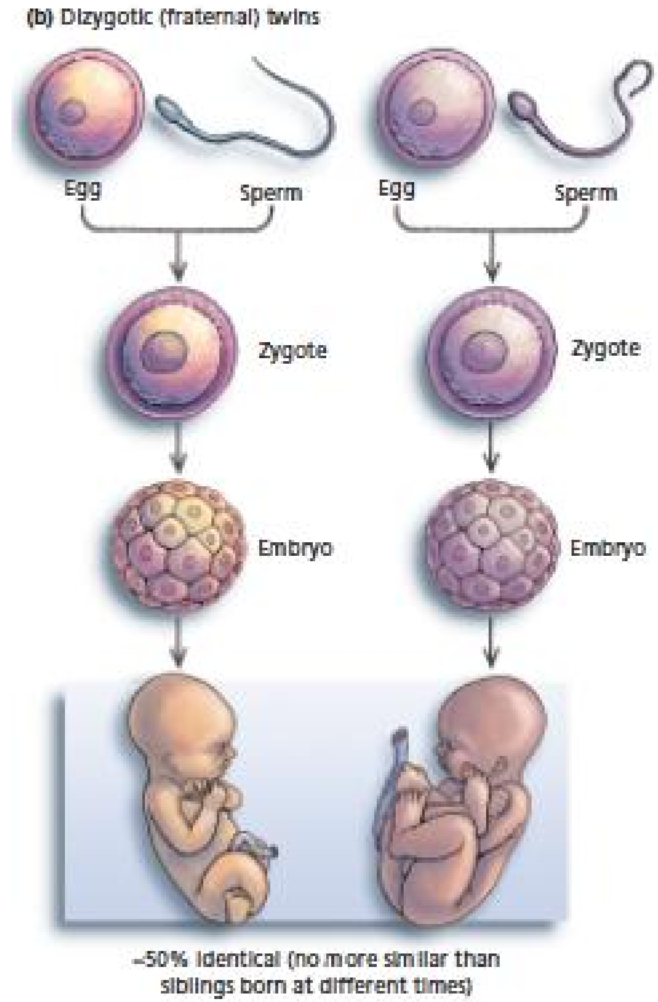
•after fertilization, the fertilized egg cell grows and divides, producing an embryo made up of many daughter cells containing the same genetic information.

•Monozygotic twinning occurs when cells in an embryo separate from each other. If this happens early in development, each cell or clump of cells can develop into a complete individual, yielding twins who carry identical genetic information.

•In the United States, approximately one person in 150 is an identical twin.

•Dizygotic twins occur when two separate eggs fuse with different sperm. The resulting embryos, which develop together, are genetically not similar.

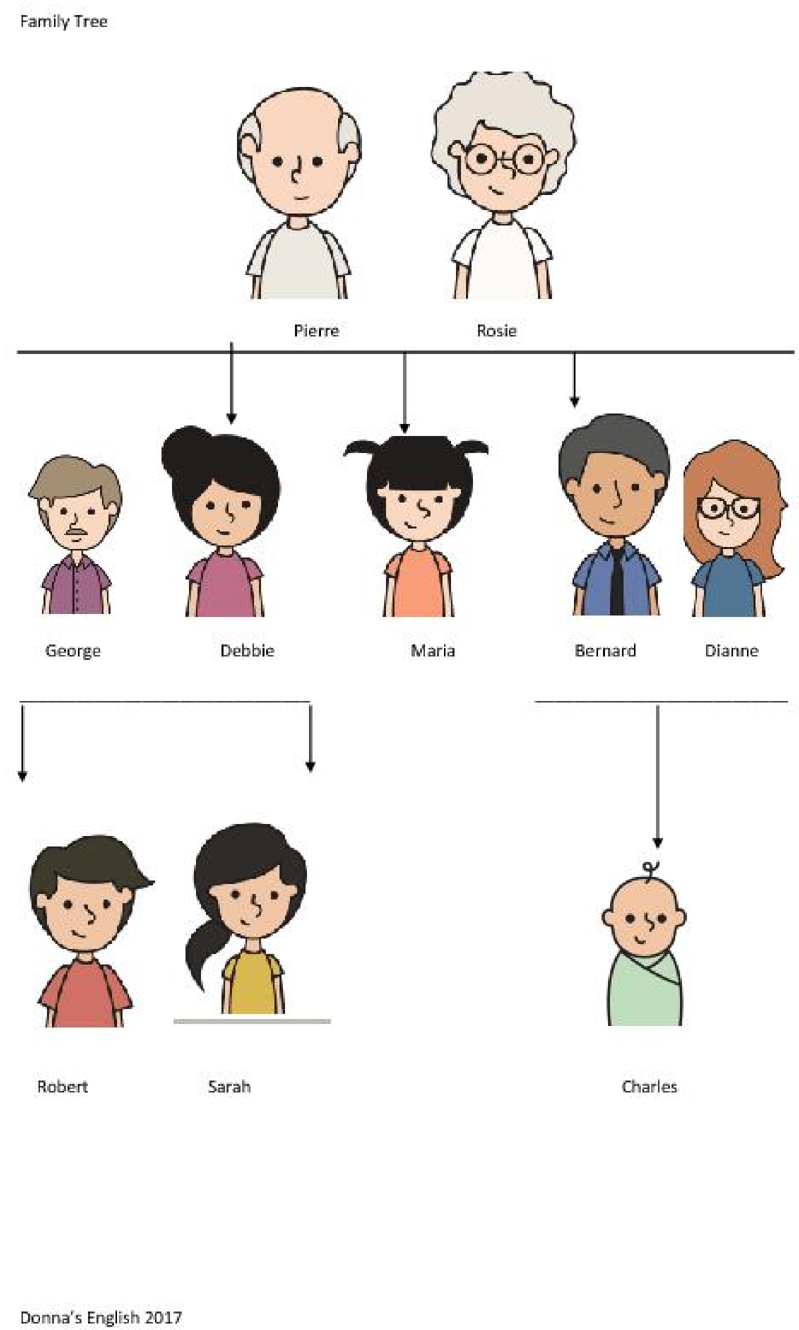




The formation of twins

(a) Monozygotic twins form when a newly fertilized embryo splits in two, resulting in two identical embryos.
(b) Dizygotic twins form when two different eggs combine with two different sperm cells, resulting in two embryos who are only as similar as siblings

Gene inheritence

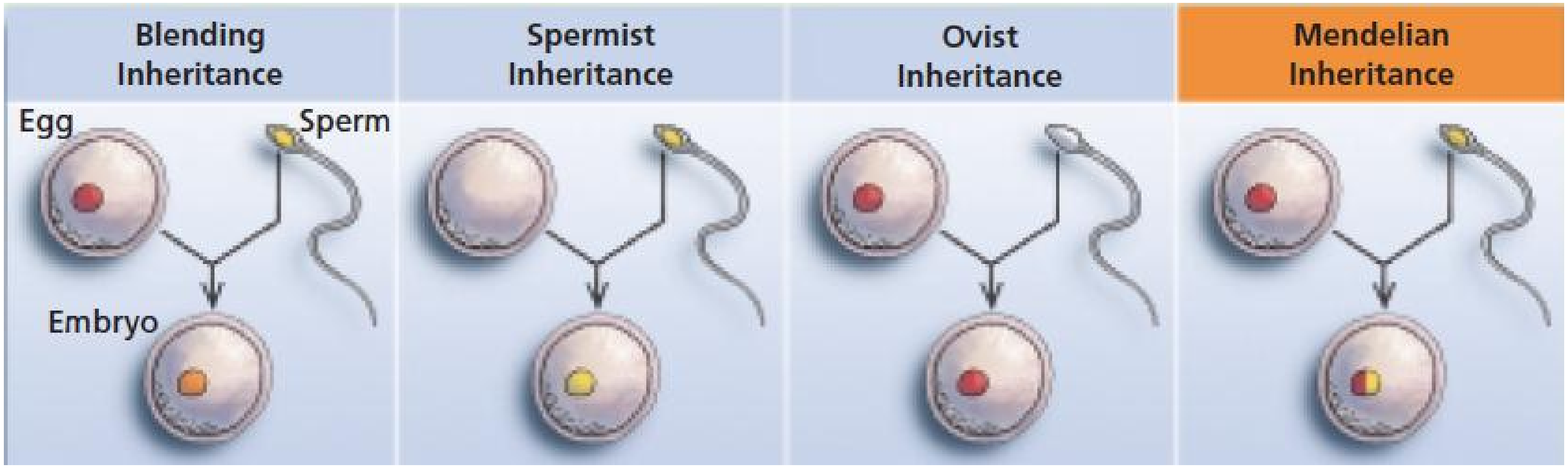


Gene inheritence

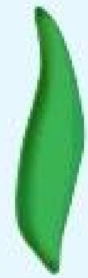
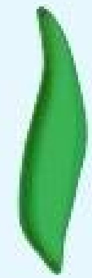
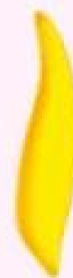
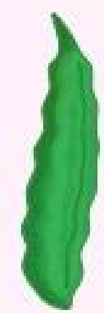
Gregor Mendel the first person to accurately describe the inheritance of genetic traits. Mendelian pattern of inheritance.

- Mendel was born in a poor family Austria in 1822.
- Being poor, he entered a monastery to obtain an education.
- Later, Mendel attended the University of Vienna; studied math and botany.
- but was unable to pass the examinations.
- Mendel returned to the monastery and began his
- Experimental studies of inheritance in garden peas.
- Mendel studied close to 30,000 pea plants over a 10- year period

able to control the types of mating that occurred by hand-pollinating the peas' flowers.



Mendel worked with seven characteristics of pea plants:
plant height, pod shape and color, seed shape and color, and flower position and color.

	Flower Colour	Plant Height	Seed Color	Seed Shape	Pod Colour	Pod Shape	Flower Position
Dominant Trait	 Purple	 Tall	 Yellow	 Round	 Green	 Inflated (full)	 Axial
Recessive Trait	 White	 Short	 Green	 Wrinkled	 Yellow	 Constricted (flat)	 Terminal

- Mendel’s patient, scientifically sound experiments showing that both parents contribute equal amounts of genetic information to their offspring went largely unnoticed.

- Mendel eventually gave up his genetic studies.

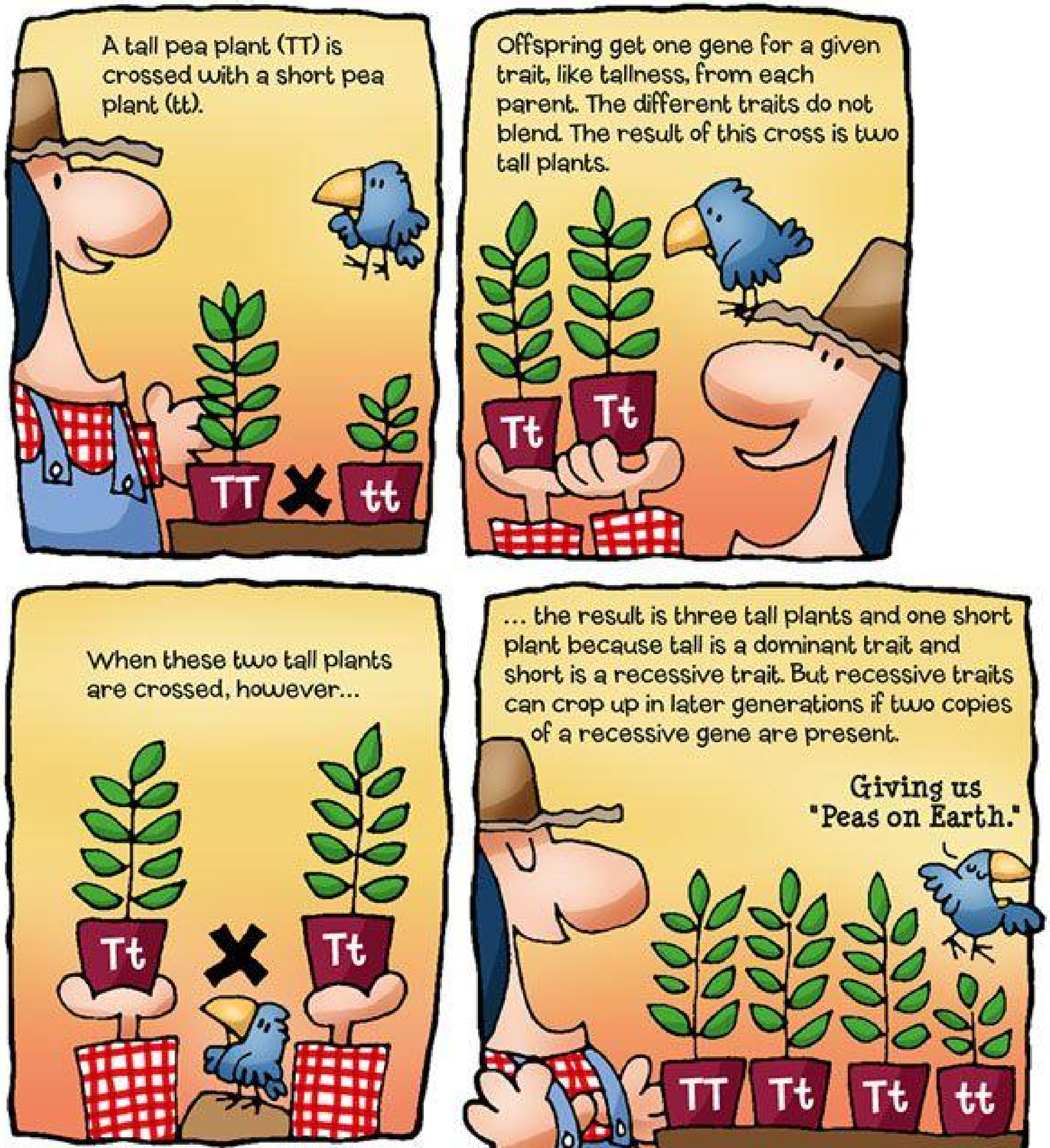
- Mendel started his focus on running monastery until his death in 1884.

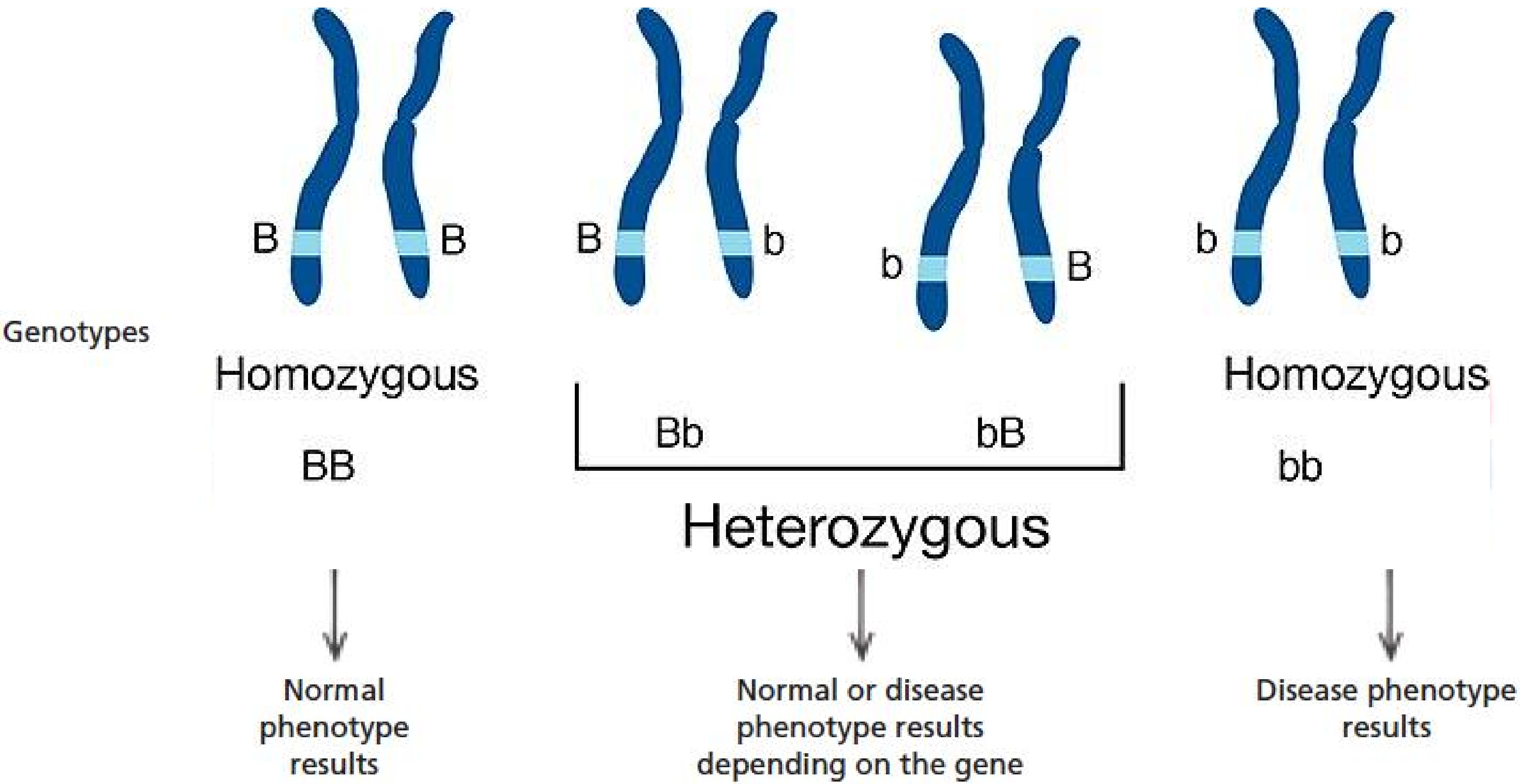
- His work was independently rediscovered by three scientists in 1900; only then did its significance to the new science of genetics become apparent.

- Mendelian traits identified in humans are the result of genes with mutant alleles that result in some type of disease or dysfunction.

- genetic composition of an individual is called genotype.

- the physical traits of an individual is called phenotype.

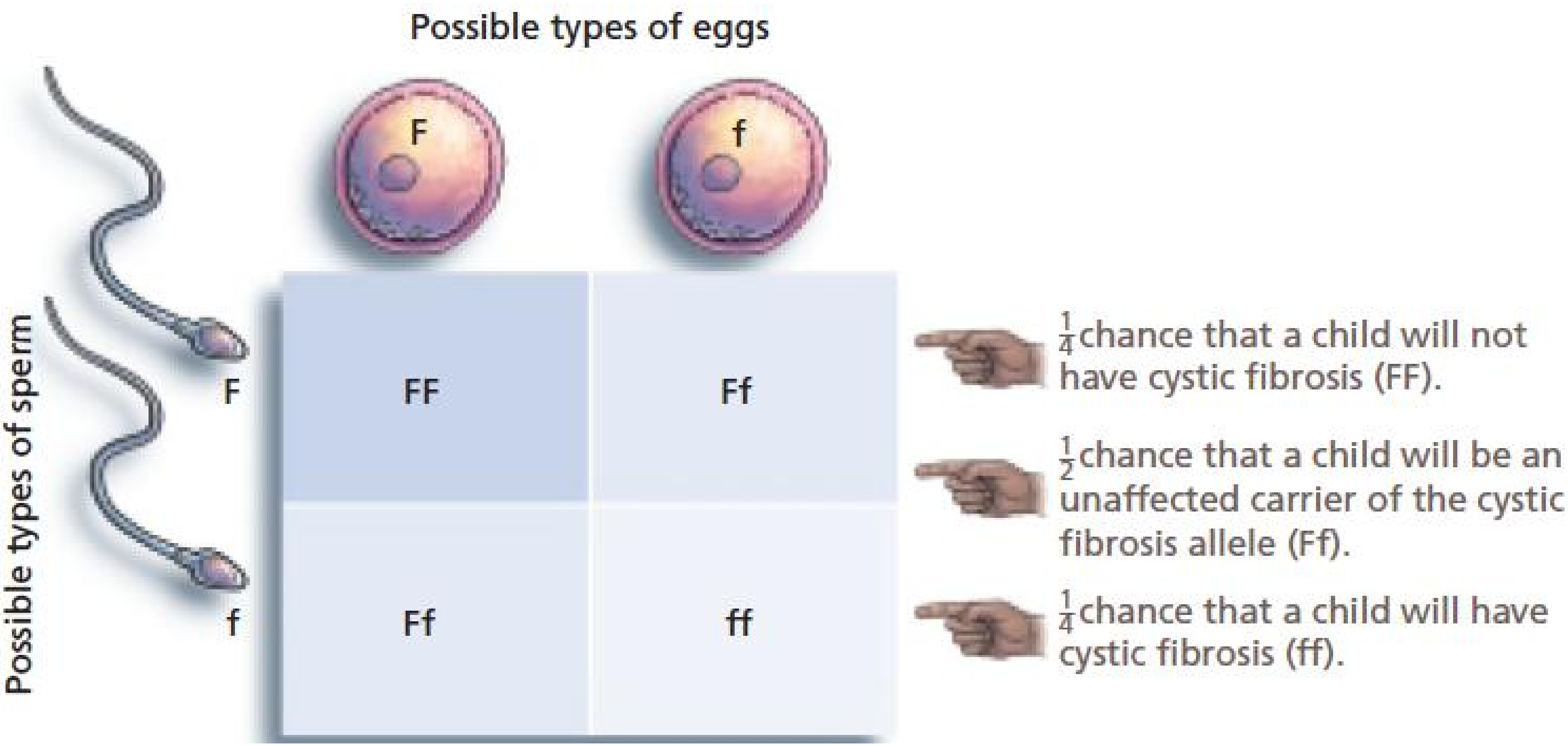

A tall pea plant (TT) is crossed with a short pea plant (tt).
TT
tt
Offspring get one gene for a given trait, like tallness, from each parent. The different traits do not blend. The result of this cross is two tall plants.
Tt
Tt
When these two tall plants are crossed, however...
Tt
Tt
... the result is three tall plants and one short plant because tall is a dominant trait and short is a recessive trait. But recessive traits can crop up in later generations if two copies of a recessive gene are present.
Giving us "Peas on Earth."
TT
Tt
Tt
tt


B
B
B
b
b
B
b
b
Genotypes
Homozygous
BB
Bb
bB
Heterozygous
Homozygous
bb
Normal phenotype results
Normal or disease phenotype results depending on the gene
Disease phenotype results

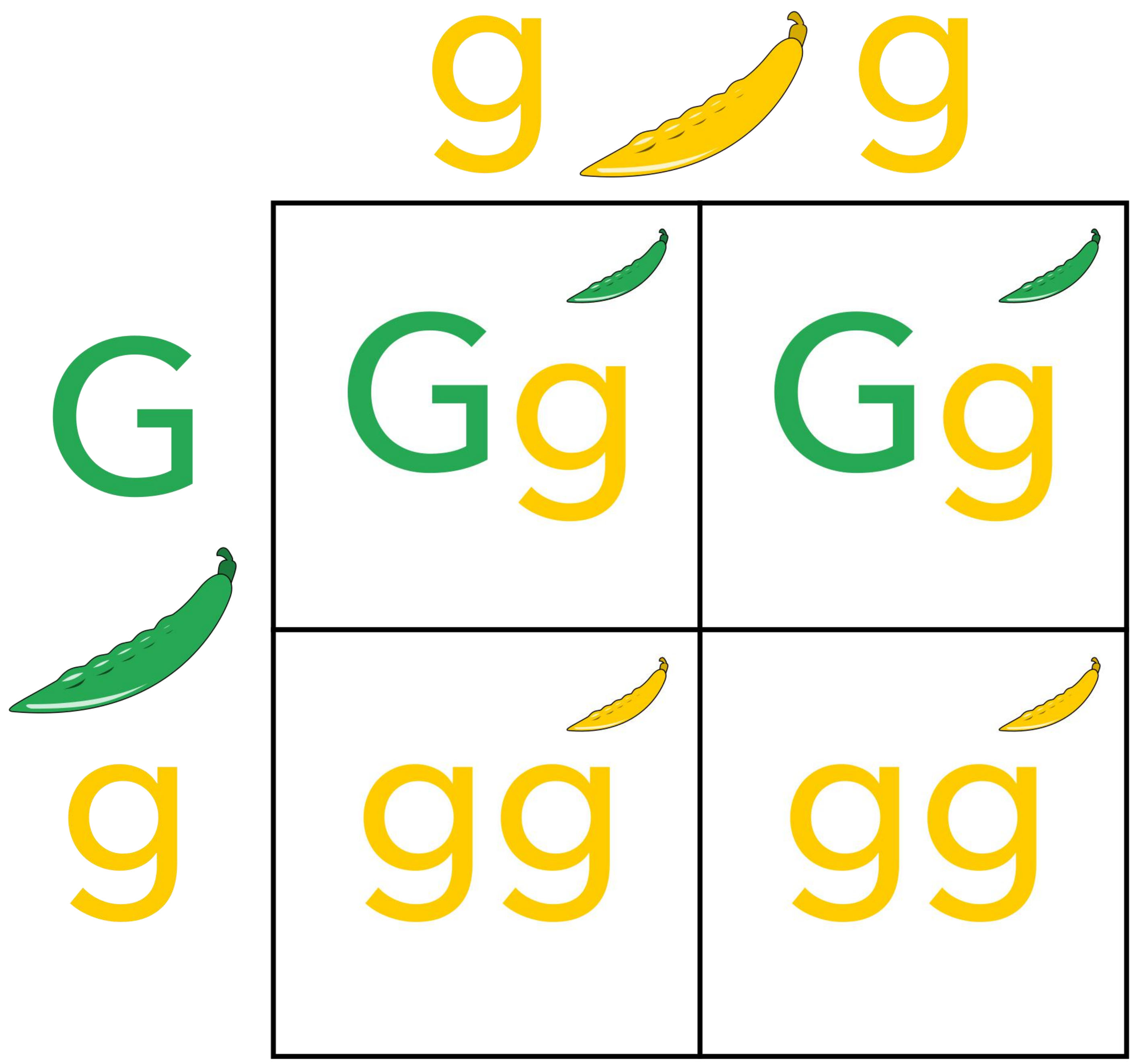
Punnett square is a tool to follow inheritance of the alleles for different types of genes .

A Punnett square is a table that lists the different kinds of sperm or eggs parents can produce relative to the gene or genes in question and then predicts the possible outcomes of a cross , or mating, between these parents.

Suppose letters F and f to represent the functional and dysfunctional allele.



every offspring of two carriers has a chance of being affected


g
g
G
g
Gg
Gg
gg
gg

ABO genotype in the offspring		ABO alleles inherited from the mother		
		A	B	O
ABO alleles inherited from the father	A	A	AB	A
	B	AB	B	B
	O	A	B	O

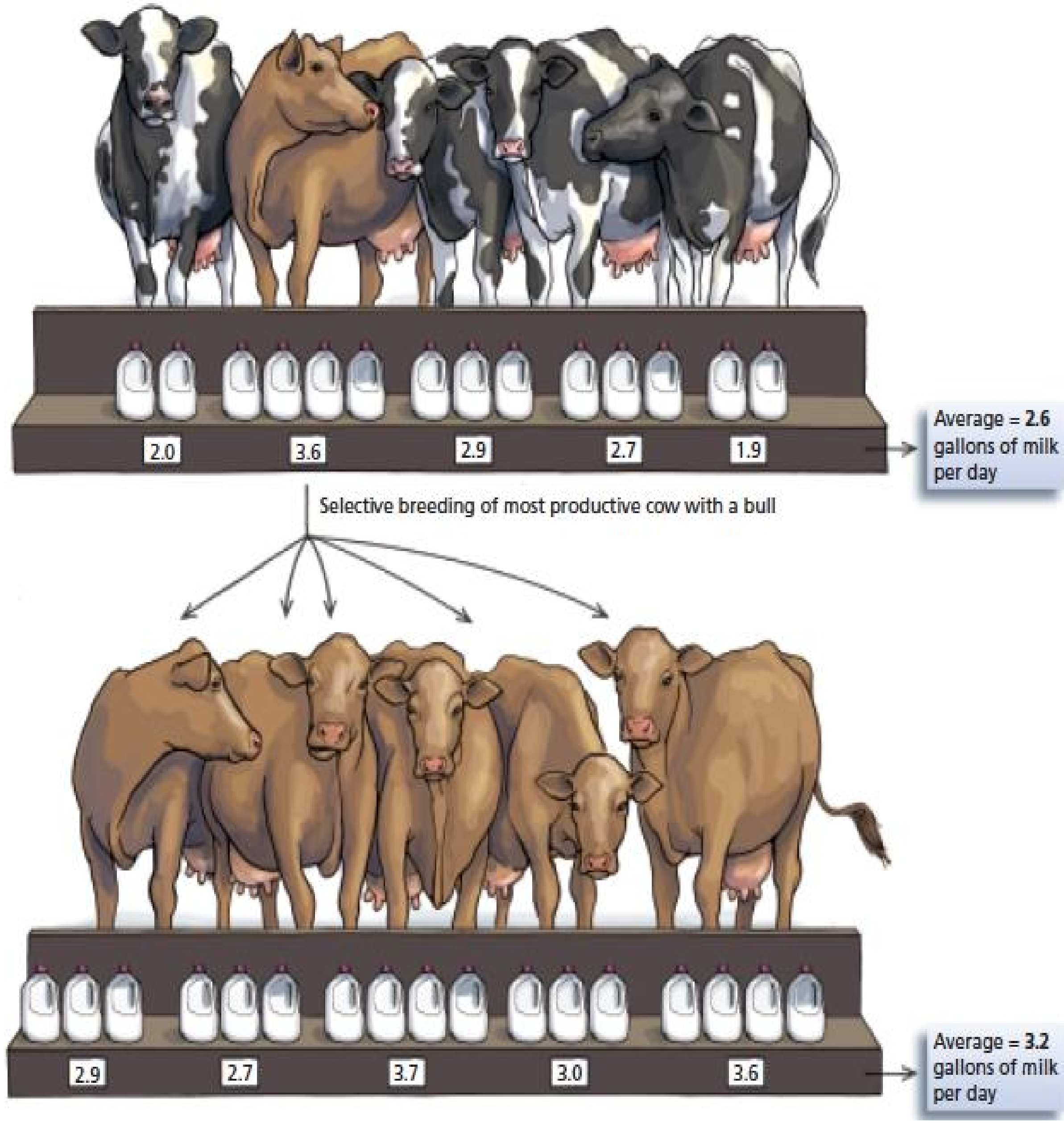
https://www.ncbi.nlm.nih.gov/books/NBK2267/

importance of genes in determining the value of quantitative traits.

e.g. farmers who wish to increase their dairy herd' s milk production

(a)Change the herd' s environment by changing the way the cows are reared, housed, and fed; or
(b)change the herd genetically by choosing only the offspring of the best milk producers for the next-generation herd.

The technique of controlling the reproduction of individual organisms to influence the phenotype of the next generation is known as artificial selection.



physical Analogy consider a pair of shoes and pair of chromosomes because the two shoes are similar in size, shape, and style, but are not exactly similar.

If 23 students are asked to take off their shoes and place them in a row across the front of the classroom, and they arrange their shoes so that the left shoe is on the left, and the right shoe is on the right, the students could then separate all of the left shoes from the right shoes, just as meiosis separates homologous chromosomes.

The students could continue making different combinations of left and right shoes for a very long time, because there are 2^{23}(over 8 million) possible ways to line up these pairs of shoes.

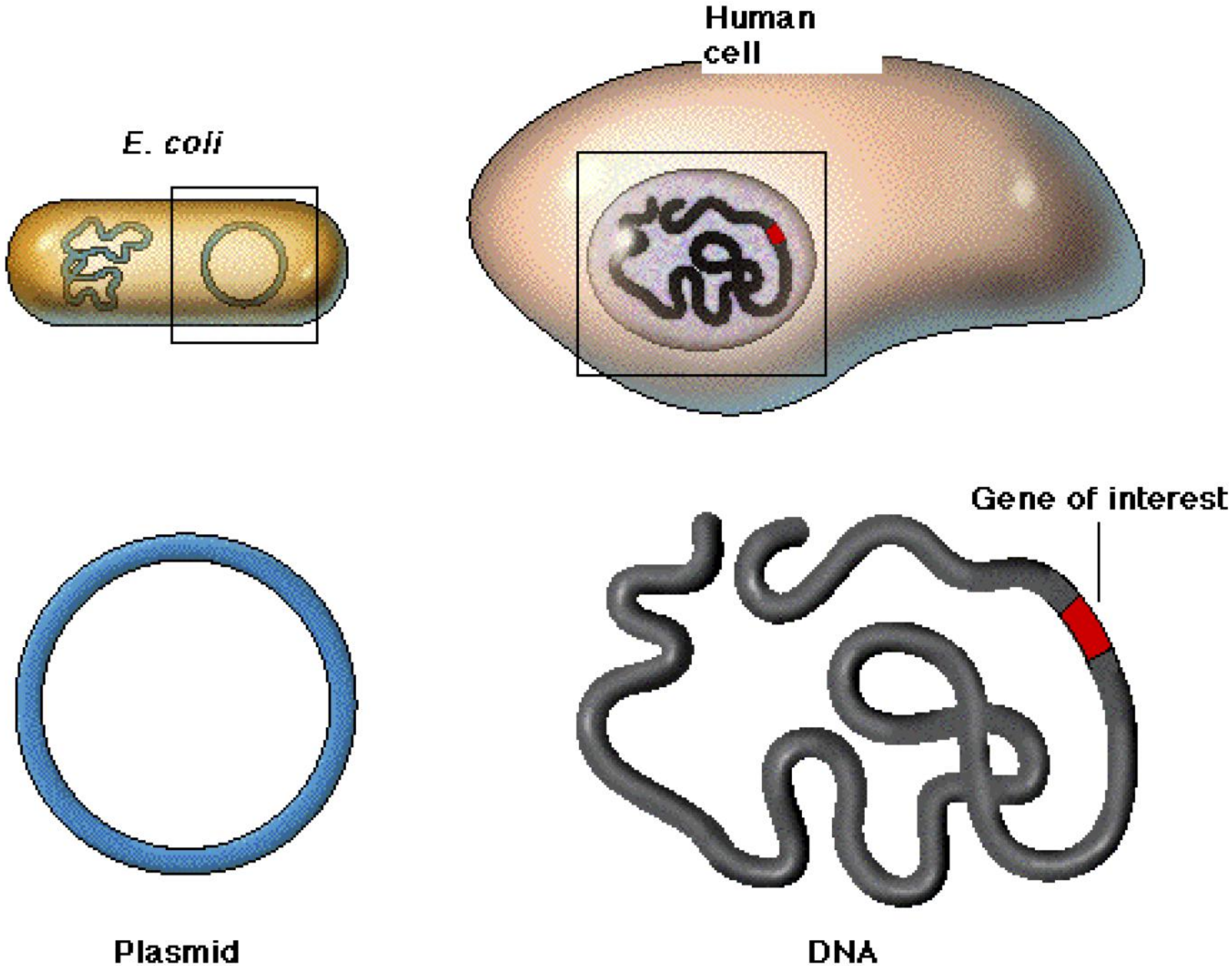
Same is true with chromosomes

2^{23}(over 8 million) genetically different gametes are possible.

1 x 8 million x 1 x 8 million = 64 trillion

Together our parents could have made over 64 trillion genetically different children, and we are only one of the possibilities.

How genetic modification can be used?



How genetic modification is used to produce insulin in bacteria?

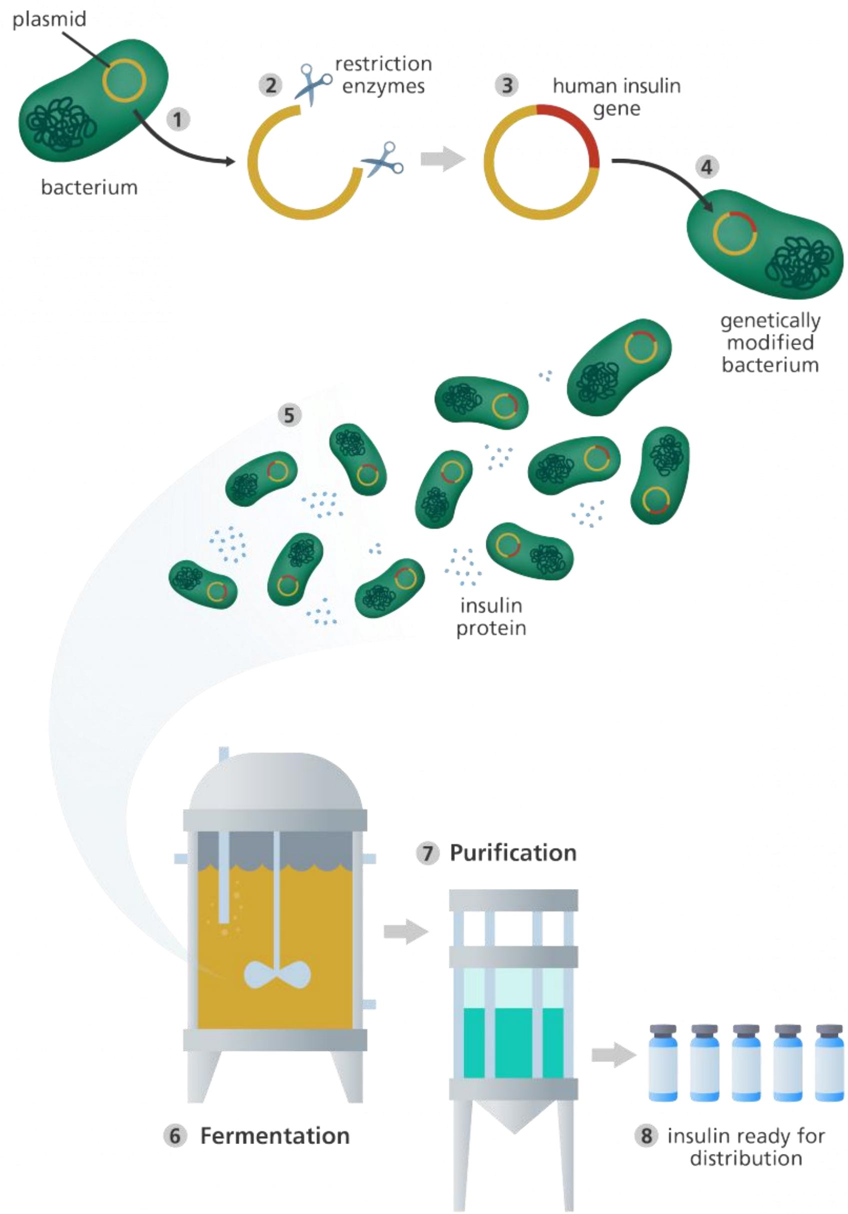
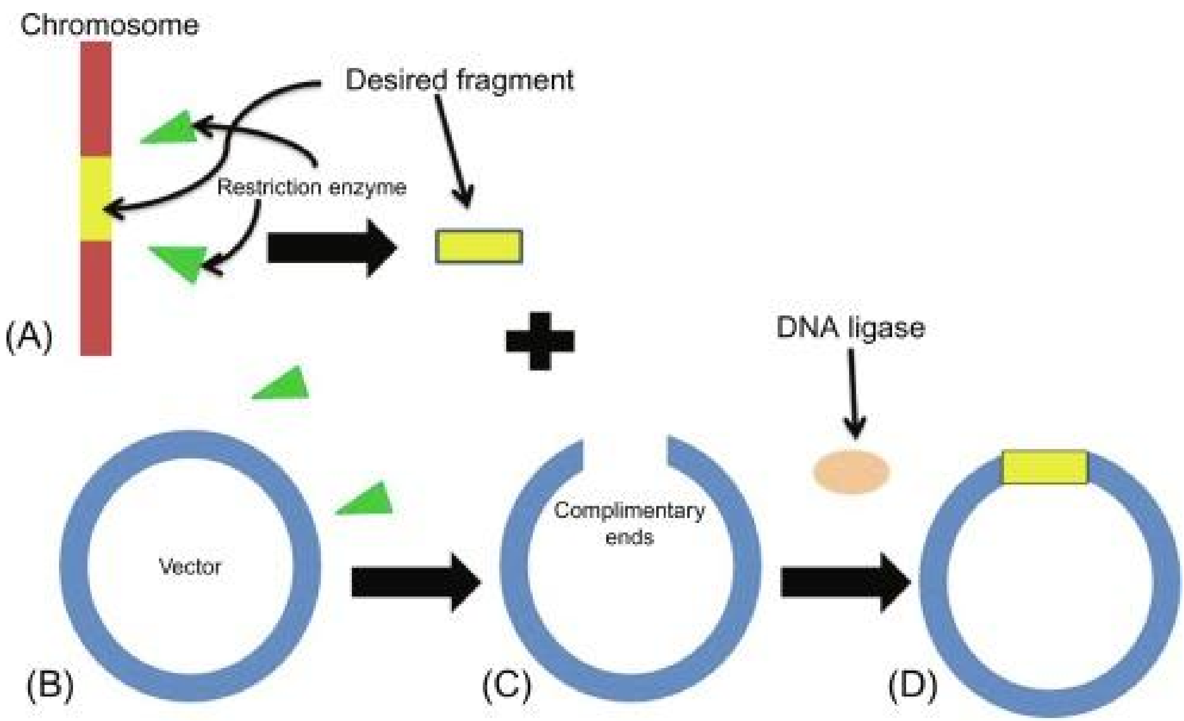


Image credit: Genome Research Limited



from Enosh Phillips,New and Future Developments in Microbial Biotechnology and Bioengineering, 2019

- Isolation of DNA fragment from donor organism.
- Insertion of isolated fragment into an appropriate vector system.
- Growth of the vector in the host.
- Expression of gene and purification of product.

Generalized view of the steps involved in genetic engineering.
(A) Using the specific restriction enzyme (RE) to cut the desired fragment containing the gene of interest from the chromosome.
(B) Taking an appropriate vector by cutting the same RE to create complementary ends.
(C). Mixing the desired gene (DG) fragment and RE-digested vector with ligase enzyme.
(D). Joining ligase with the DG and the vector, which is then multiplied and expressed in the appropriate host.

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