The Gene for Cellular Respiration—COX6B

We all assume that genes in different organisms differ enormously. But are plant genes very different from human genes? How are they organized?

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We might think that genes differ: when we think of a flower and a person, we might not see any similarities between the two. But in reality, the genes are not that different in their organization: the double helix and the components (different base pairs—A, G, C, T) are identical, except that they code for different information.

The second difference that we can observe is the number of genes in the genetic code of different species:

Table 20.1 Genome Sizes and Numbers of Genes

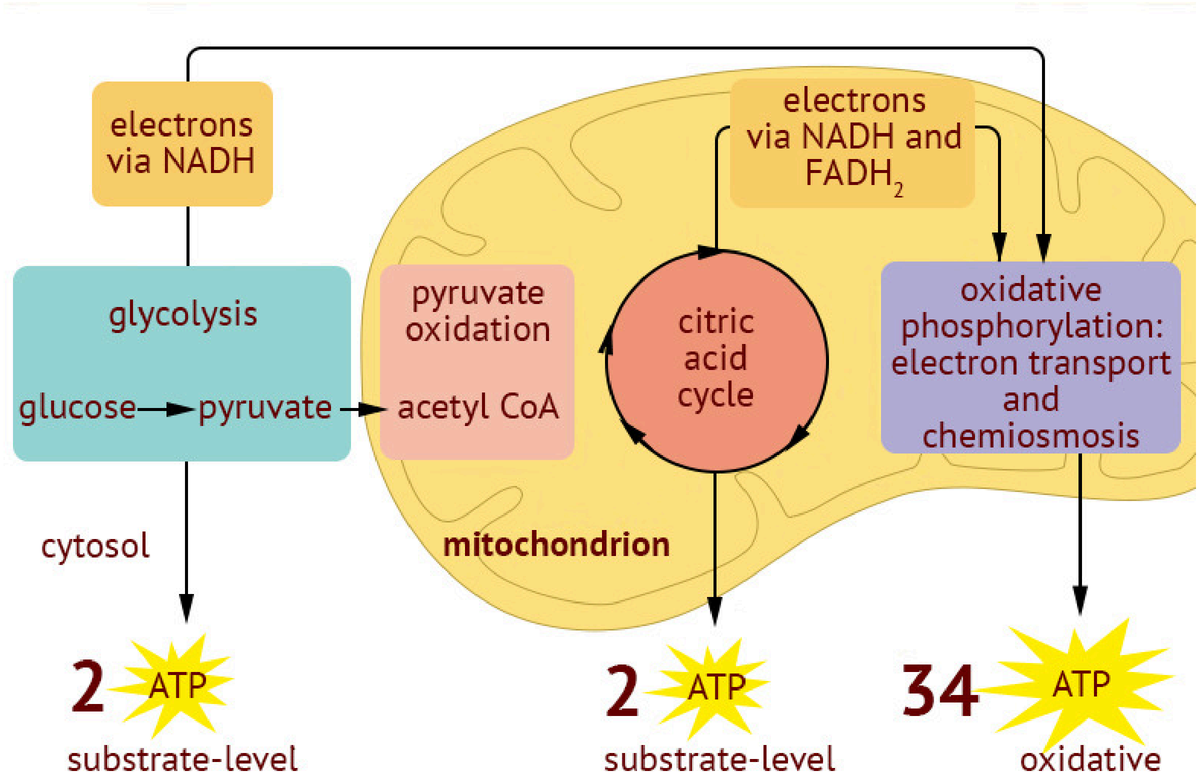
Organism	Genome Size	Estimated Number of Genes	Genes per Mb*
H. influenzae (bacterium)	1.8 Mb*	1,700	950
S. cerevisiae (yeast)	12 Mb	6,000	500
C. elegans (nematode)	97 Mb	19,000	200
A. thaliana (plant)	100 Mb	25,000	200
D. melanogaster (fruit fly)	180 Mb	13,000	100
H. sapiens (human)	3,200 Mb	30,000–40,000	10

*Mb = million base pairs

This table shows the differences in genome sizes and the number of genes that they have. Of course, the human will always have the most genes, having 46 chromosomes. The plant A. thaliana, in contrast, only has 10 chromosomes, so the number of genes will obviously be smaller.

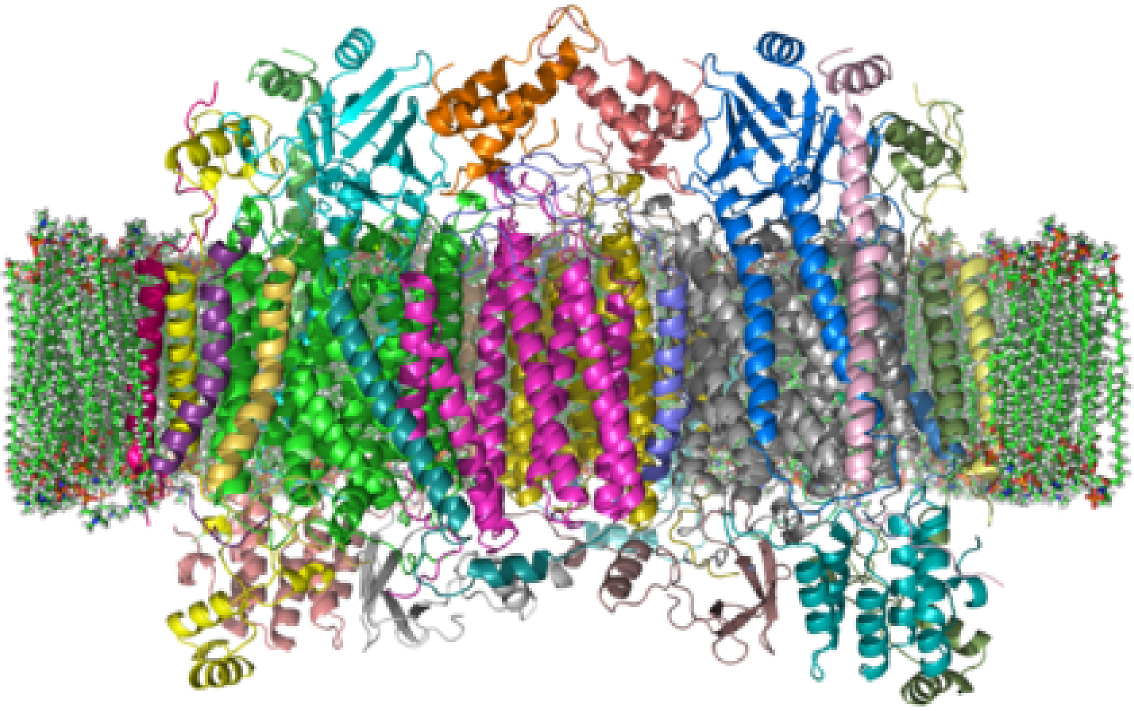
But the similarities between plants and humans are held in the **function** of the genes that are encoded: the most important one is cellular respiration.

Cellular respiration is a process that will allow, in an aerobic environment, to convert oxygen and sugars to CO2, water but also ATP: the molecule that carries all the energy that is used in the cells of humans, plants, and all the other organisms in order to function.



Indeed, ATP is produced in the mitochondria: the organelle that will integrate glucose (so sugars), into a series of chemical reactions, together with water, to yield the ATP molecule.

The most important process that happens is oxidative phosphorylation: this is the step that allows the most ATP production. The process is allowed mainly because of a very important protein: the Cytochrome C Oxidase complex, also called COX. This complex is composed of the base, plus 12 adjacent proteins, one of them being the 6B protein (see below how it looks both in plants and humans).



The COX protein is always present in the mitochondria, and ATP production would not be possible without it.

The interesting phenomenon that we can observe, however, is the presence of the gene that encodes the COX6B protein in both humans and plants:

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Human Cytochrome C Oxidase subunit 6B: TGTCAGAAGGCAATGACCGCTAA
Plant Cytochrome C Oxidase subunit 6B:  TATCACAGATGTGTAGCTGCTAA

AGGAGGCGATATCTCTGTGTGCGAATGGTACCAGCGTGTGTACCAGTCCCT
GGGTGATGATGCTCCAGAATGCGATAAGTTTGCAAAGTTTTATCGATCTCT

CTGCCCCACATCCTGGGTCACAGACTGGGATGAGCAACGGGCTGAAGGCAC
TTGCCCCAGCGAATGGGTTGATAGGTGGAACGAGCAAAGAGAAAATGGAAC

GTTTCCCGGGAAGAT
ATTCCCTGGTCCTCT
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(*Small side explanation: this gene encodes the production of ATP from oxygen and sugar in the third step of cellular respiration—in humans, this is the only cellular respiration process. However, plants also “breathe” oxygen; in parallel to photosynthesis, they also absorb O_2, and not only CO_2. Indeed, CO_2 is used for photosynthesis to produce the sugar that will later be used for cellular respiration. But the phenomenon of the intake of CO_2 and output of O_2 from photosynthesis is much more prominent than the small intake of O_2 for respiration, that is as such ignored).

We can see in this photo the exact sequence of the COX6B gene in humans and in the A. thaliana plant that we talked about earlier. The red letters show the similarities between the two genomes. As you can see, they are quite similar! As such, we can assume these are the genes that encode for their exact function, and the differences that occur are the ones that change along with the evolution of the two species. As such, plants and humans are not so different after all!

Sources

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