Genetic mechanisms of evolution

According to the synthetic theory, these include: mutation, gene duplication, selection and gene drift.

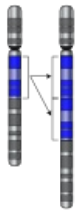
Mutation

🔎 *For more information see Mutation.*

- we distinguish between ***tolerated*** mutations, which can be *advantageous or neutral* for their bearer, and ***forbidden'***, unfavorable *mutations. Forbidden mutations are counteracted by selection, because they reduce the ability of their bearer to reproduce. An extreme case of such mutations are lethal mutations. Tolerated mutations are not selected, in the case of beneficial mutations they may be preferred. This is because it brings its bearer an evolutionary advantage over other individuals without this beneficial mutation.*

Gene duplications

- most mutations have negative consequences for their bearer, as they result in the loss of the original function of the gene
- by mutating only the original genes, the original function can be improved at most
- gene duplication changes prohibited mutations to tolerated ones → the original function is preserved + a new function is created (by mutation in duplication)
- duplication mechanisms: uneven crossing-over, uneven exchange between sister chromatids, slippage of DNA polymerase
- during evolution, the entire genome is enlarged - polyploidization, tandem duplication (rRNA, Hb, Ig, haptoglobin)



Gene duplication

Selection

🔎 *For more information see Selection.*

- the classical evolutionary mechanism of Darwinism
- selection types:

1. ***normalizing selection*** - preservation of the current state of the population by excluding deviations from the norm (e.g. hereditary diseases)
2. ***balancing selection*** - maintains a certain degree of polymorphism in the population, e.g. preference of heterozygotes
3. ***directional selection*** - applied when external conditions change, when the best adapted phenotype survives. This is natural selection in the sense of classical Darwinism. An example can be the industrial melanism of some insects.

- **Haldane's dilemma:** selection reduces the number of offspring. When selecting against more diverse genes, these losses are already negligible, which would lead to the extinction of the population. However, if selection were not so strong as to lead to extinction, evolution would proceed much more slowly than it actually does.
- **Fisher's Fundamental Theorem** = "The rate of increase in relative fertility of any organism at any time is equal to the genetic variance of relative fertility at that time." Better: "The greater the genetic variability that can be acted upon by selection toward higher fitness, the greater the progress in fitness." or "The rate of change of a trait depends exclusively on the additive genetic variance in the fitness of that trait." (1930) A number of theorists object to a purely linear model of the inheritance of relative fertility.

Gene Drift

🔎 *For more information see Gene Drift.*

- random fluctuations in gene frequencies are used in small populations, leading to the fixation of one allele
- mutation and migration work against drift
- gene drift is very strong in very small populations – '**funnel effect**'
- similarly applies the ***founder effect'*** *- the creation of a new population from a very small group of individuals (for example, the frequency of porphyria among the Caucasian population of the Republic of South Africa)*
- **selection drift** - fluctuations in the intensity of selection

Links

- ws: Genetické mechanismy evoluce

References