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Genetics: *"branch of biology concerned with the study of genes, genetic variation, and heredity in organisms"*

Epigenetics: *"study of heritable phenotype changes that do not involve alterations in the DNA sequence"*

From Wikipedia:

"...

Ultimate causation explains traits in terms of evolutionary forces acting on them.

..."

"...

Proximate causation explains biological function in terms of immediate physiological or environmental factors

..."

From Wikipedia:

"... Example: female animals often display preferences among male display traits, such as song. An ultimate explanation based on sexual selection states that females who display preferences have more vigorous or more attractive male offspring. ..."

"... Example: a female animal chooses to mate with a particular male during a mate choice trial. A possible proximate explanation states that one male produced a more intense signal, leading to elevated hormone levels in the female producing copulatory behaviour. Although the behavior in these two examples is the same, the explanations are based on different sets of factors incorporating evolutionary versus physiological factors. ..."

What is the evidence for evolution?

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Paleontology
Comparative Biology
Experimental Evolution
Direct observation of quickly evolving pathogens

DNA and RNA Evidence

Why is evolution relevant to medicine?

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I. Human evolution can be used to explain/understand disease.

Tracking a moving fitness optimum:

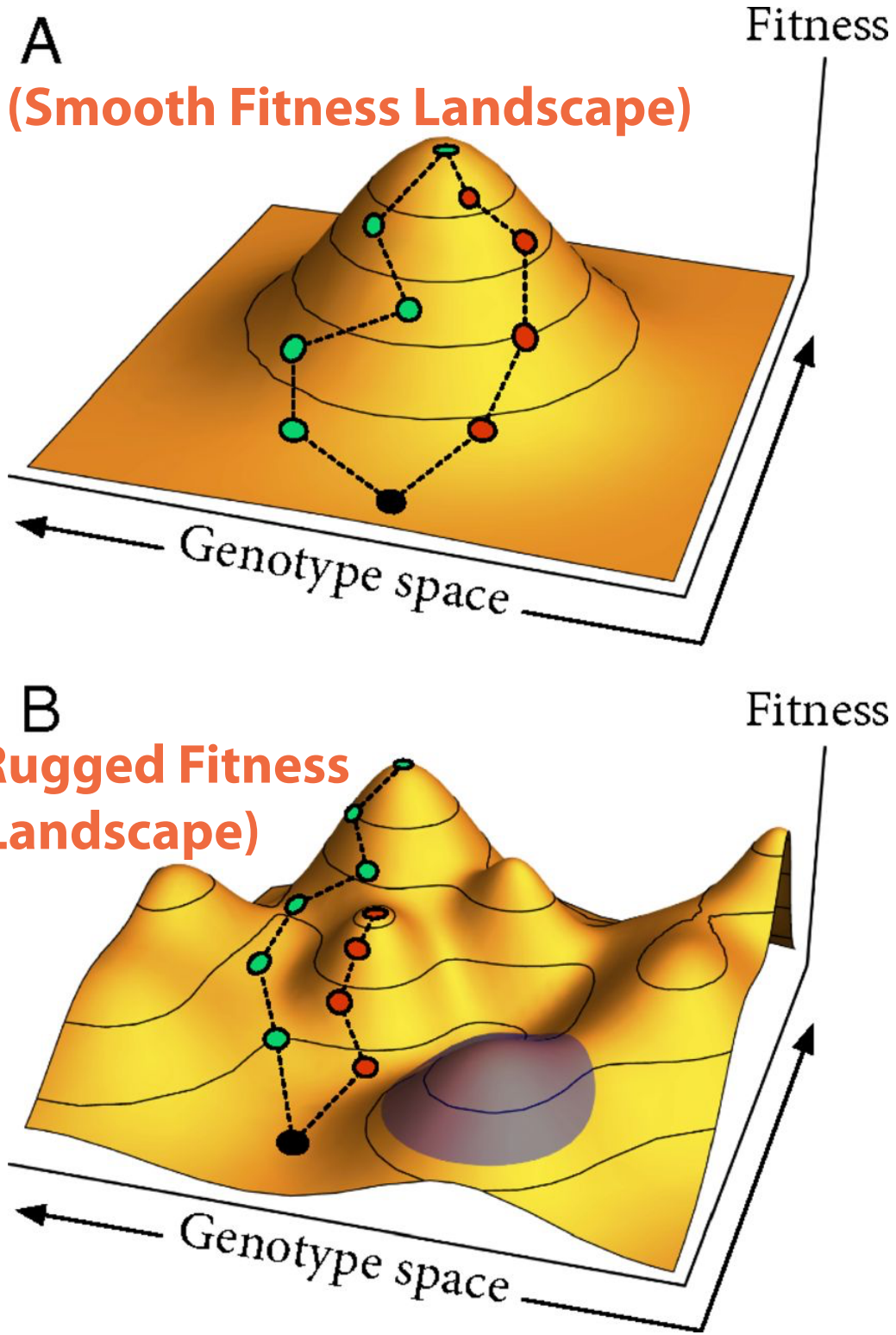
Human evolution is slow relative to the rates at which some aspects of environment (e.g., culture, human pathogens) change. Therefore, human genotypes may not be optimized for fitness.

"Ruggedness" of fitness landscape means that human genotypes may not be at global optimum (even if optimum is not changing over time).

Do we expect population to be centered on global peak of fitness landscape?

(note that population can be envisioned as a "cloud" of points on a fitness landscape.

Why a "cloud" ?)



Modified from Figure 1 of PNAS June 16, 2015 112 (24) 7345-7346

Movement of a population on a fitness landscape depends on ...

the fitness landscape (i.e., genotype-phenotype mapping)

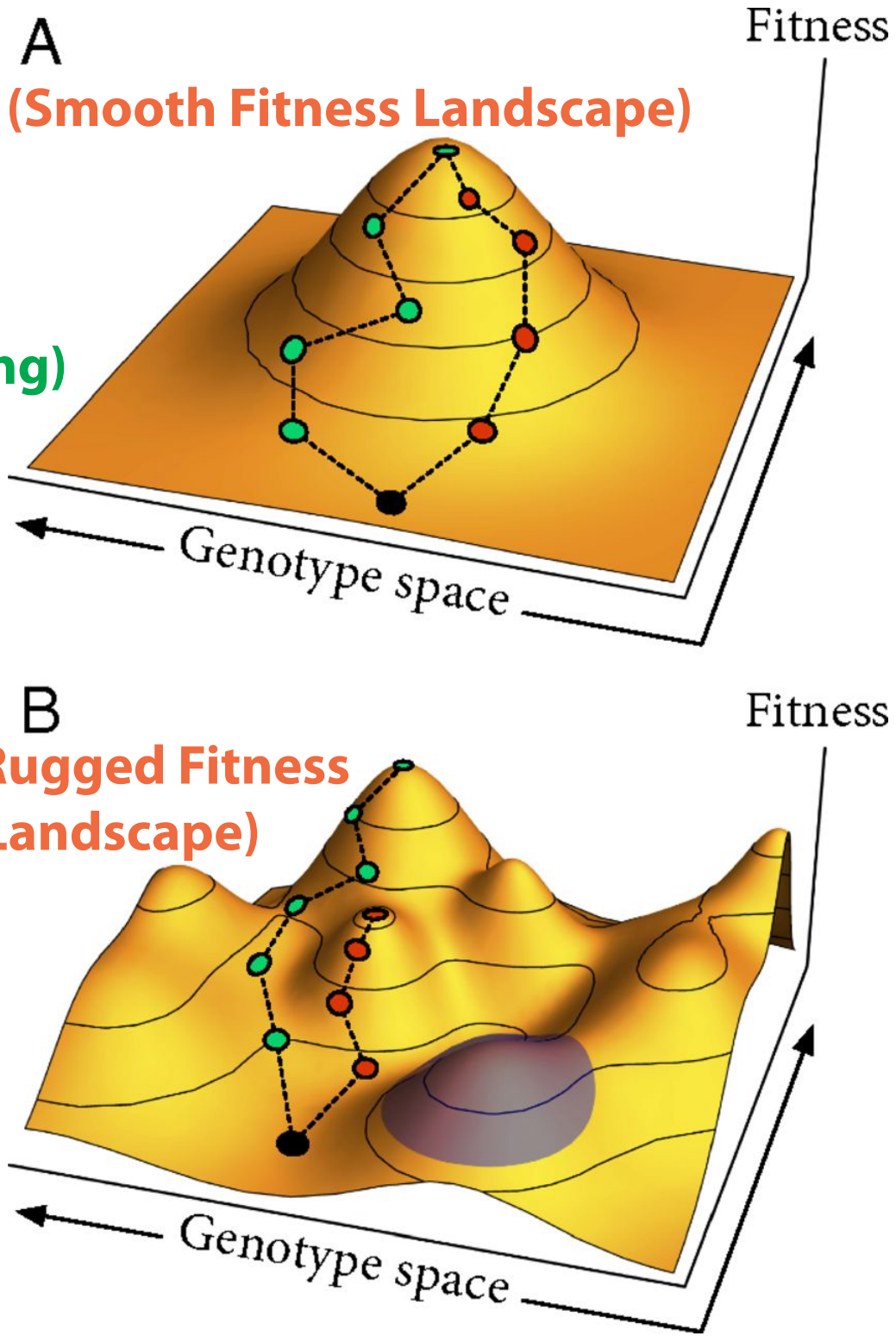
stability over time of the fitness landscape (do optima change?)

population size (Why?)

rate of mutation (Why?)

mutational spectrum (e.g., point mutation, duplication, insertion, deletion, "complex" mutation)

recombination
population structure
etc.



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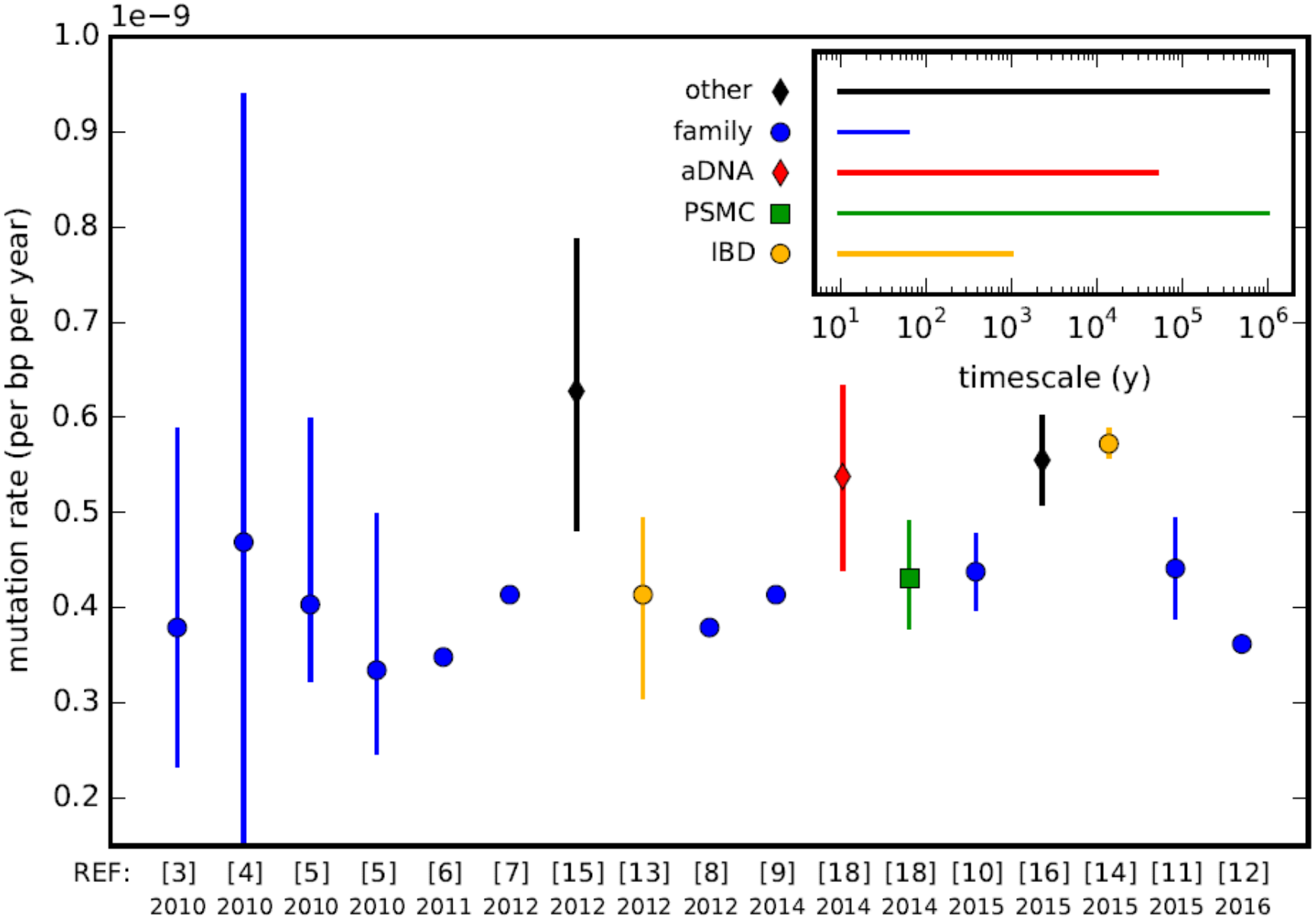
Human Point Mutation Rates are on the order of 10^{-8} per DNA position per generation.

This seems pretty low (at least to me). Could the rates be higher?



from: https://en.wikipedia.org/wiki/Mutation_rate

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Yes.

"Mutator" Alleles have been found in many species.

Some human diseases lead to higher somatic mutation rates (e.g., Xeroderma pigmentosum), although I am unclear whether these have also been shown to lead to higher germline mutation rates.

Also, candidate human genetic variation has been identified that might cause higher mutation rates but that might not necessarily directly cause disease.

(see https://journals.plos.org/plosgenetics/article?id=10.1371/journal.pgen.1006549)

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Yes (or at least "almost certainly yes").

Antimutator alleles have been found in some species (note that it is difficult to devise genetic screens for antimutator alleles)

Low mutation rates can slow adaptation but it is not necessarily the case that observed mutation rates represent evolutionarily optimal mutation rates ...

Are evolutionary rates higher in small or large populations?

Also, who is this?

Also, she has a Ph.D. Where from?

Are evolutionary rates higher in small or large populations?

Answer: Probably higher in small populations ... But, adaptation from existing genetic variation may be higher in large populations (since there is more of it).

Also, who is this?

Answer: Dr. Tomoko Ohta (author of "nearly neutral theory")

Also, she has a Ph.D. Where from?

Answer: N.C. State

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High fitness does not necessarily mean low rates of disease:

Trade-Off between fertility and viability,

reproductive value versus age.

Why is evolution relevant to medicine?

II. Evolutionary understanding can be used to combat disease.

Antibiotic resistance

Cancer

Flu

HIV

Tracking and characterizing epidemics with genetic data

Genetic Pest Management