Mutations, Substitutions, & Polymorphisms

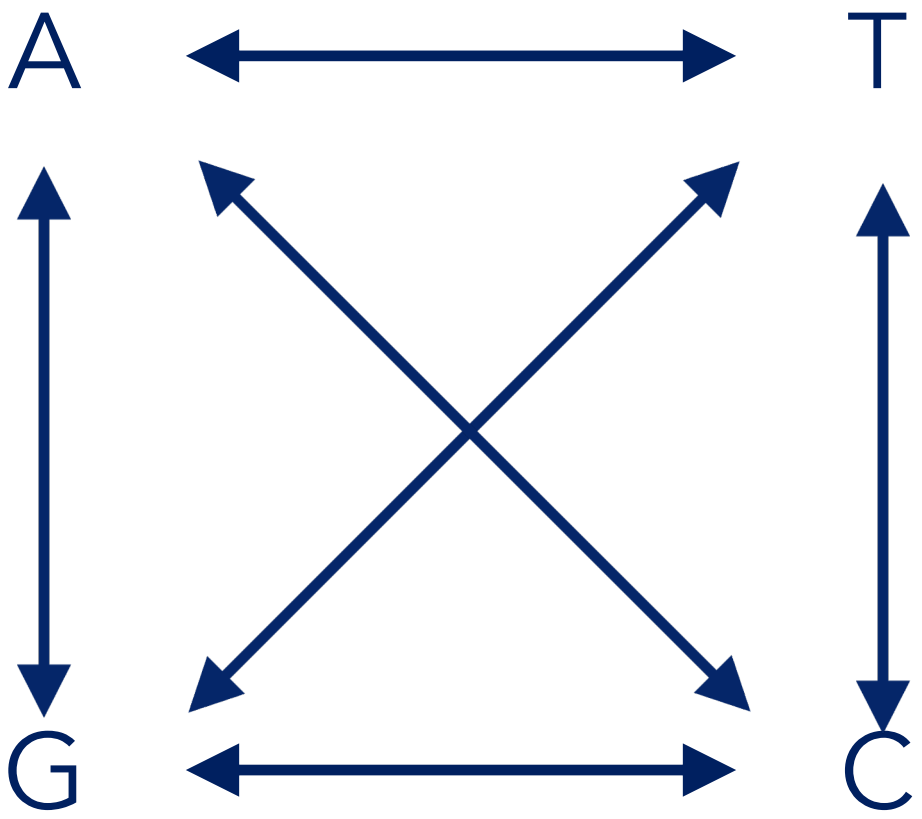
BIOL 435/535: Bioinformatics

Feb 8, 2022

Some terminology

- Mutation: A inherited change in nucleotide sequence (rate = μ)
- Substitution: A mutational change that has replaced an ancestral nucleotide (rate = d or K)
- Polymorphism: A site in the genome that has more than one allele in the population (rate = π or θ)

Mutations – Inherited changes in nucleotide sequence



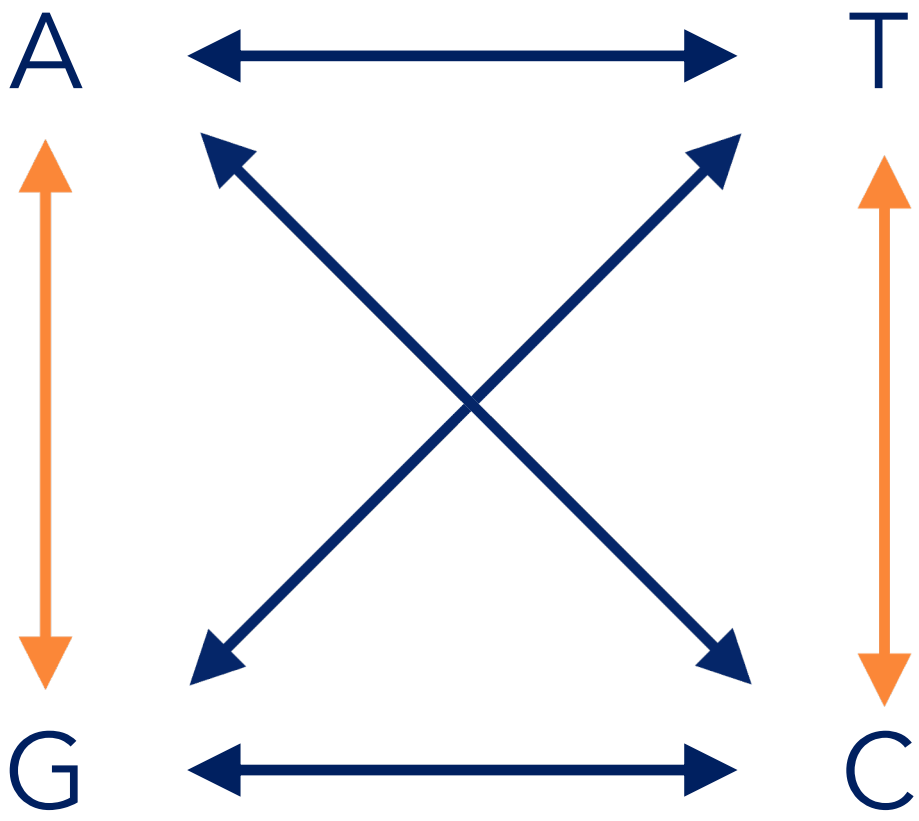
Mutations – Inherited changes in nucleotide sequence

Transitions

purine-to-purine

pyrimidine-to-pyrimidine

COMMON



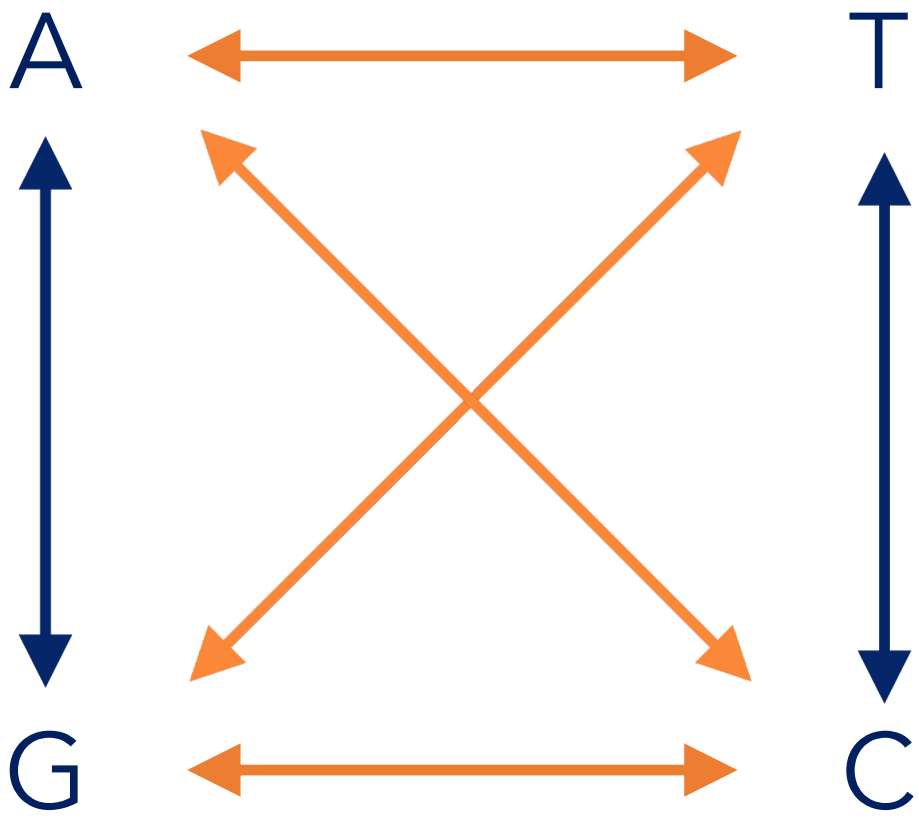
Mutations – Inherited changes in nucleotide sequence

Transversions:

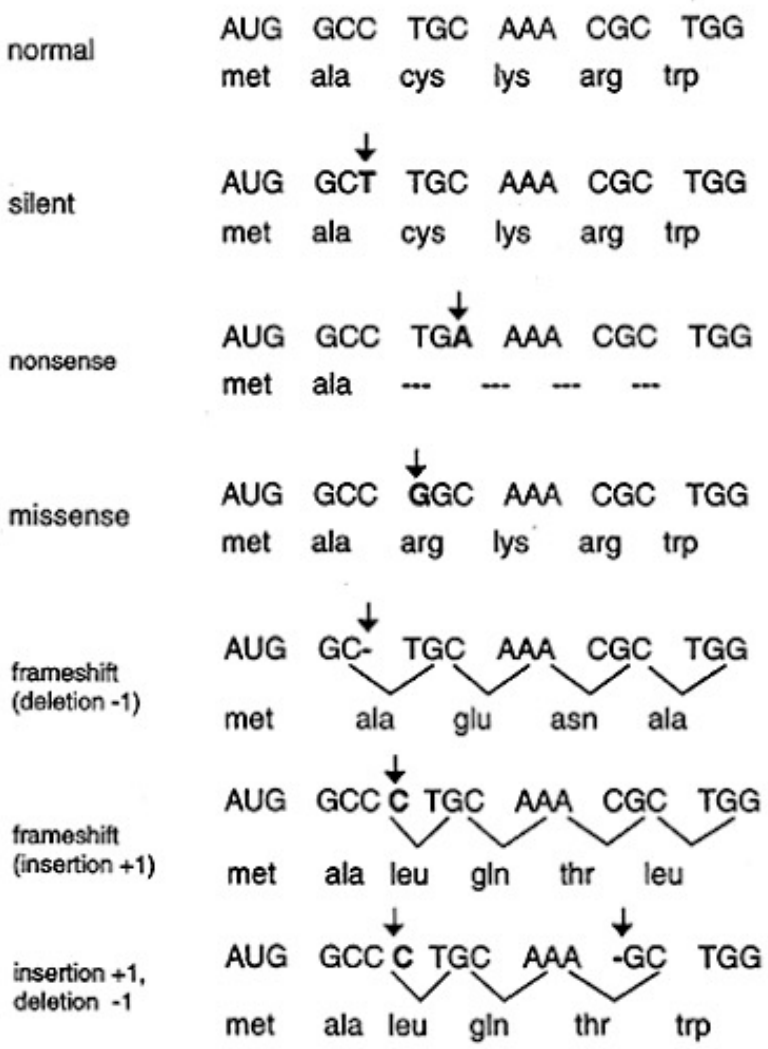
purine-to-pyrimidine

pyrimidine-to-purine

RARE



Mutations – Inherited changes in nucleotide sequence



AKA synonymous

AKA nonsynonymous

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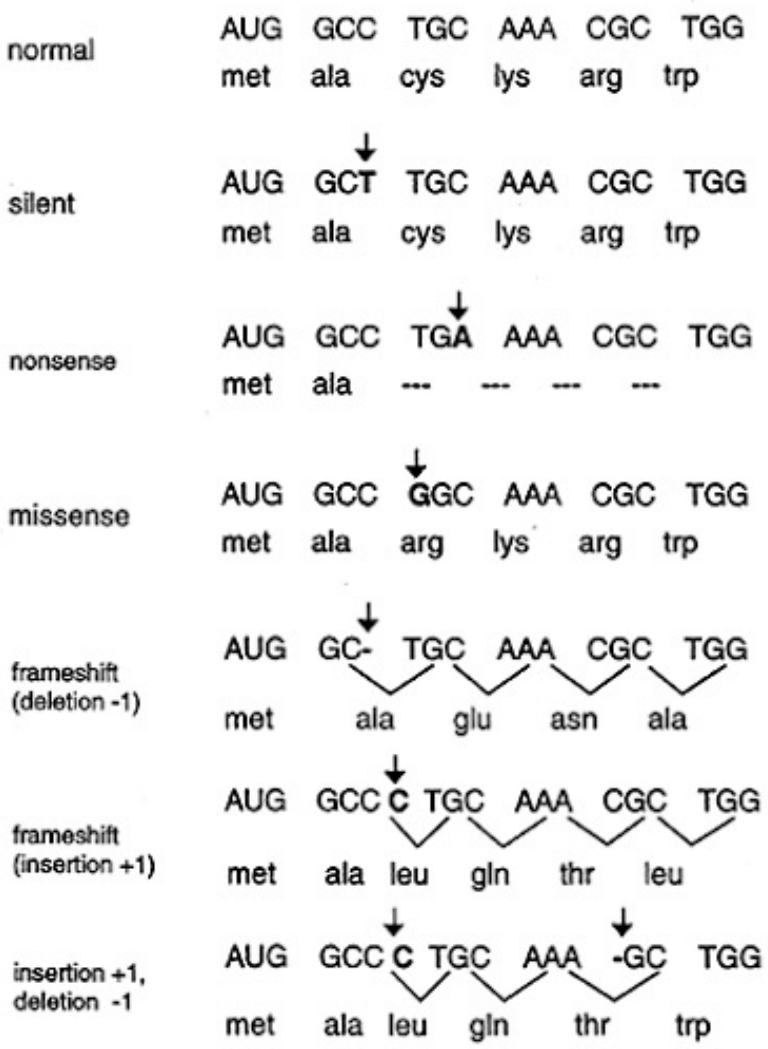

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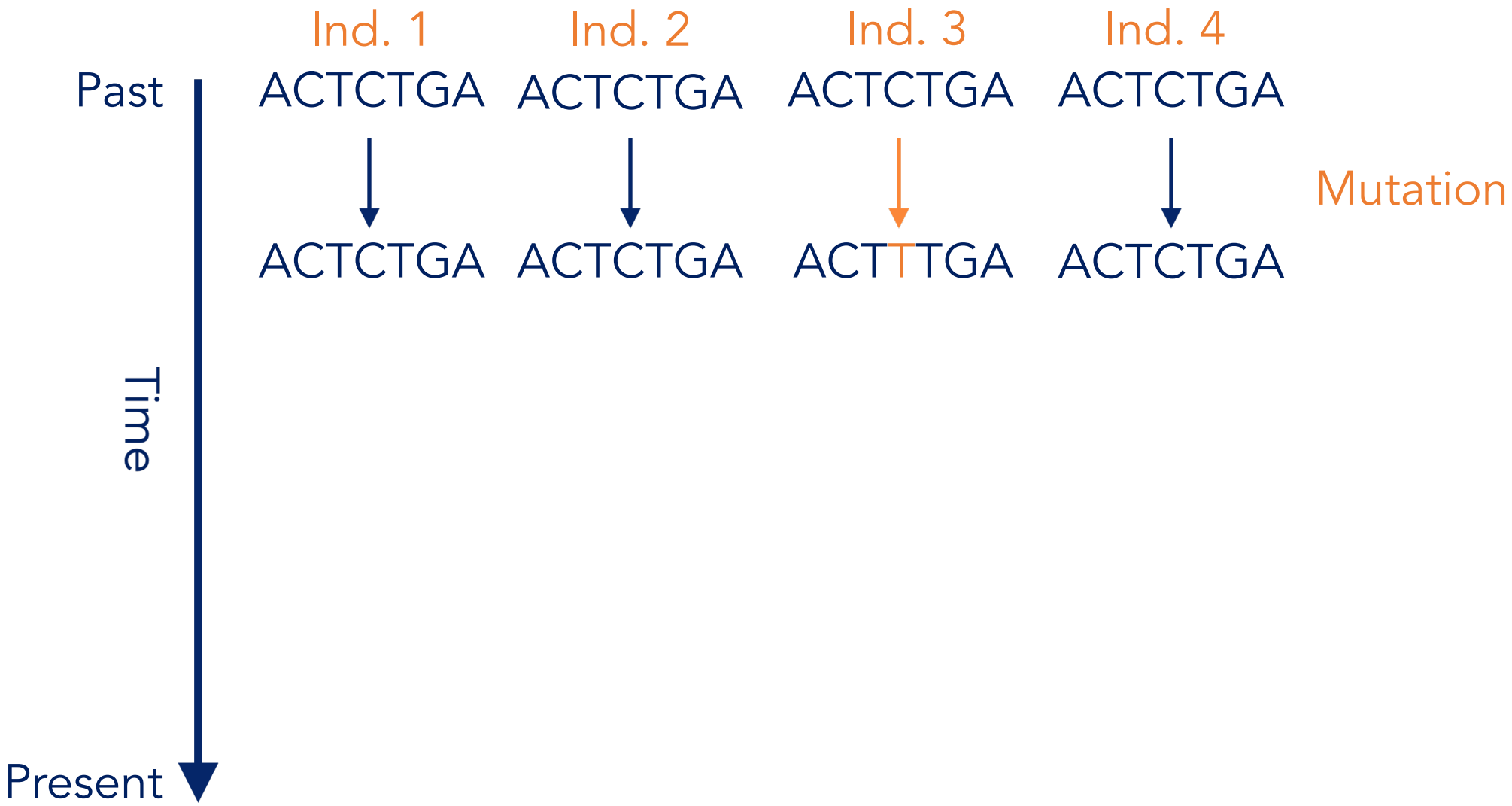

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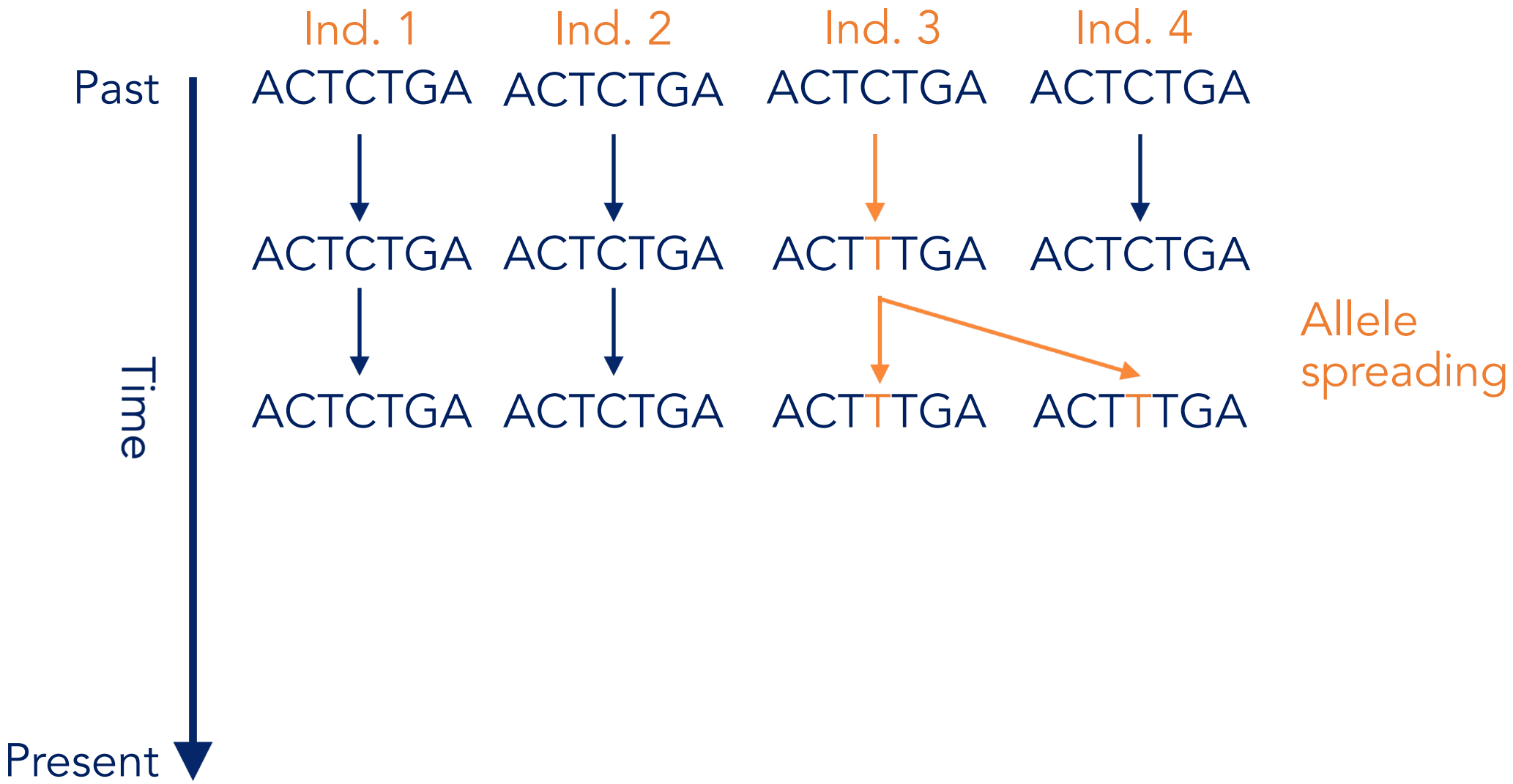

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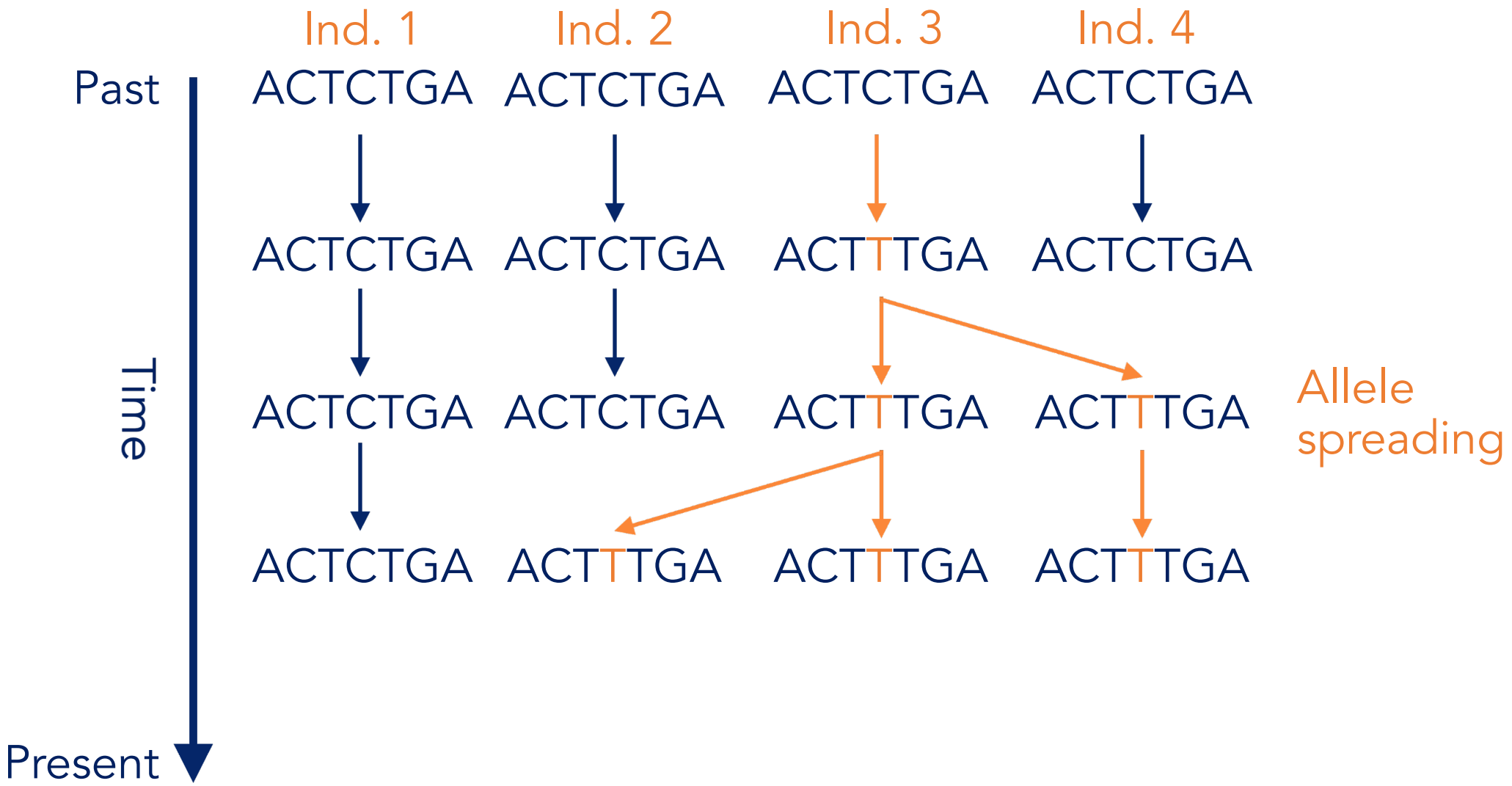

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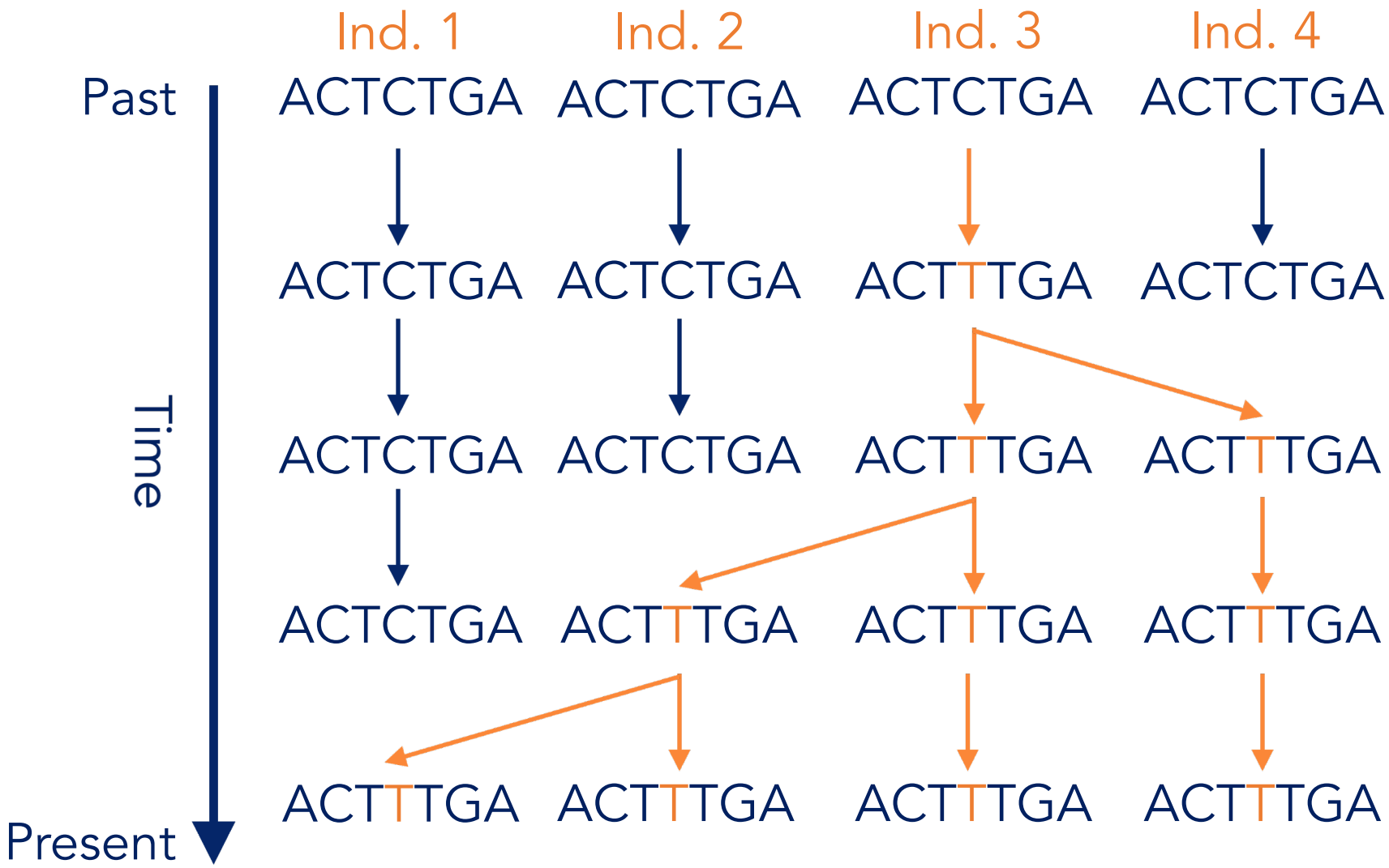
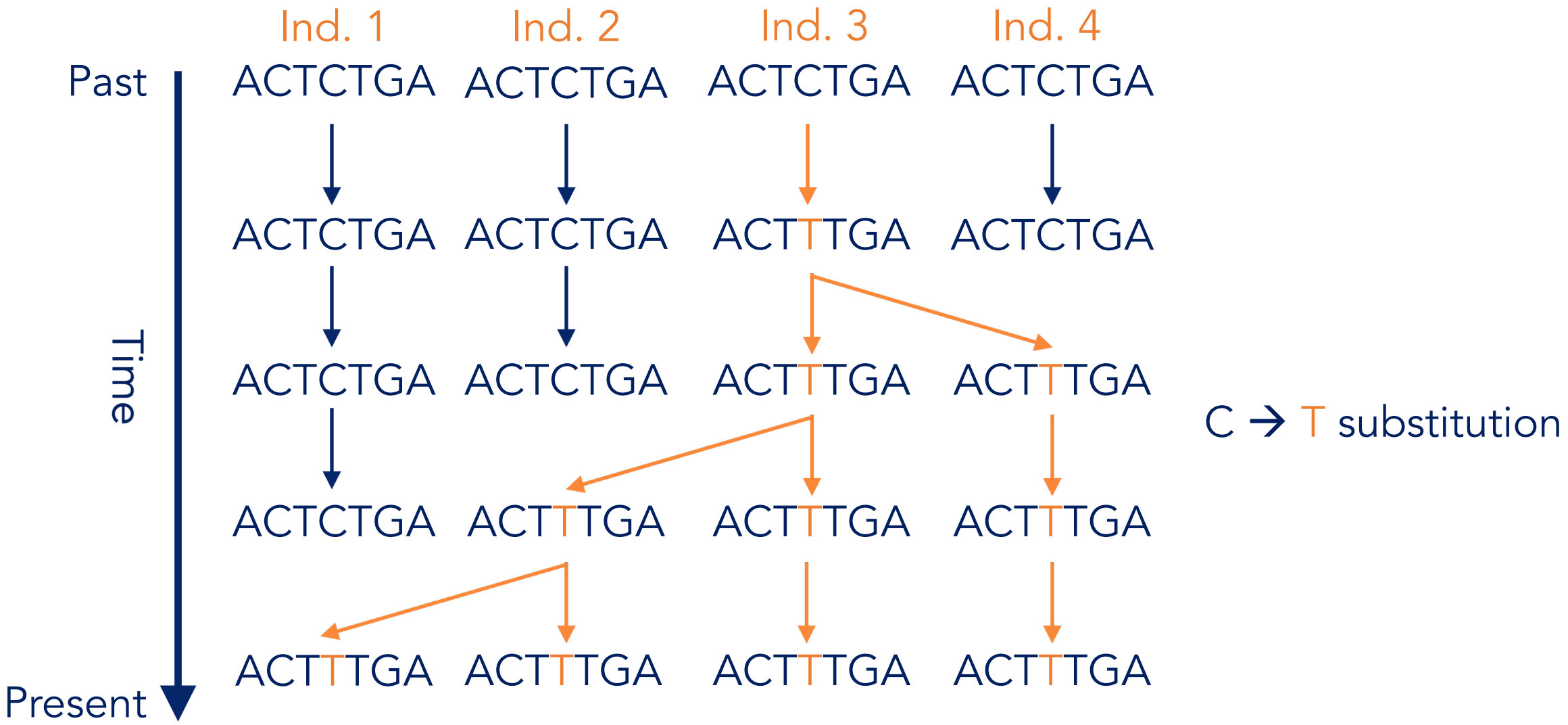


Allele fixed within population = substitution

Substitutions – Replacement of ancestral nucleotide



Multiple substitutions at a single site can obscure past evolutionary events

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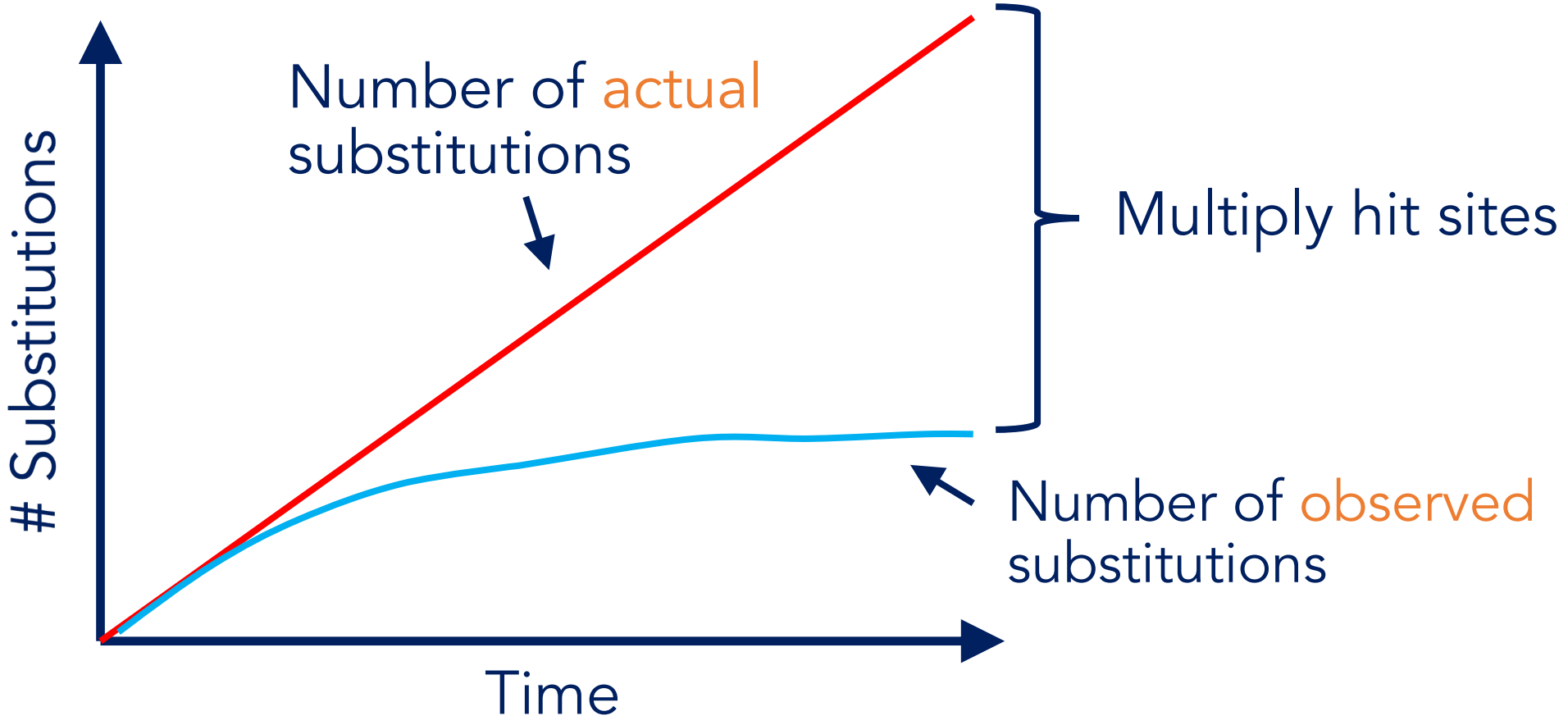
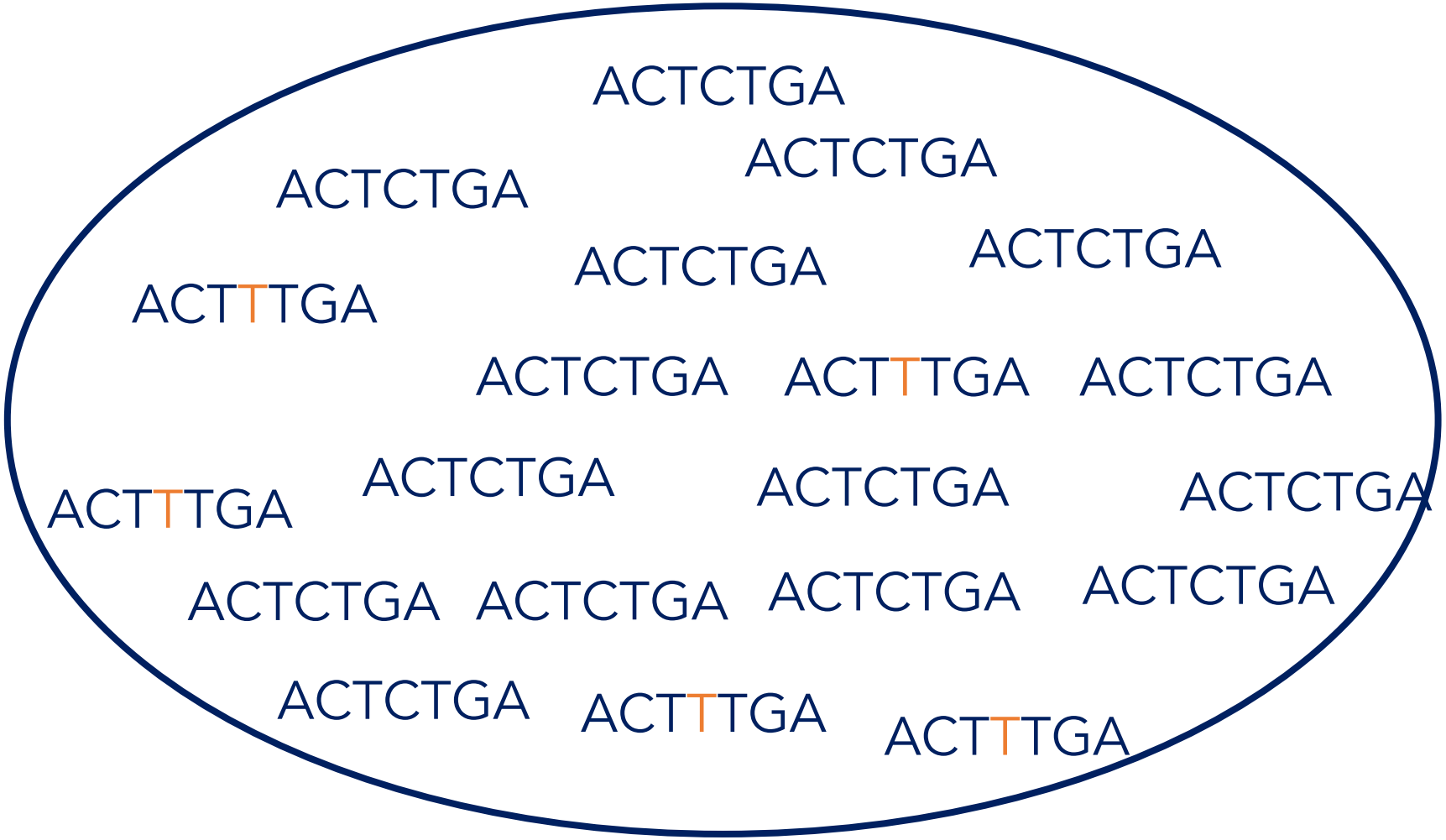


Polymorphisms – Intraspecific variation in nucleotide sequence

Single Nucleotide Polymorphisms (SNPs)



Population

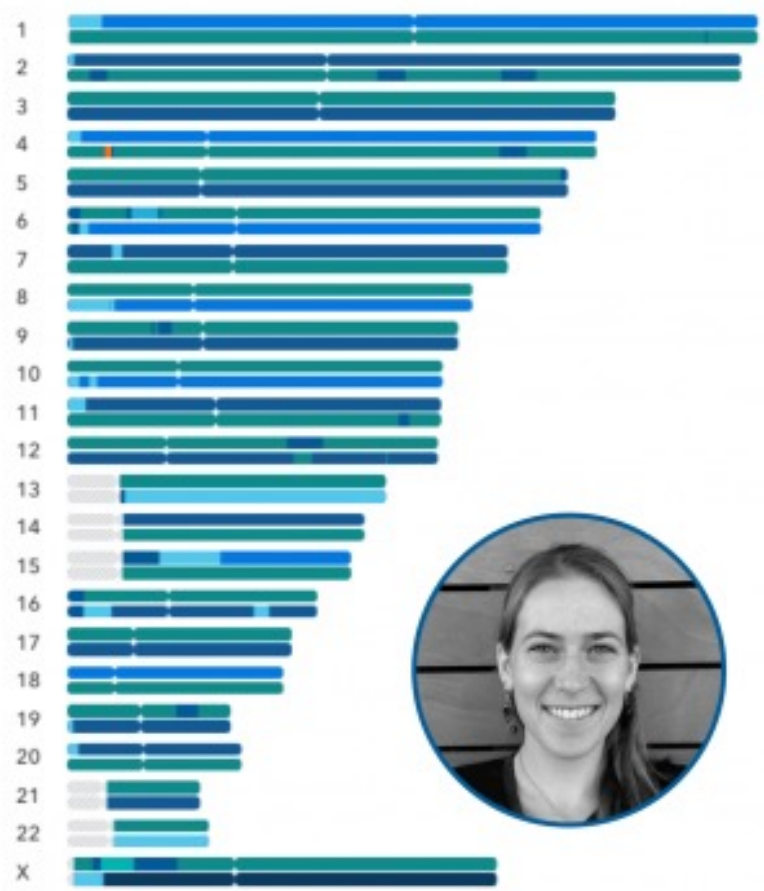
C/T polymorphism

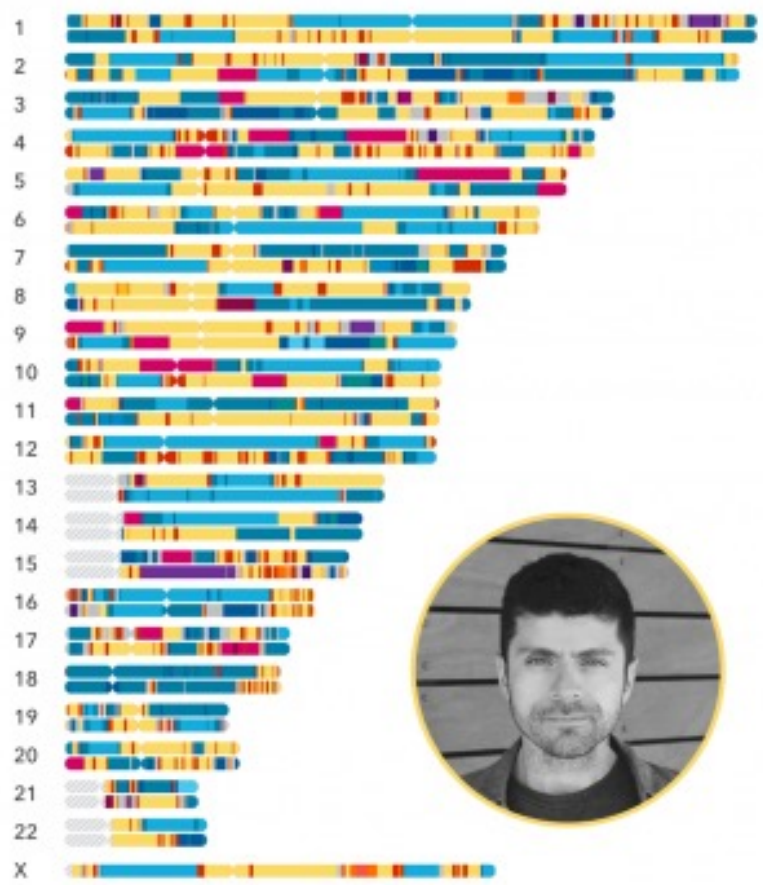
Single Nucleotide Polymorphisms (SNPs)

- Synonymous (sSNP) – SNP in coding region that does not have any effect on amino acid sequence

- Nonsynonymous SNP (nsSNP) – SNP in coding region that results in a different amino acid compared to the other allele

Population history based on SNPs





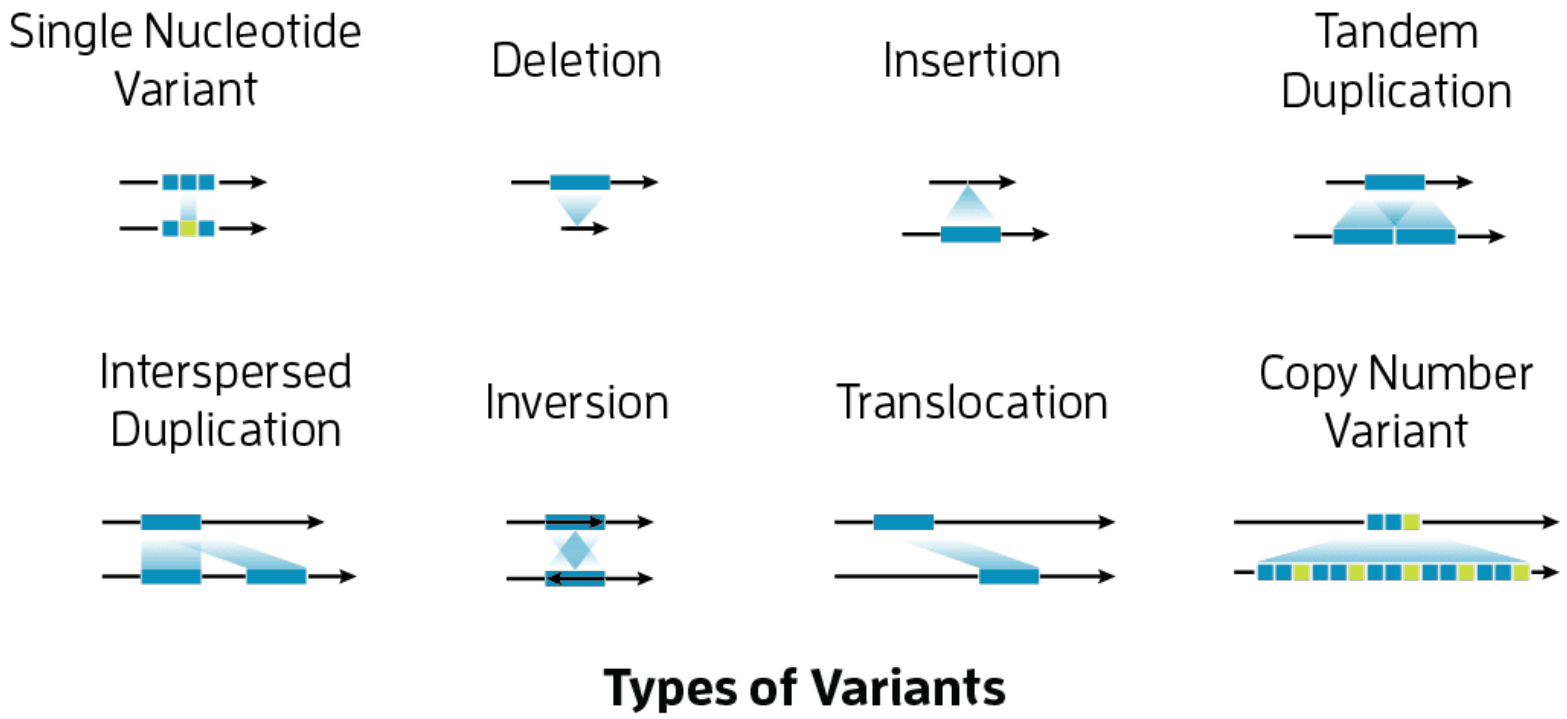
23andMe

Population history based on SNPs

- Genotyping-by-sequencing (GBS)
  - Obtain SNP genotypes by sequencing whole genomes (or specific regions)
  - Lots of data, potentially more complicated dataset

- SNP array (e.g., 23 & Me, Bird Genoscape Project)
  - Simple dataset/analysis, high throughput
  - Not very flexible

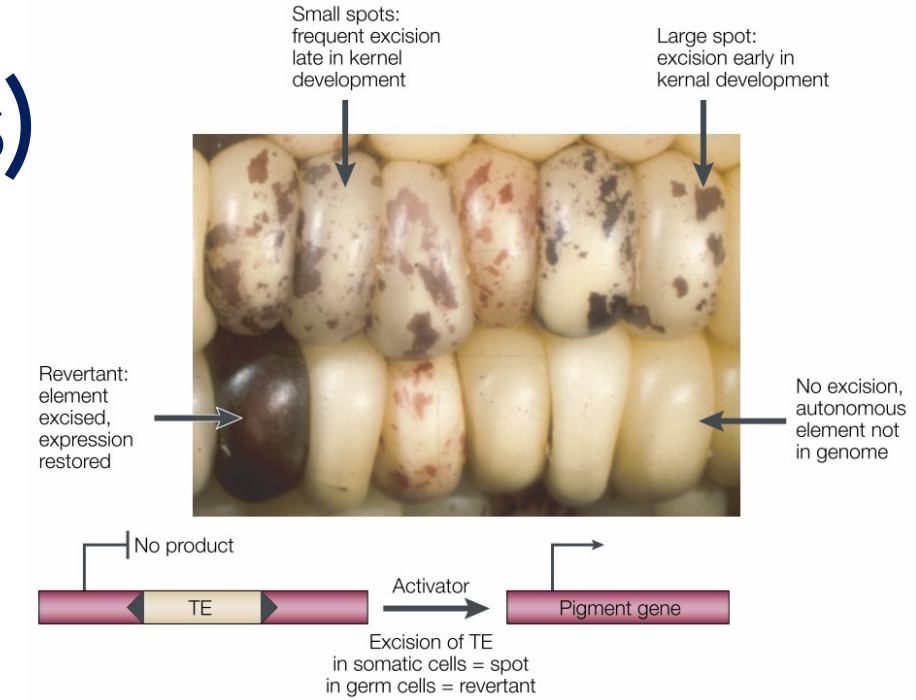
Many different kinds of mutations



Types of Variants

Transposable elements (TEs)

- "Genomic parasites" or "jumping genes"
- Discovered by Barbara McClintock in 1940s
- Can have potentially harmful consequences on host genome



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Feschotte et al. 2002 Nat Rev Ge

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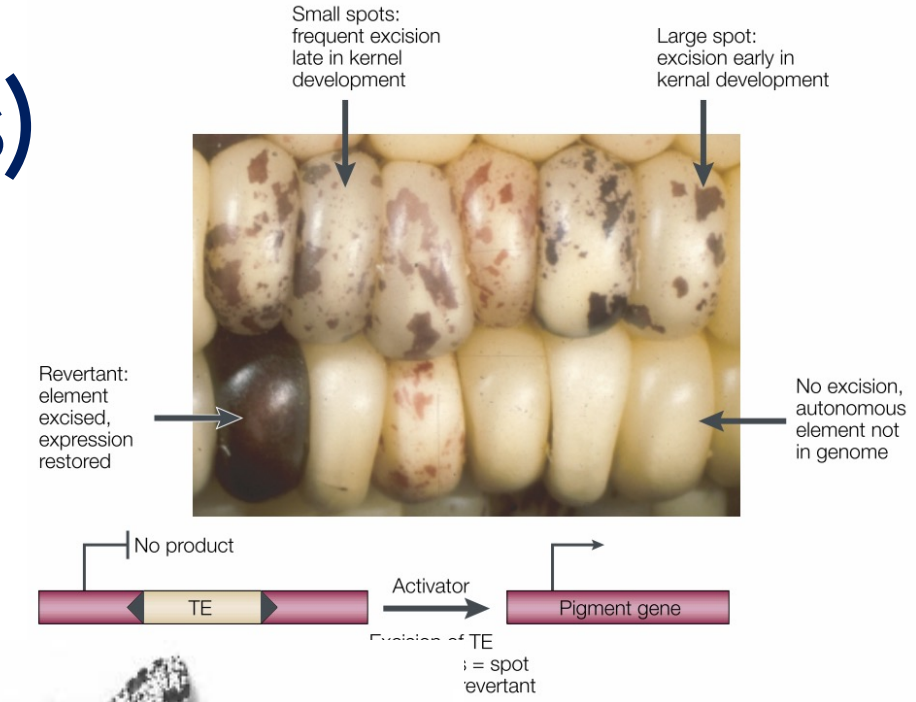

- Growing appreciation for important but complex role in evolution
  - Genome architecture
  - Adaptation

LETTER

doi:10.1038/nature17951

The industrial melanism mutation in British peppered moths is a transposable element

Arjen E. van't Hof[1]*, Pascal Campagne[1]*, Daniel J. Rigden[1], Carl J. Yung[1], Jessica Lingley[1], Michael A. Quail[2], Neil Hall[1], Alistair C. Darby[1] & Ilik J. Saccheri[1]

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Feschotte et al. 2002 Nat Rev Ge

Movement of TEs

DNA transposon: “cut and paste”

Retrotransposon: “copy and paste”

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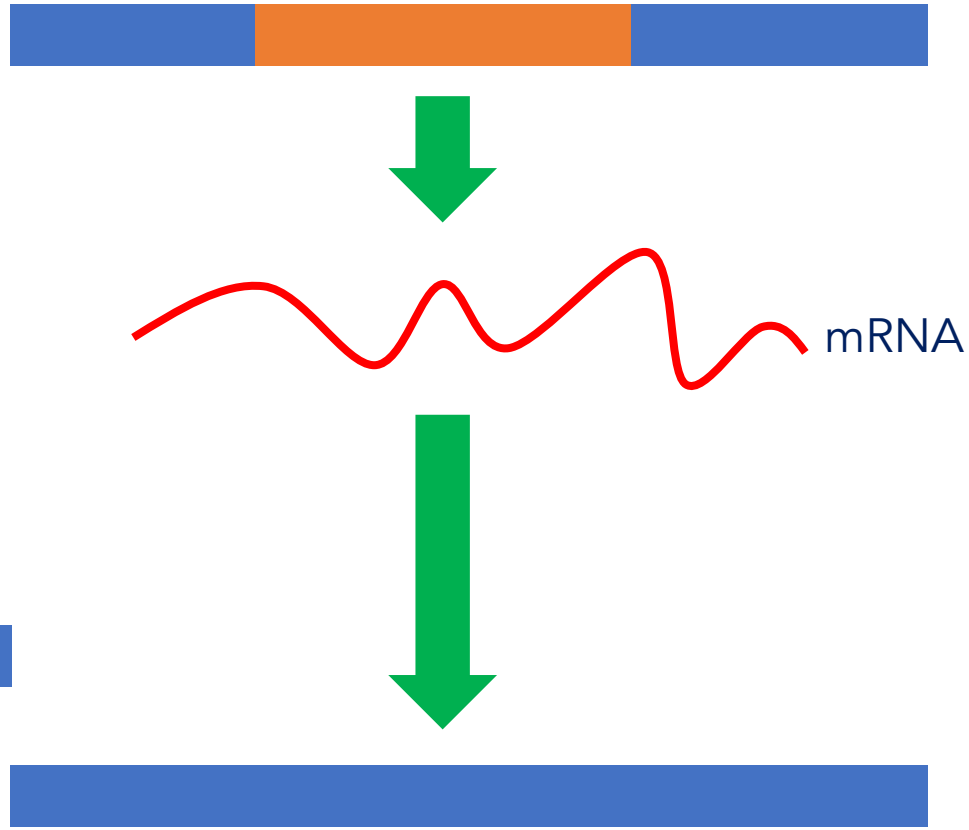

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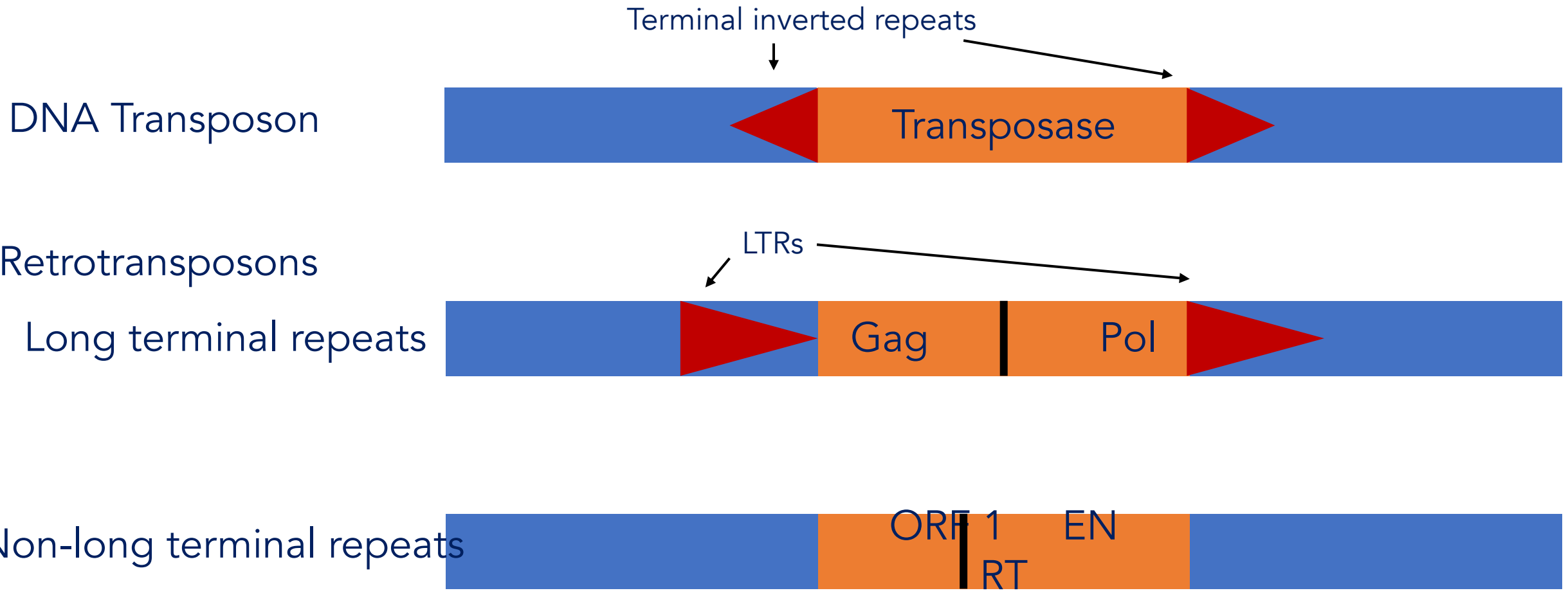
Classes of TEs



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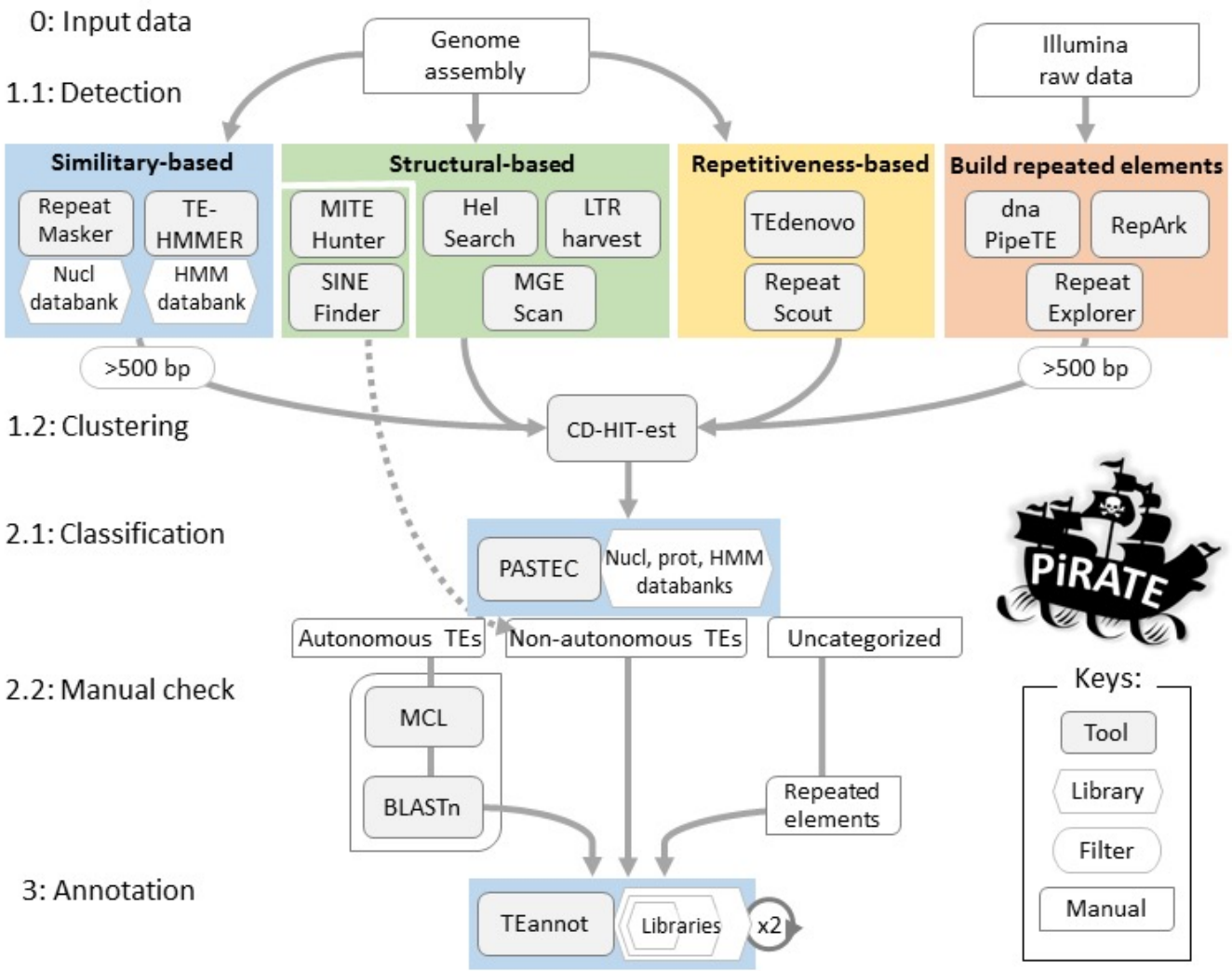
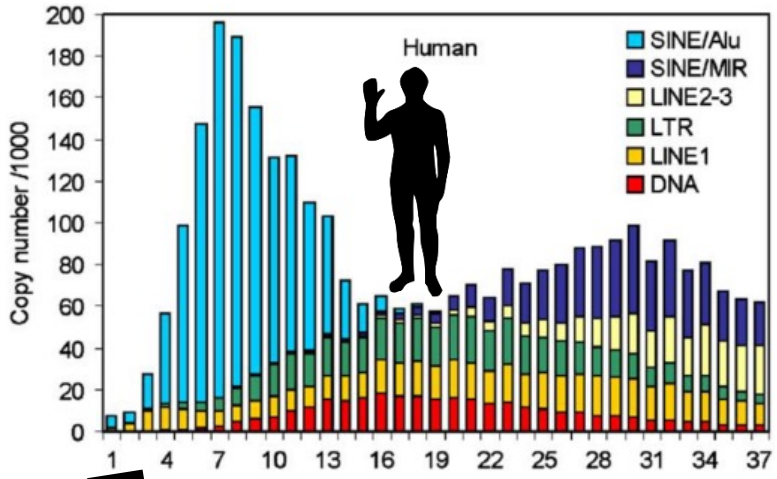
Identifying, annotating, and characterizing Transposable Elements



PiRATE

Berthelier et al. 2018 BMC Genomics

Evolutionary dynamics and diversity of TEs vary greatly across species



Recent activity

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György et al. 2007 Theoretical Population Biology

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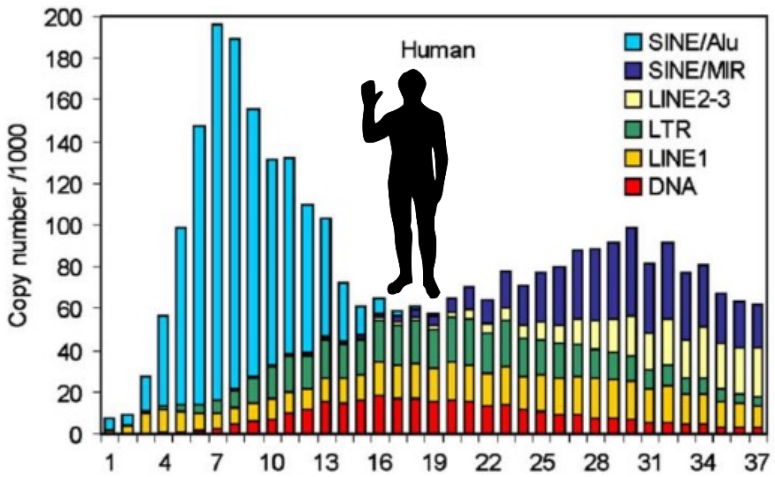

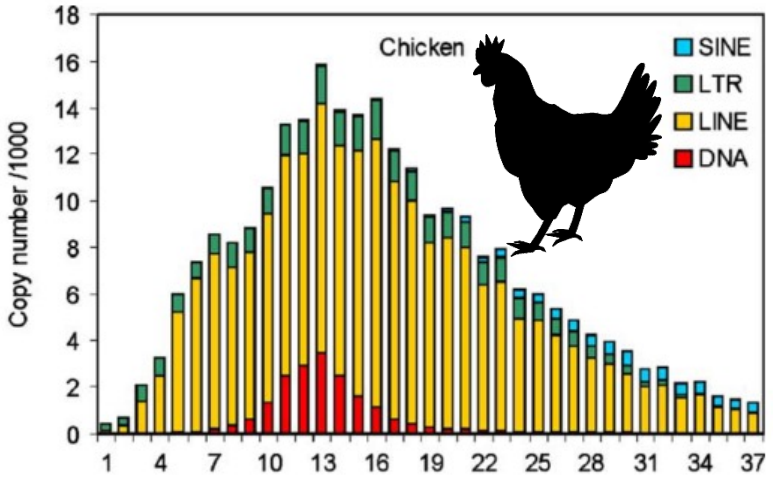

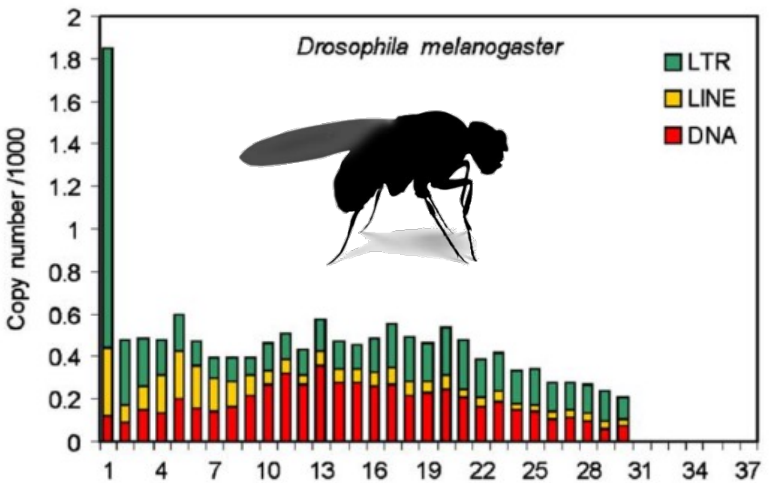

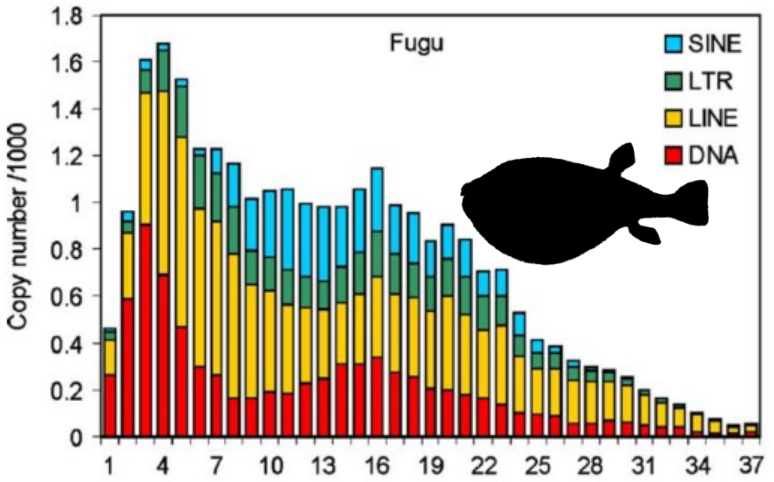

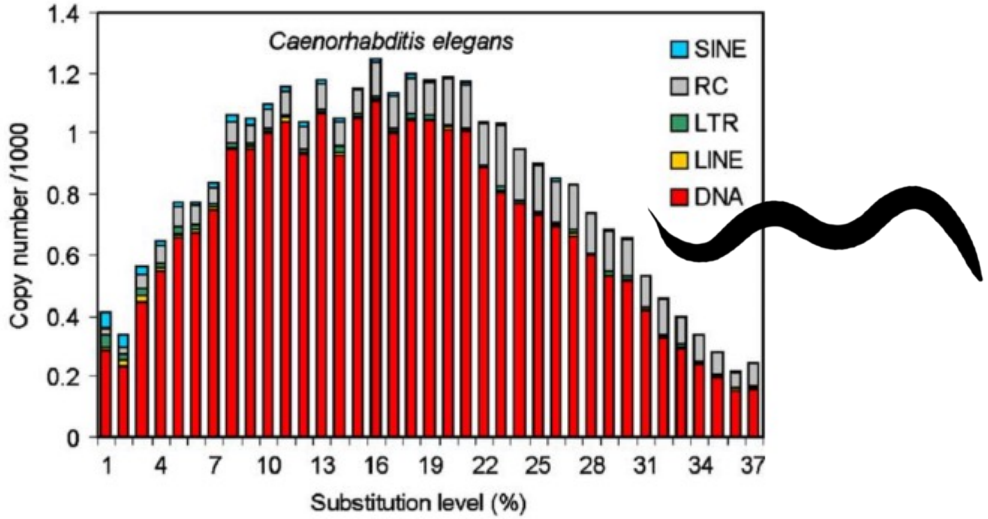

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György et al. 2007 Theoretical Population Biology

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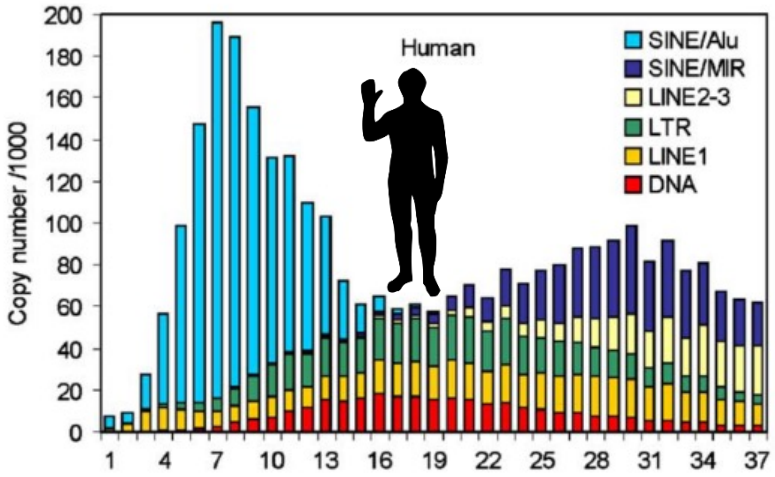

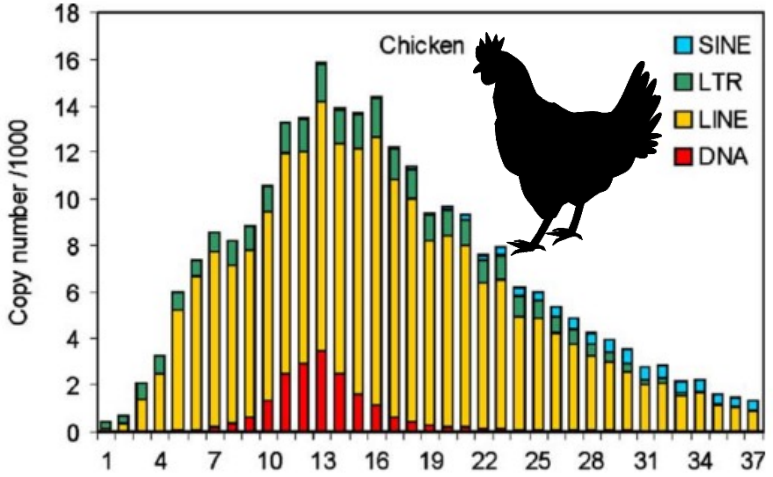

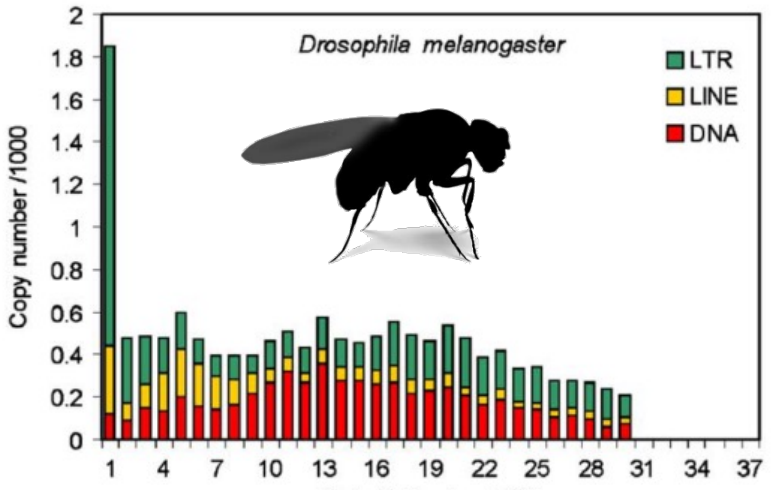

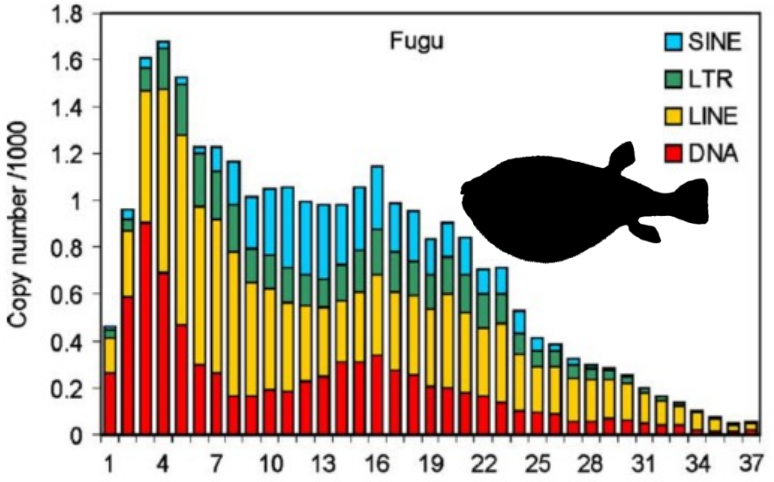

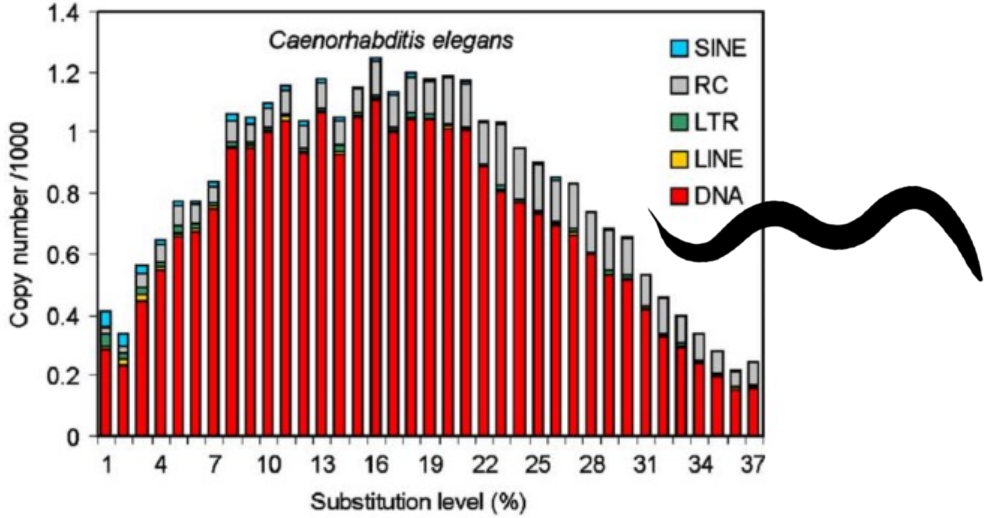

RepeatMasker

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