

# Evoluční medicína

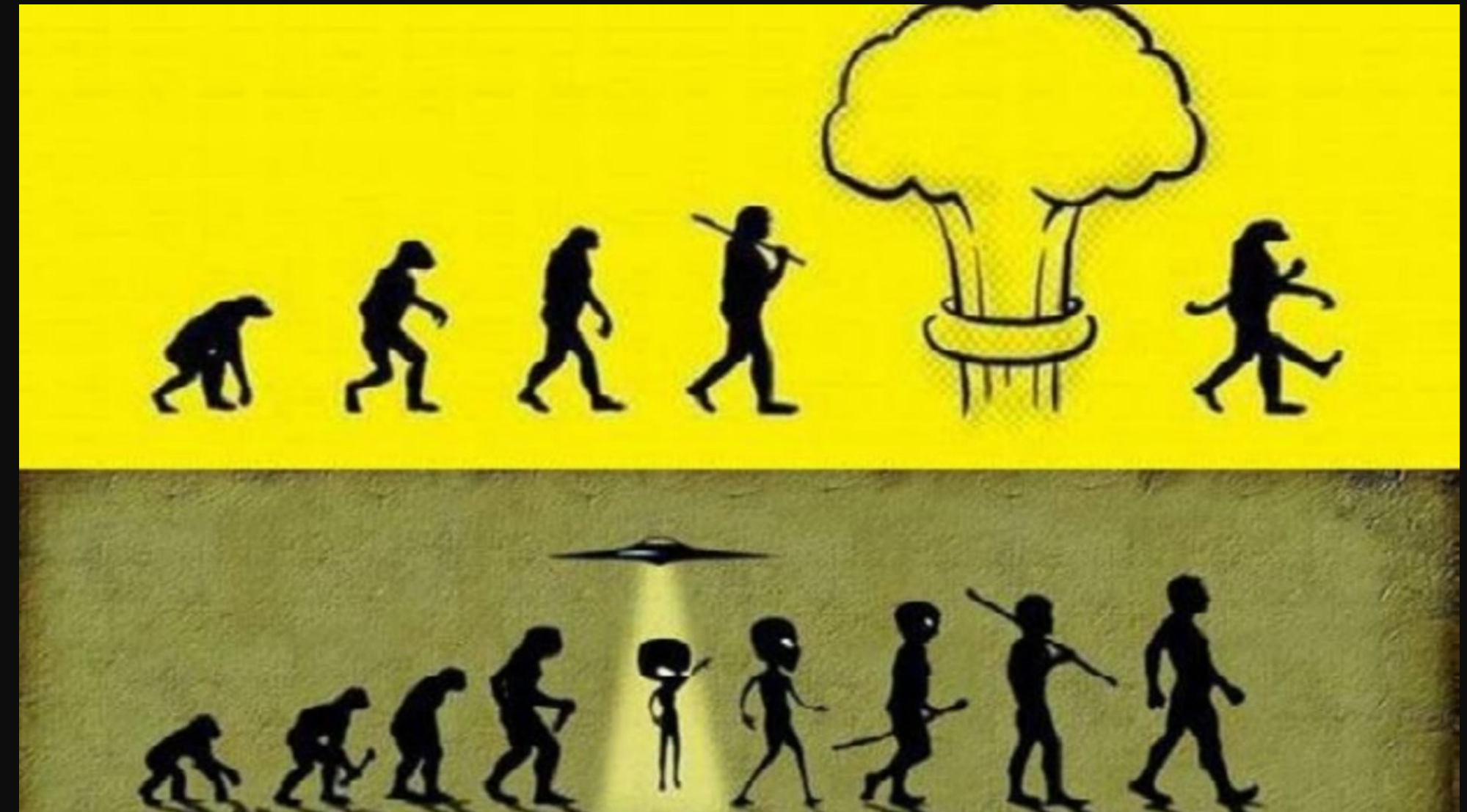
Miriam Nývltová Fišáková

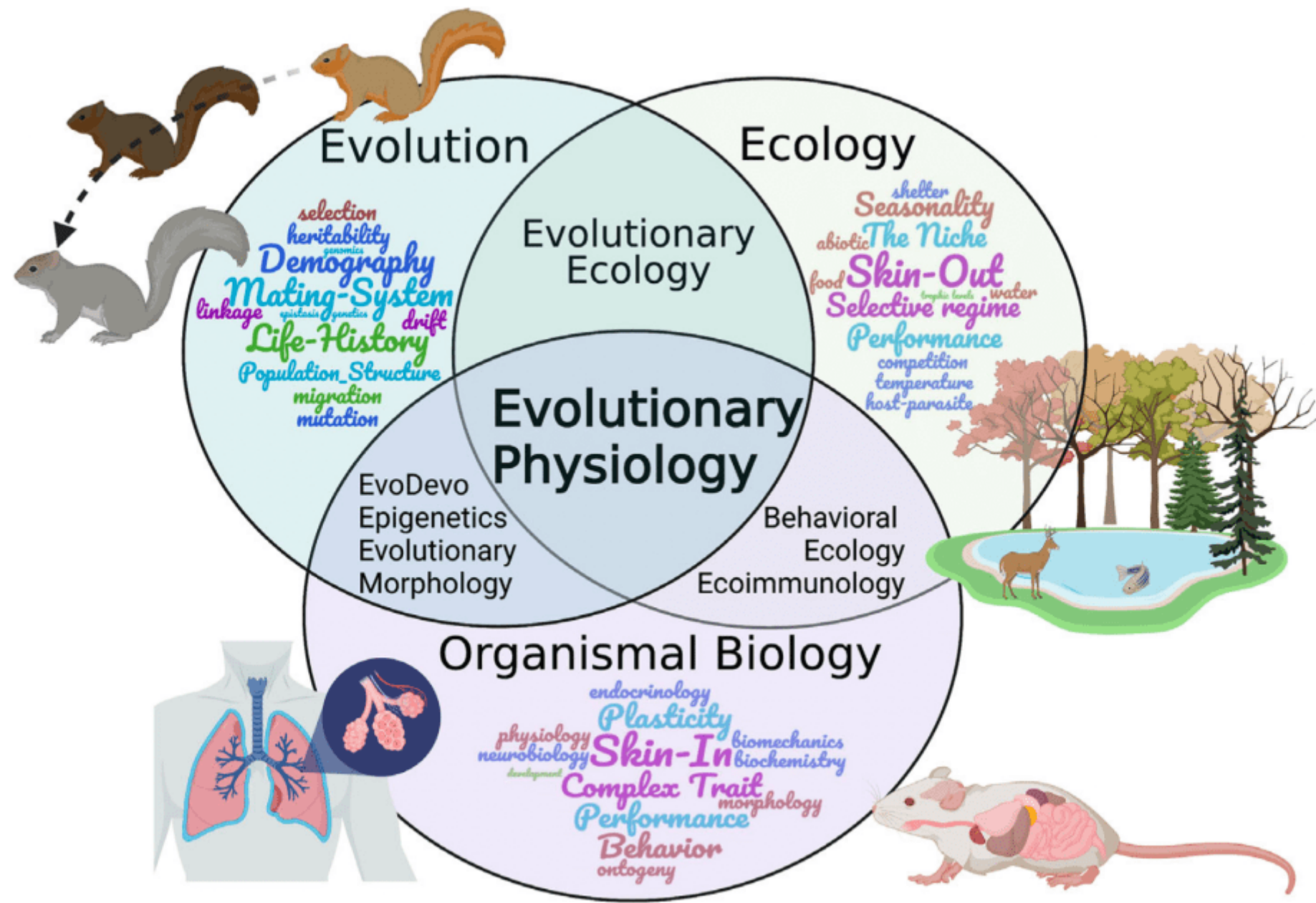
*Ústav fyziologie*  
*LF MU*  
[miriam.nyvltova@med.muni.cz](mailto:miriam.nyvltova@med.muni.cz)



# Co je evoluční medicína?

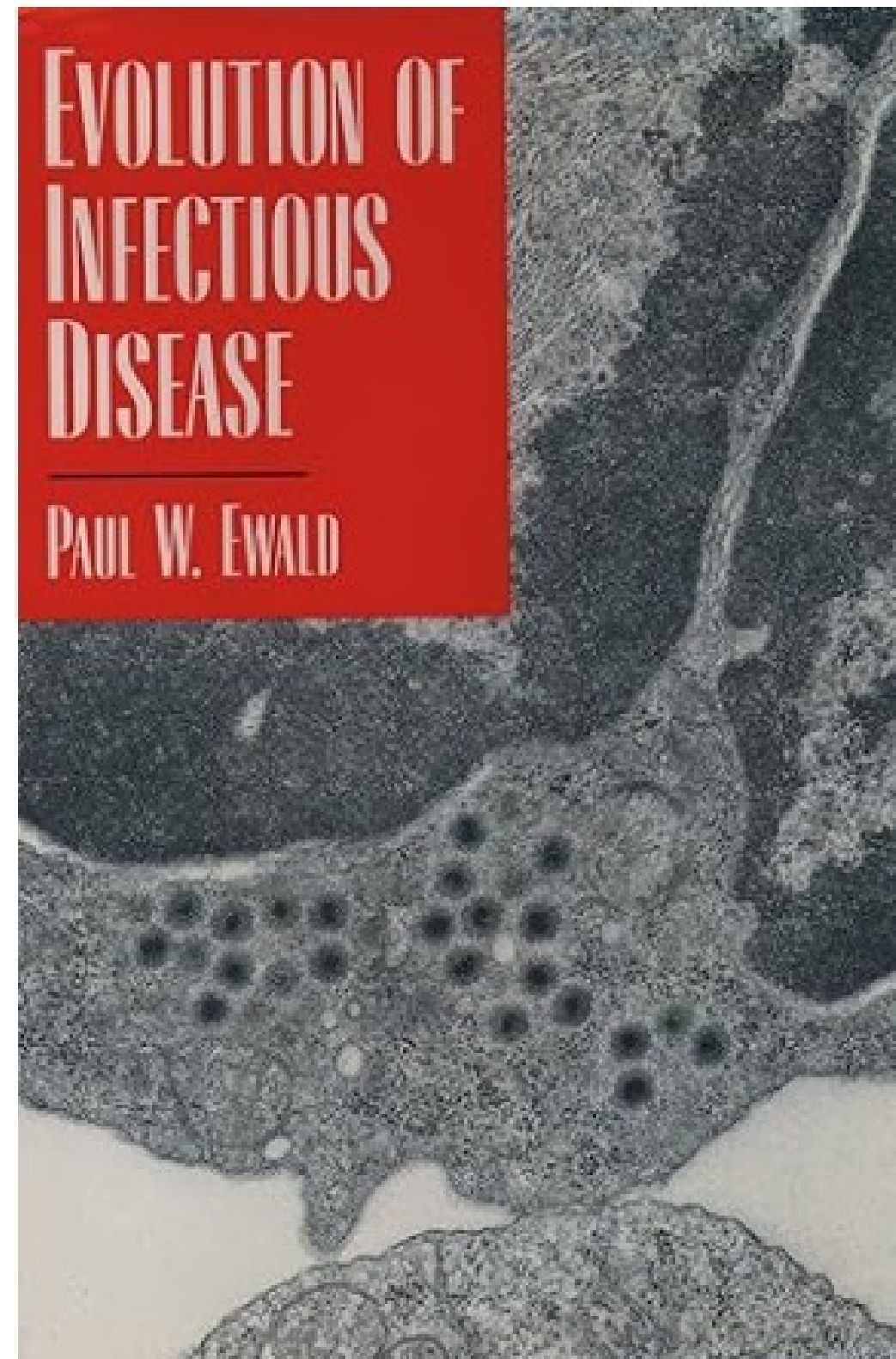
- Evoluční medicína neboli darwinovská medicína je aplikací moderní evoluční teorie k pochopení zdraví a nemoci.
- Moderní biomedicínský výzkum a praxe se soustředily na molekulární a fyziologické mechanismy, které jsou základem zdraví a nemoci,
- zatímco evoluční medicína se zaměřuje na otázku, proč evoluce utvářela tyto mechanismy způsobem, který nás může zanechat náchylný k nemocem.
- Evoluční přístup vedl k důležitým pokrokům v chápání rakoviny,] autoimunitních onemocnění] a anatomie . Mezinárodní společnost pro evoluci, medicínu a veřejné zdraví koordinuje úsilí o rozvoj tohoto oboru.
- Vlastní časopis **Oxford University Press** *Evolution, Medicine and Public Health* a *The Evolution and Medicine Review*.





# Kdy?

Obor tak měl nejisté rané dětství, ale brzy jej přivedly k omezení dospívání dvě díla: pojednání z roku 1991 „Úsvit darwinovské medicíny“ od George Williamse a Nesse a kniha „Evoluce infekčních chorob“ z roku 1993 od Paula Ewalda.



56 odborníků z různých oborů, včetně antropologie, medicíny, ošetřovatelství a biologie, se s využitím metody Delphi dohodlo na 14 základních principech, které jsou vlastní vzdělávání a praxi evoluční medicíny.[5] Těchto 14 principů lze dále seskupit do pěti obecných kategorií: rámování otázek, evoluce I a II (s II zahrnuje vyšší úroveň složitosti), evoluční kompromisy, důvody zranitelnosti a kultura. Další informace o těchto zásadách naleznete v tabulce níže.

**Základní principy evoluční medicíny**[5]  
**Základní princip tématu**  
Typy vysvětlení (rámování otázek) K úplnému biologickému pochopení vlastností, včetně těch, které zvyšují zranitelnost vůči nemocem, jsou zapotřebí jak přibližná (mechanistická), tak konečná (evoluční) vysvětlení.

**Evoluční procesy (evoluce I)** Všechny evoluční procesy, včetně přirozeného výběru, genetického driftu, mutace, migrace a nenáhodného páření, jsou důležité pro pochopení vlastností a nemocí.

**Reprodukční úspěch (evoluce I)** Přírodní výběr maximalizuje reprodukční úspěch, někdy na úkor zdraví a dlouhověkosti.

**Sexuální výběr (evoluce I)** Sexuální výběr formuje rysy, které mají za následek různá zdravotní rizika mezi pohlavími.

**Omezení (evoluce I)** Několik omezení brání schopnosti přirozeného výběru utvářet vlastnosti, které jsou hypoteticky optimální pro zdraví.

**Kompromisy (evoluční kompromisy)** Evoluční změny v jedné vlastnosti, které zlepšují kondici, mohou být spojeny se změnami v jiných vlastnostech, které kondici snižují.

**Teorie životní historie (evoluční kompromisy)** Vlastnosti životní historie, jako je věk při prvním rozmnožování, reprodukční délka života a rychlost stárnutí, jsou utvářeny evolucí a mají důsledky pro zdraví a nemoci.

**Úrovně selekce (evoluce II)** Zranitelnost vůči chorobám může nastat, když má selekce protichůdné účinky na různých úrovních (např. genetické prvky, buňky, organismy, příbuzní a další úrovně).

**Fylogeneze (evoluce II)** Sledování fylogenetických vztahů pro druhy, populace, znaky nebo patogeny může poskytnout pohled na zdraví a nemoci.

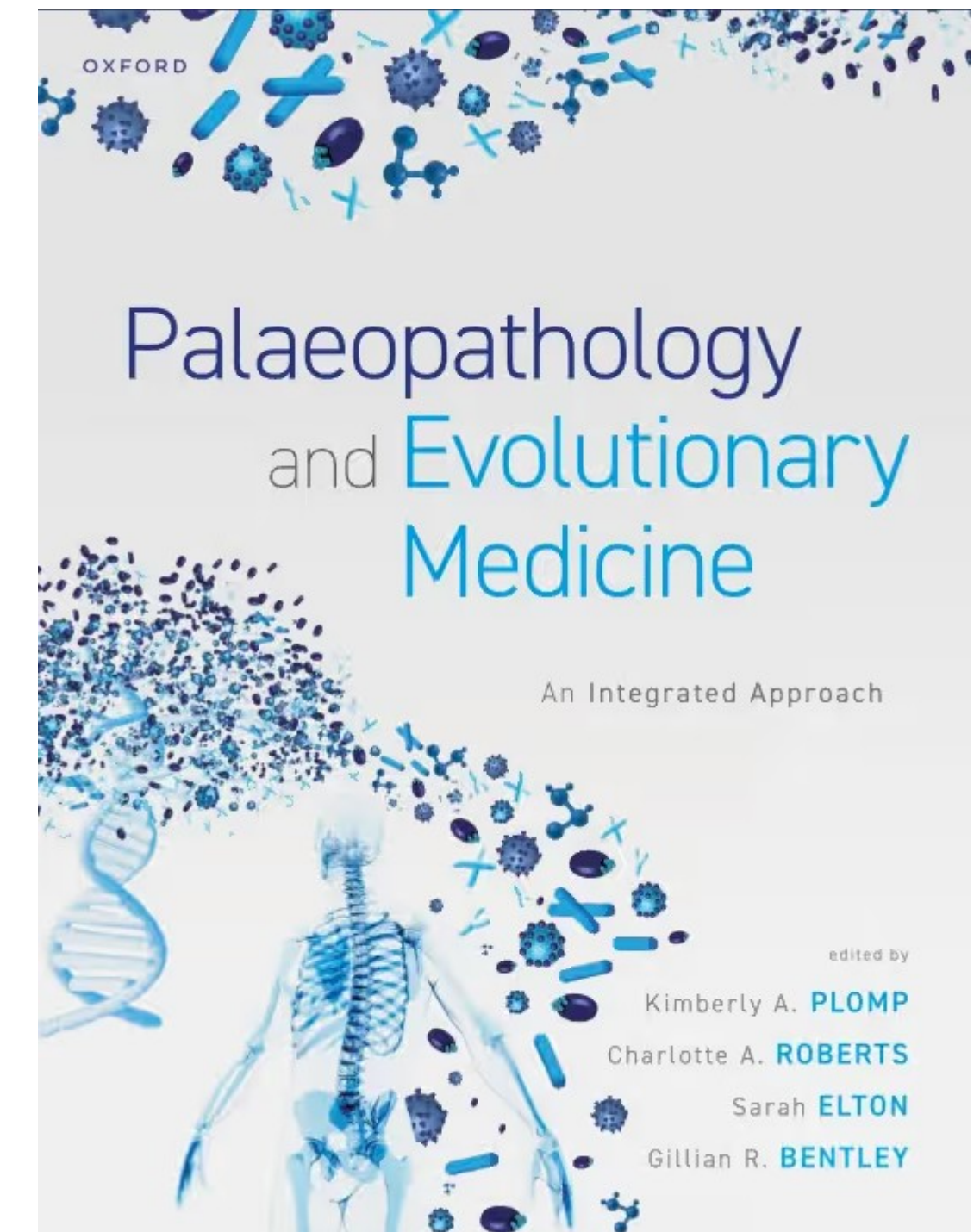
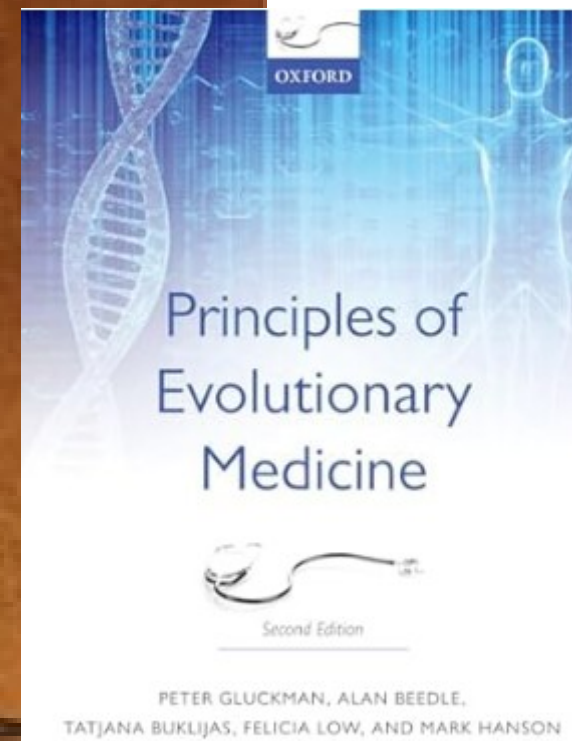
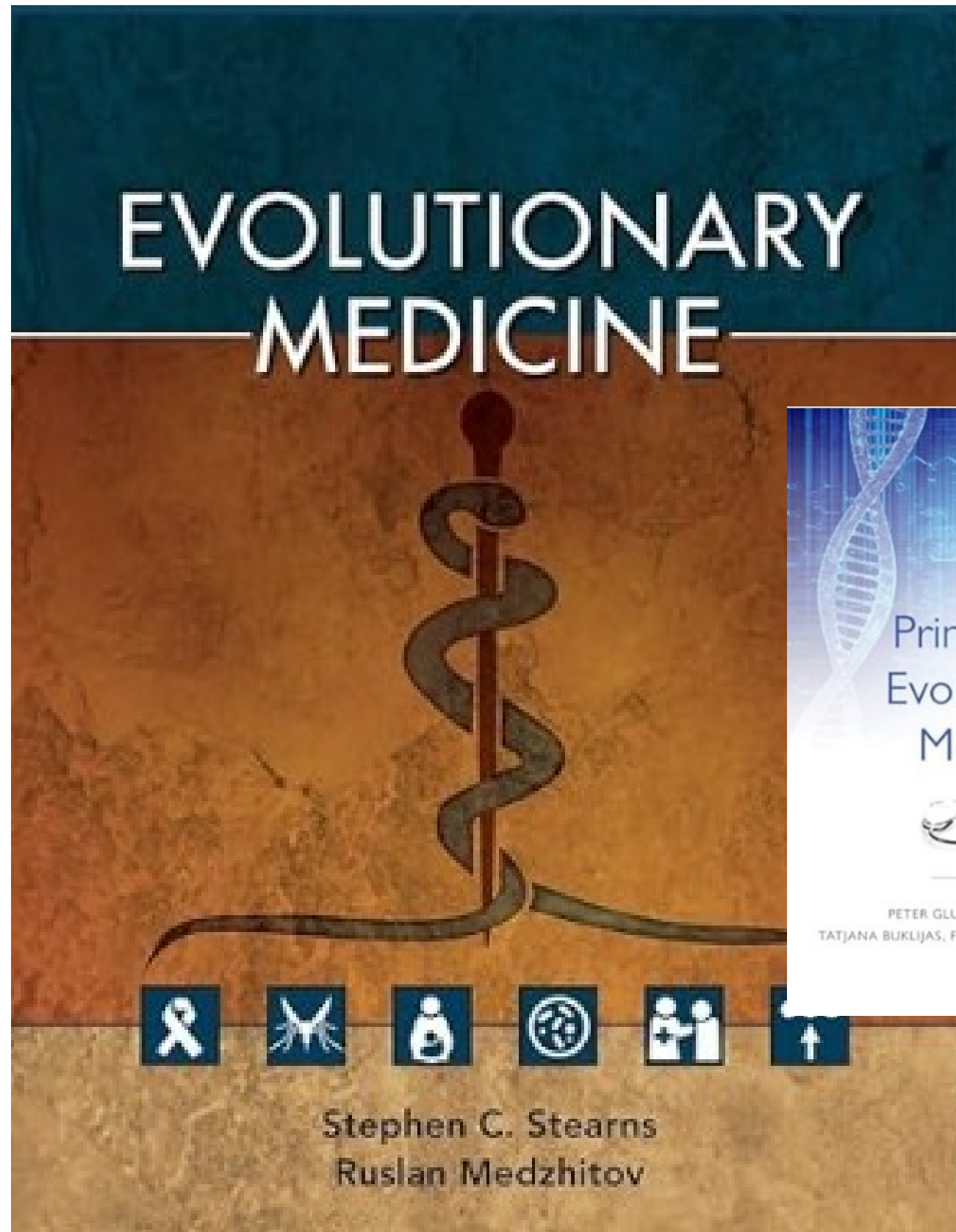
**Koevoluce (evoluce II)** Koevoluce mezi druhy může ovlivnit zdraví a nemoci (např. evoluční závody ve zbrojení a vzájemné vztahy, jako jsou ty, které lze vidět v mikrobiomu).

**Plasticita (evoluce II)** Faktory prostředí mohou posunout vývojové trajektorie způsoby, které ovlivňují zdraví, a plasticita těchto trajektorií může být produktem vyvinutých adaptivních mechanismů.

**Obrany (důvody zranitelnosti)** Mnoho příznaků a symptomů onemocnění (např. horečka) je užitečným obranným prostředkem, který může být patologický, pokud je dysregulován.

**Nesoulad (důvody zranitelnosti)** Rizika onemocnění mohou být změněna u organismů žijících v prostředí, které se liší od prostředí, ve kterém se vyvinuli jejich předkové.

**Kulturní praktiky (kultura)** Kulturní praktiky mohou ovlivnit evoluci lidí a jiných druhů (včetně patogenů) způsoby, které mohou ovlivnit zdraví a nemoci (např. užívání antibiotik, porodní praktiky, strava atd.).





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8 New Clinical Briefs in EMPH 2019

# EVOLUTION, MEDICINE, & PUBLIC HEALTH



The Oxford Press open access journal *Evolution, Medicine & Public Health* has published eight new Clinical Briefs in 2019. They are lovely one page summaries that are perfect for teaching...or just pleasure reading.

The shapes of virulence to come  
Aakash Pandey, Daniel E Dawson *Evol Med Public Health*, Volume 2019, Issue 1, 2019, Page 3, <https://doi.org/10.1093/emph/eoy037>

Tandem repeat disorders  
Calen P Ryan *Evol Med Public Health*, Volume 2019, Issue 1, 2019, Page

About The Evolution & Medicine Review

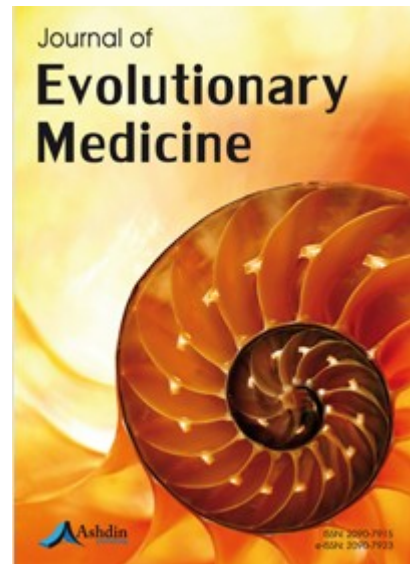
The International Society for Evolution, Medicine, and Public Health

*Evolution, Medicine, and Public Health* - open-access from Oxford Univ. Press

EvMedEd - Online resources for teaching and learning evolutionary medicine

ClubEvMed - Online journal club/discussion of current topics

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Edited by  
George H Perry et al.

## Evolutionary Medicine: A Special Issue

eLife is pleased to present a Special Issue to highlight recent advances in the growing and increasingly interdisciplinary field of evolutionary medicine.

[f](#) [t](#) [e](#) [v](#)

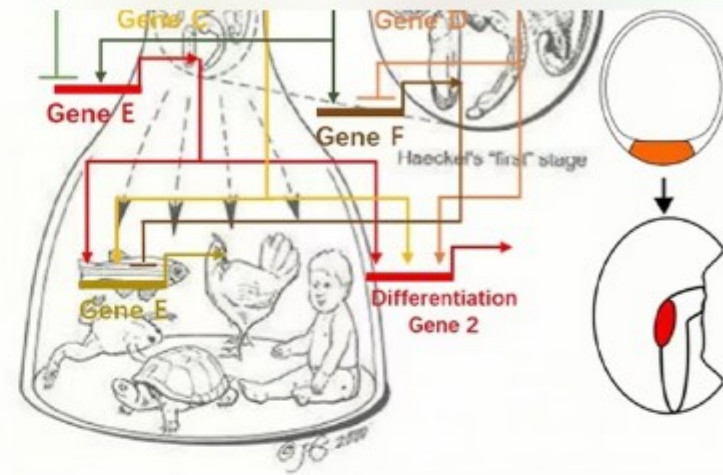
Collection · Jul 22, 2021

LABORATORY OF  
EVOLUTIONARY MEDICINE  
& ONE HEALTH

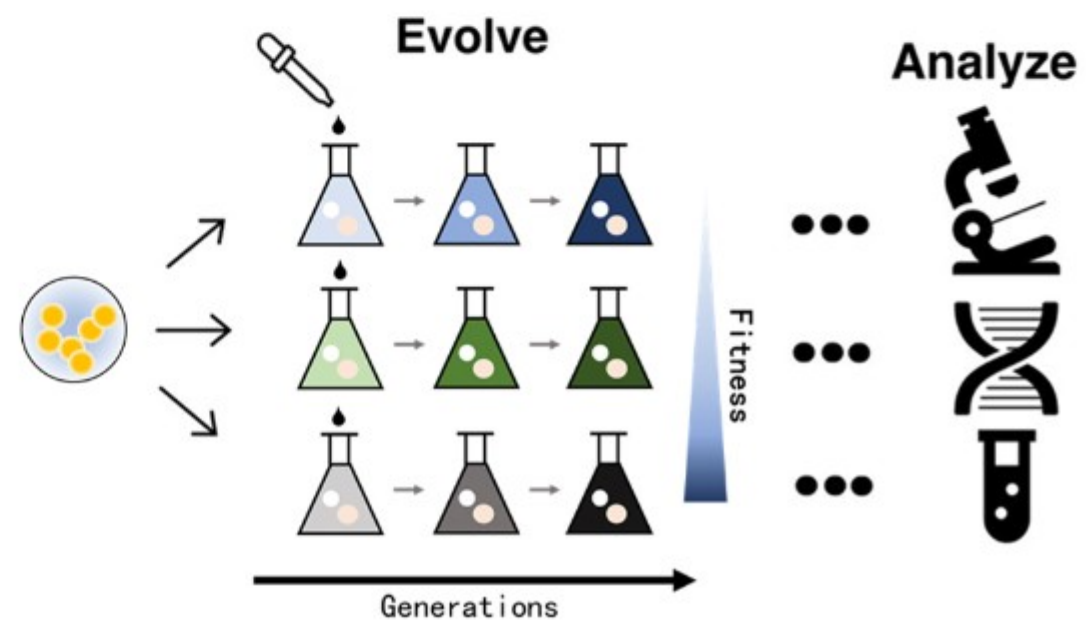
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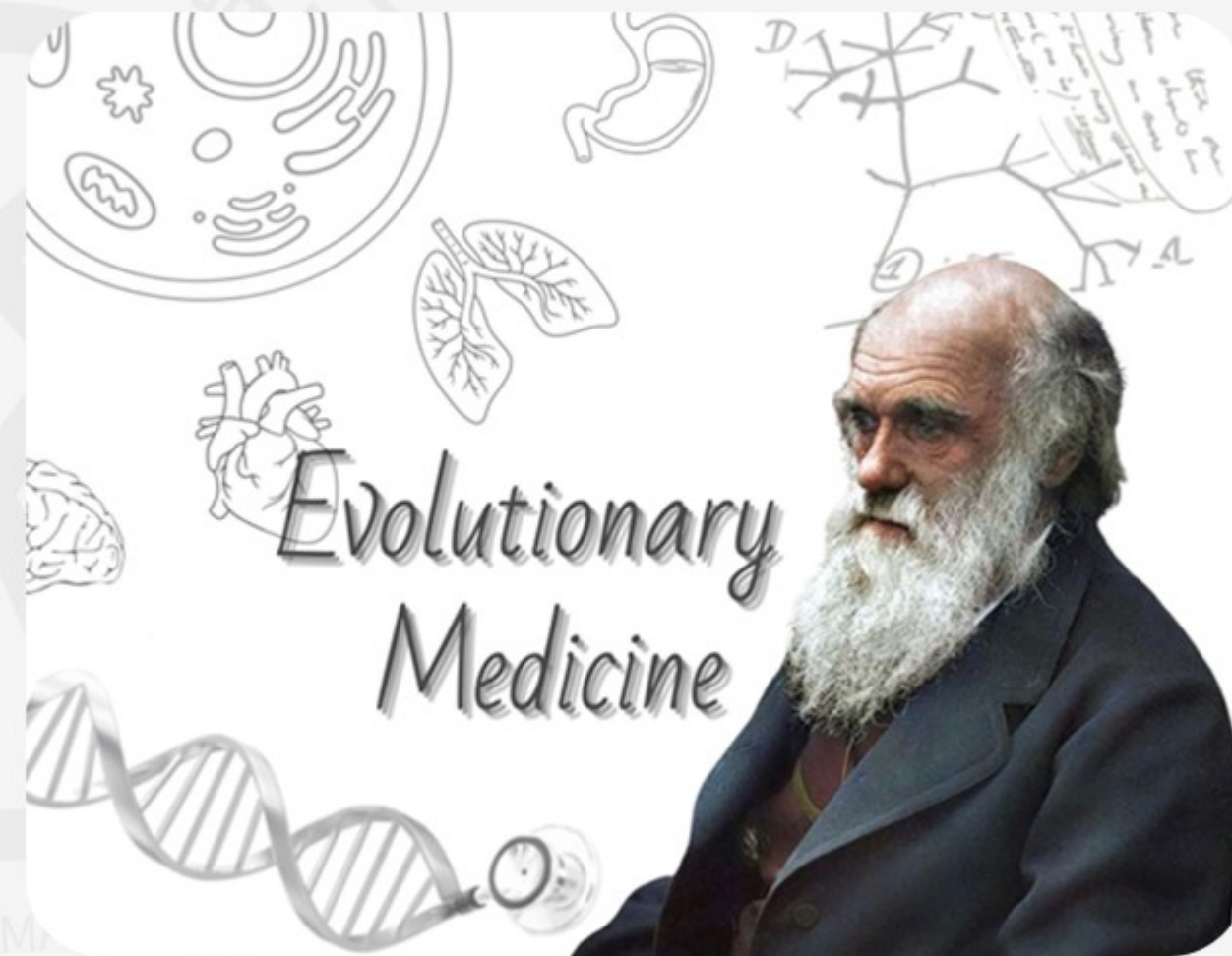




○ Marcoevolutionary developmental biology



○ Genomic evolution of major transition



○ Evolutionary implication on medicine

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### Focus area EVOLUTIONARY MEDICINE

**Medical Life Sciences** is one of the few Master programmes worldwide with a focus on **Evolutionary Medicine**. It has been part of Medical Life Sciences from the start, and for a reason.

Diseases can be puzzling. Why certain conditions occur or how to treat them are often questions for which the answers are still pending. When regarding these [→ questions](#) from an evolutionary perspective, researchers often find answers.

Understanding something that first seemed incomprehensible is a powerful experience. It makes progress possible and leads to new approaches, which is very important in medicine to prevent, diagnose and treat medical conditions. Evolutionary Medicine helps create opportunities to do so.



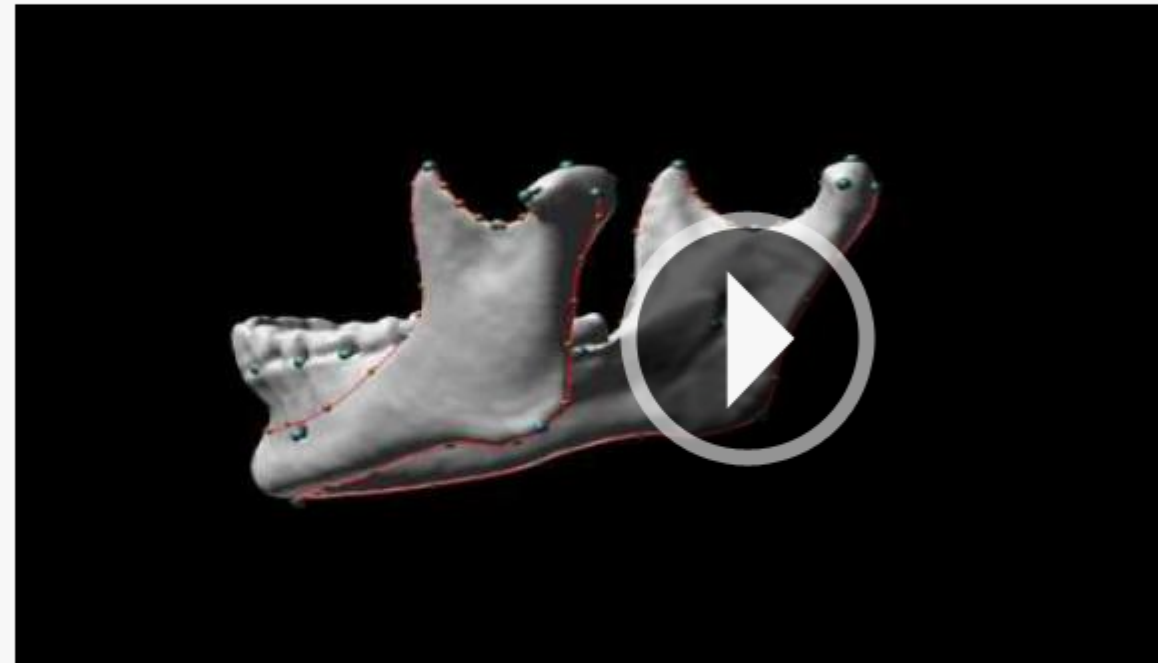
Bringing together evolution and medicine gets fascinating once you start looking at cancer, allergies, ageing, autoimmune disorders or chronic diseases: Why do we suffer from chronic conditions such as diabetes, heart disease or obesity? Why do pathogens develop drug resistance? Can we do something against it? How do our gut bacteria and diet influence our health? The more questions you try to answer, the more intriguing it gets.

You study the connections between evolution and medicine - developing hypotheses, connecting the dots and getting ready to conduct research yourself in your thesis and beyond: Evolutionary Medicine is one of the biggest drivers in today's biomedicine.

In Kiel, you are extremely well positioned for plunging into Evolutionary Medicine - or EvoMed for short:

- Medical Life Sciences has been teaching EvoMed since the programme started, with professors hosting seminars for students, running international research projects and supervising students in their thesis work. As an EvoMed student, you will be involved in research from the start.
- EvoMed lecturers are investigators in the [→ ROOTS](#) Cluster of Excellence. This huge interdisciplinary research project at Kiel University revolves around human societies through history. One big aspect is health. EvoMed researchers investigate how humans adapted to

## Biohistory & Evolutionary Medicine Laboratory



[Dr. Hila May](#)

Our biohistory and evolutionary medicine laboratory focuses on several fields of interest:

- **Evolutionary medicine:** The impact of the "trade off" mechanism on present human health. Many parts of our body had to accommodate themselves in order to facilitate the development of our large brain and erect posture.
- **Biohistory:** Much of our history is recorded in our bones. Advanced methodologies allow us to reconstruct important events on the individual level as well as on the population level. This includes daily lifestyles, health, nutrition, inter or intra-personal violence, labor intensity, demographical structure, etc.
- **Ancient DNA:** The reconstruction of past population structure and migration. The Levant witnessed dramatic population movements and replacements during the last 15,000 years, which shaped the region's history.

### Related Links



- [Dan David Center for Human Evolution and Biohistory Research](#)
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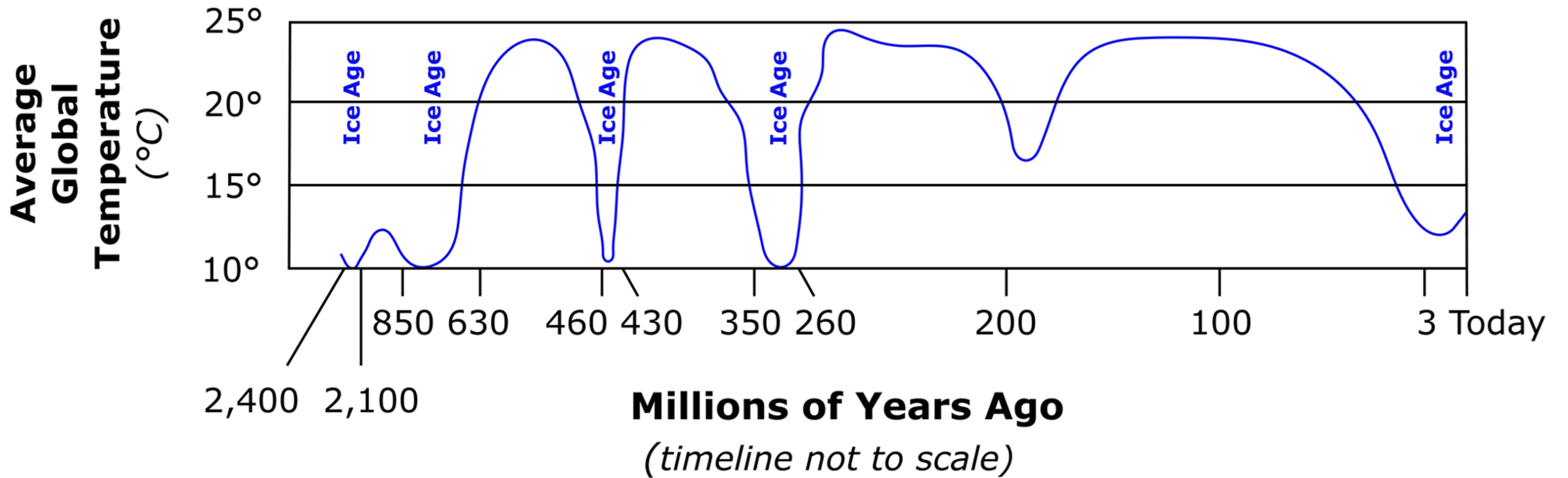
# Svante Pääbo



*Things to know about the geneticist who won this year's Nobel Prize in Physiology or Medicine*

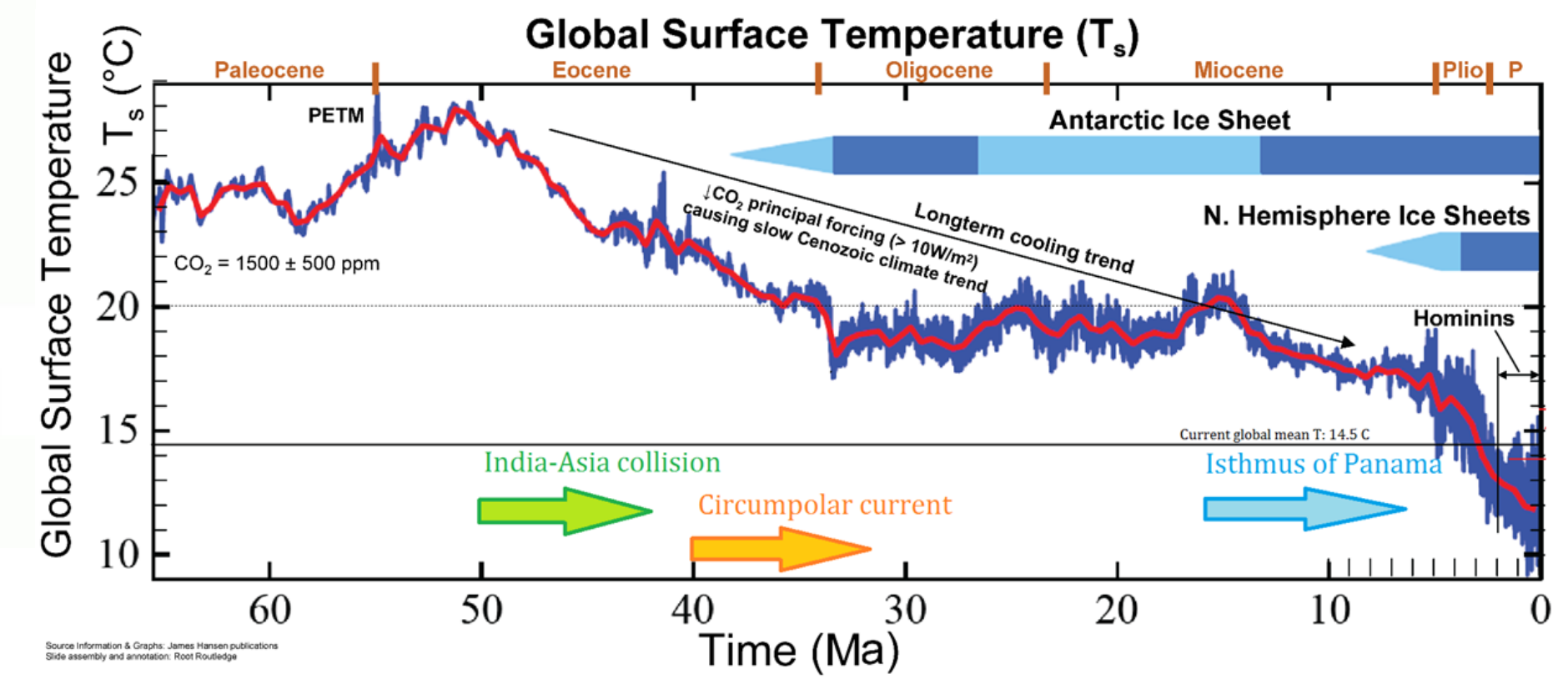
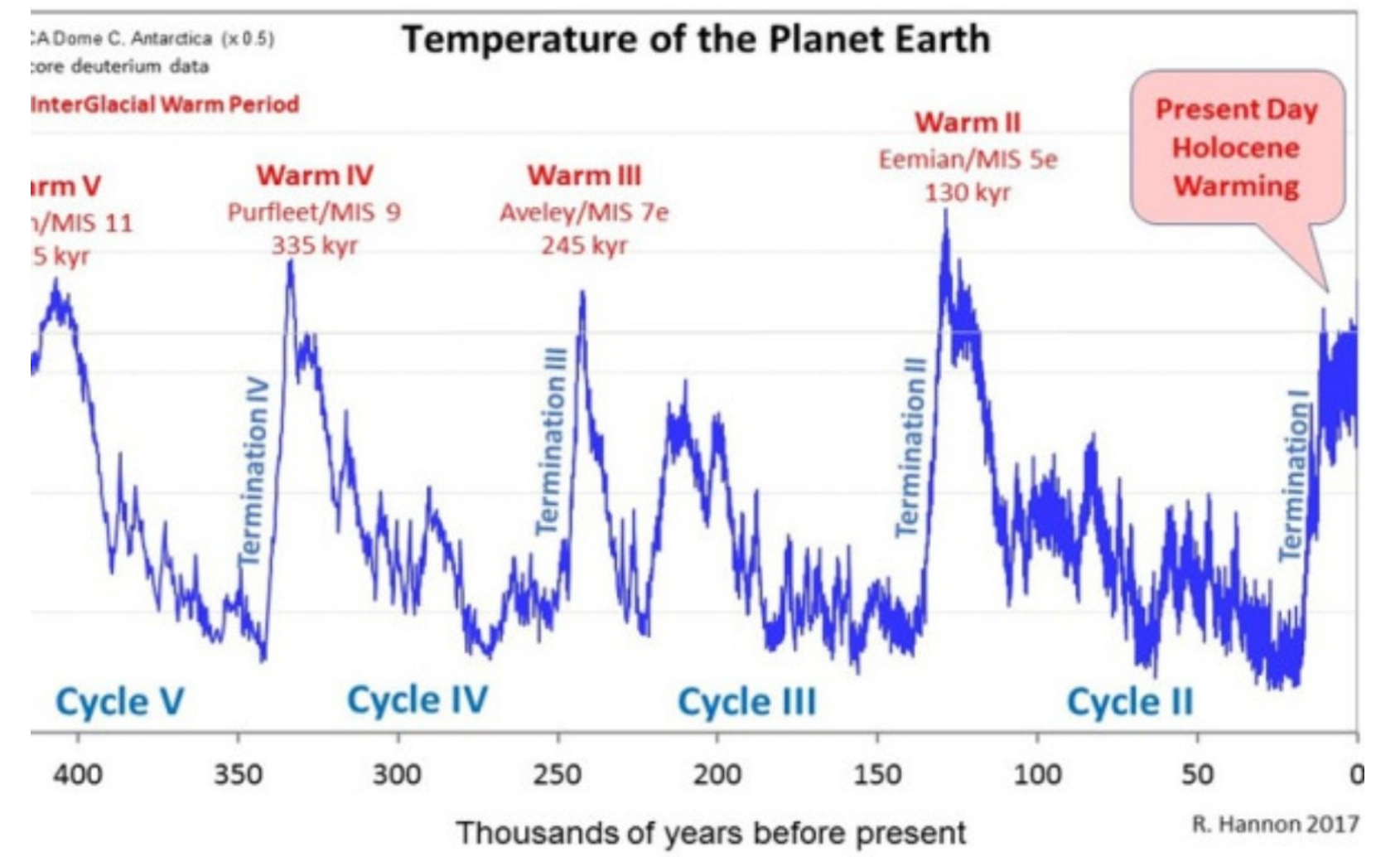
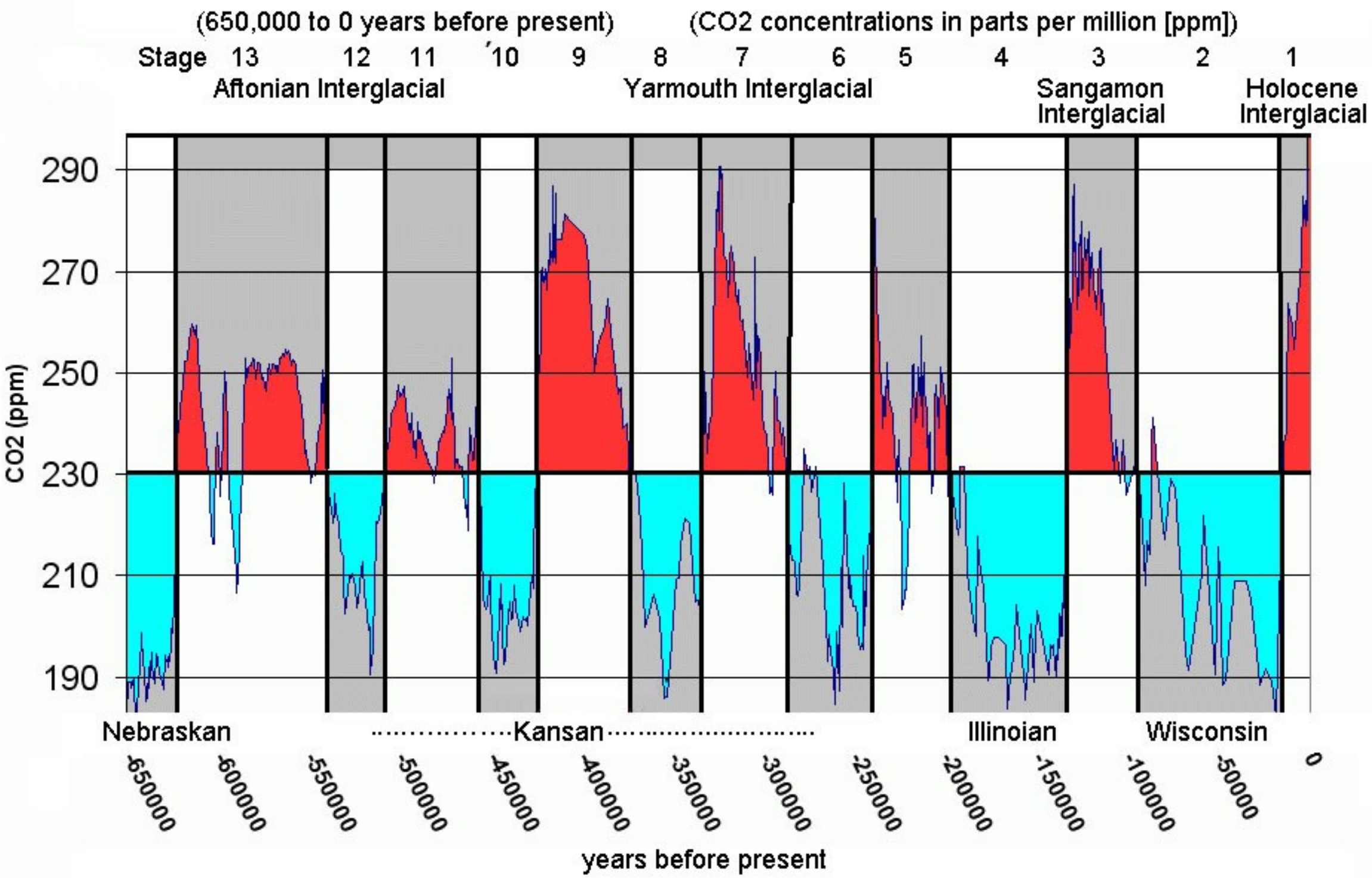
# Doby ledové

## Ice Ages during the past 2.4 billion years



# Doby ledové

Late Pleistocene glaciations compared with atmospheric CO<sub>2</sub> concentrations from glacial ice



# Doby ledové

## Global Glacial Coverage During the LGM

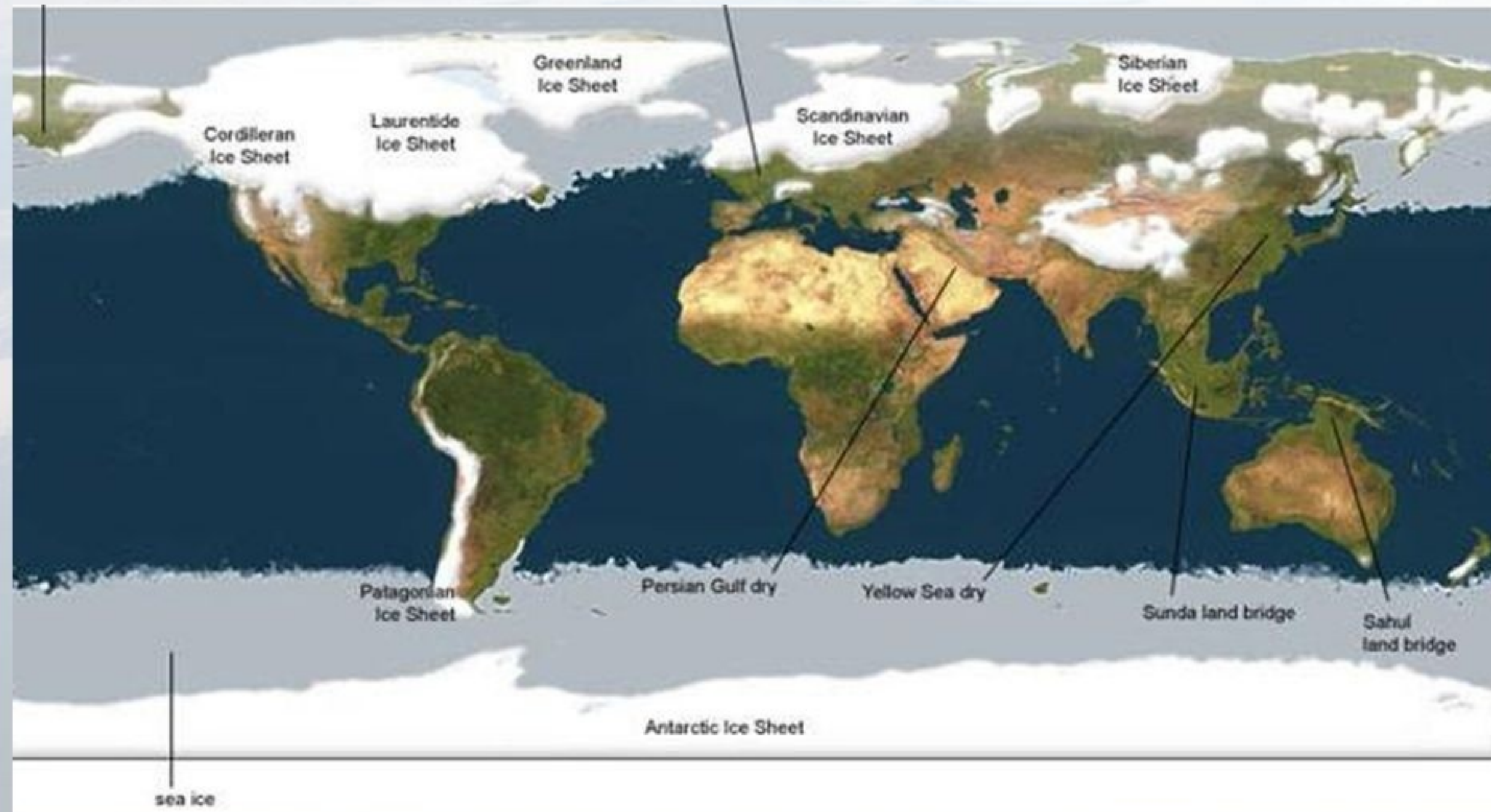


Image Source: <http://www.humberriver.ca/globalice.html>



**Člověk neandertálský – *Homo neanderthalesis***

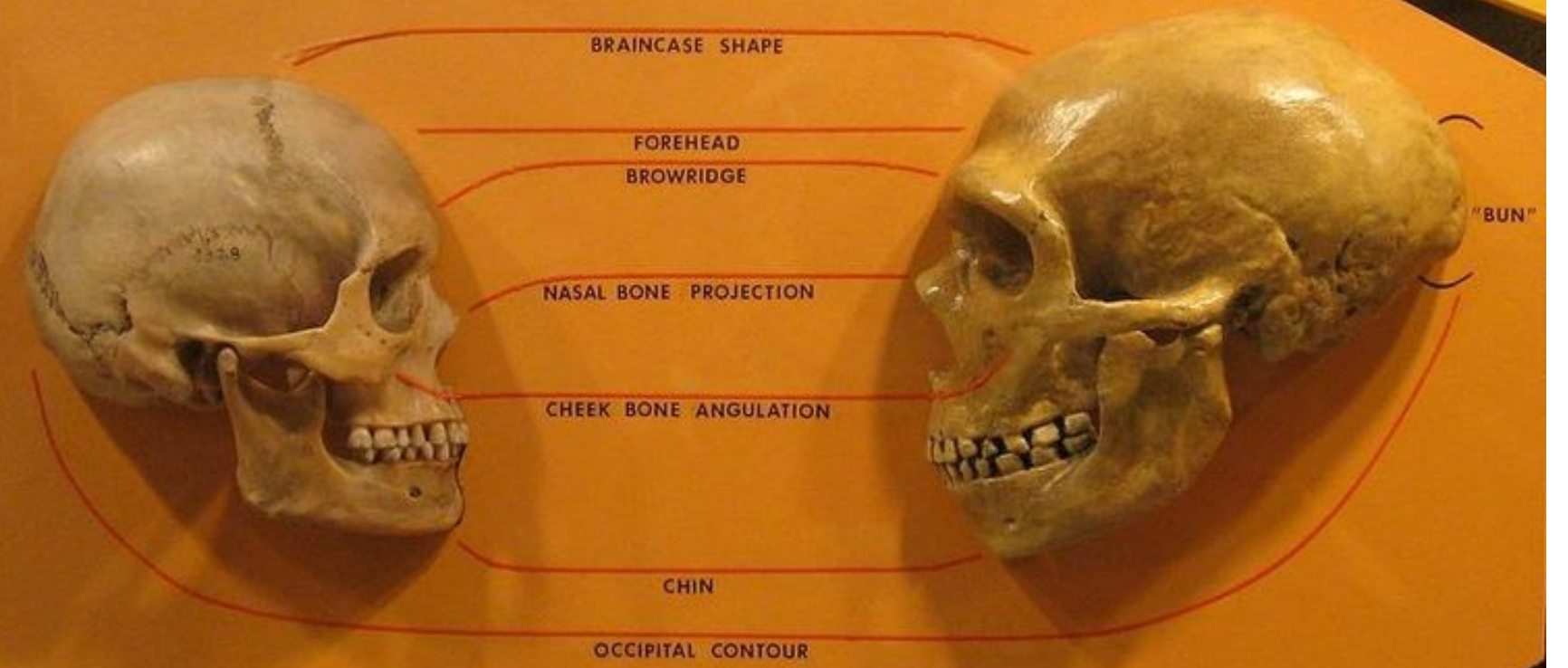


Neanderthal

Modern human



Cranial features of Modern Man and Neanderthal compared





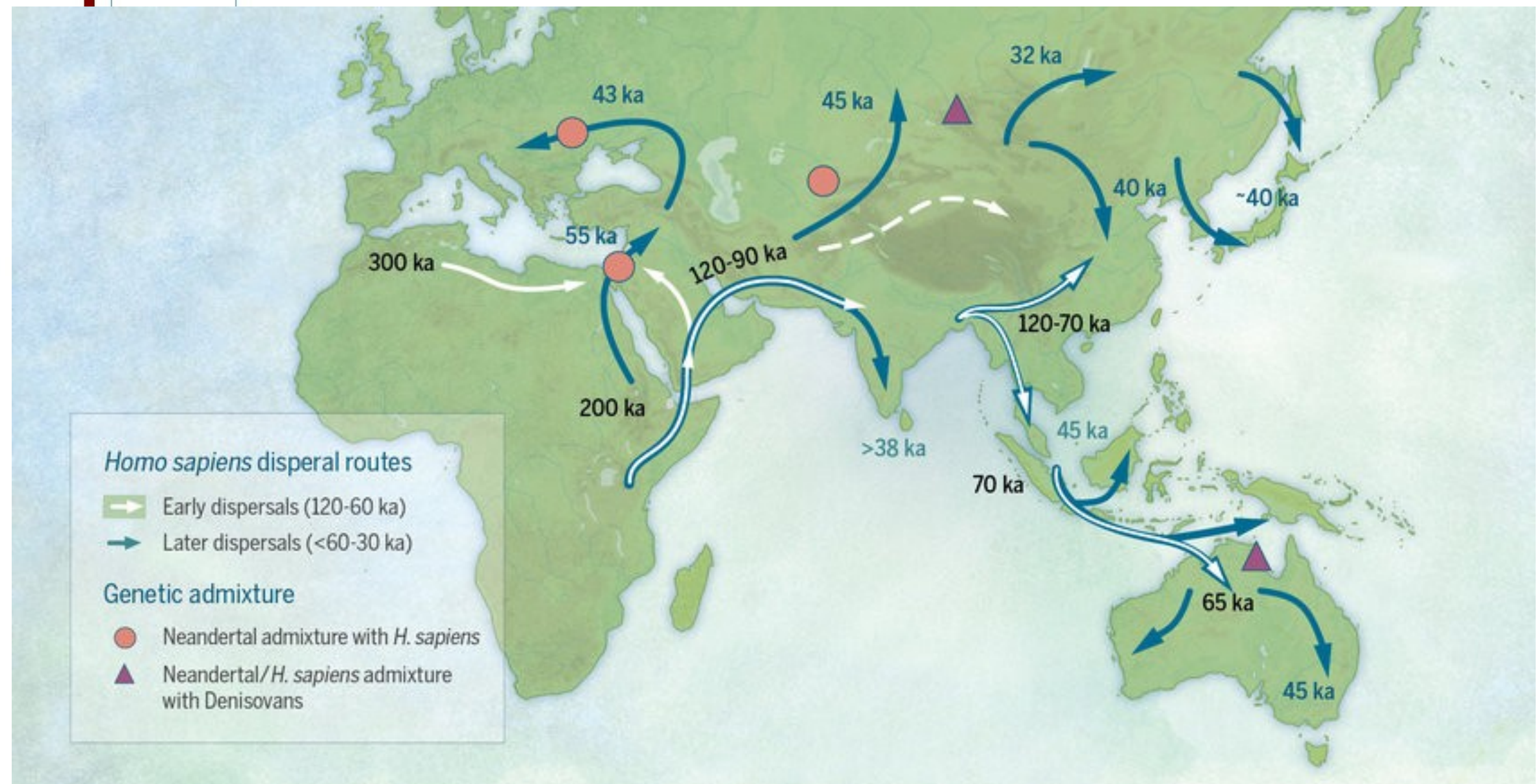
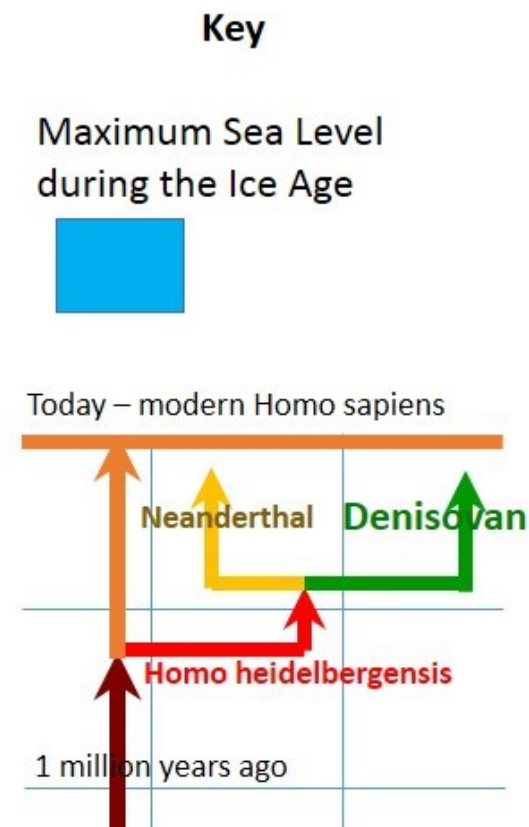
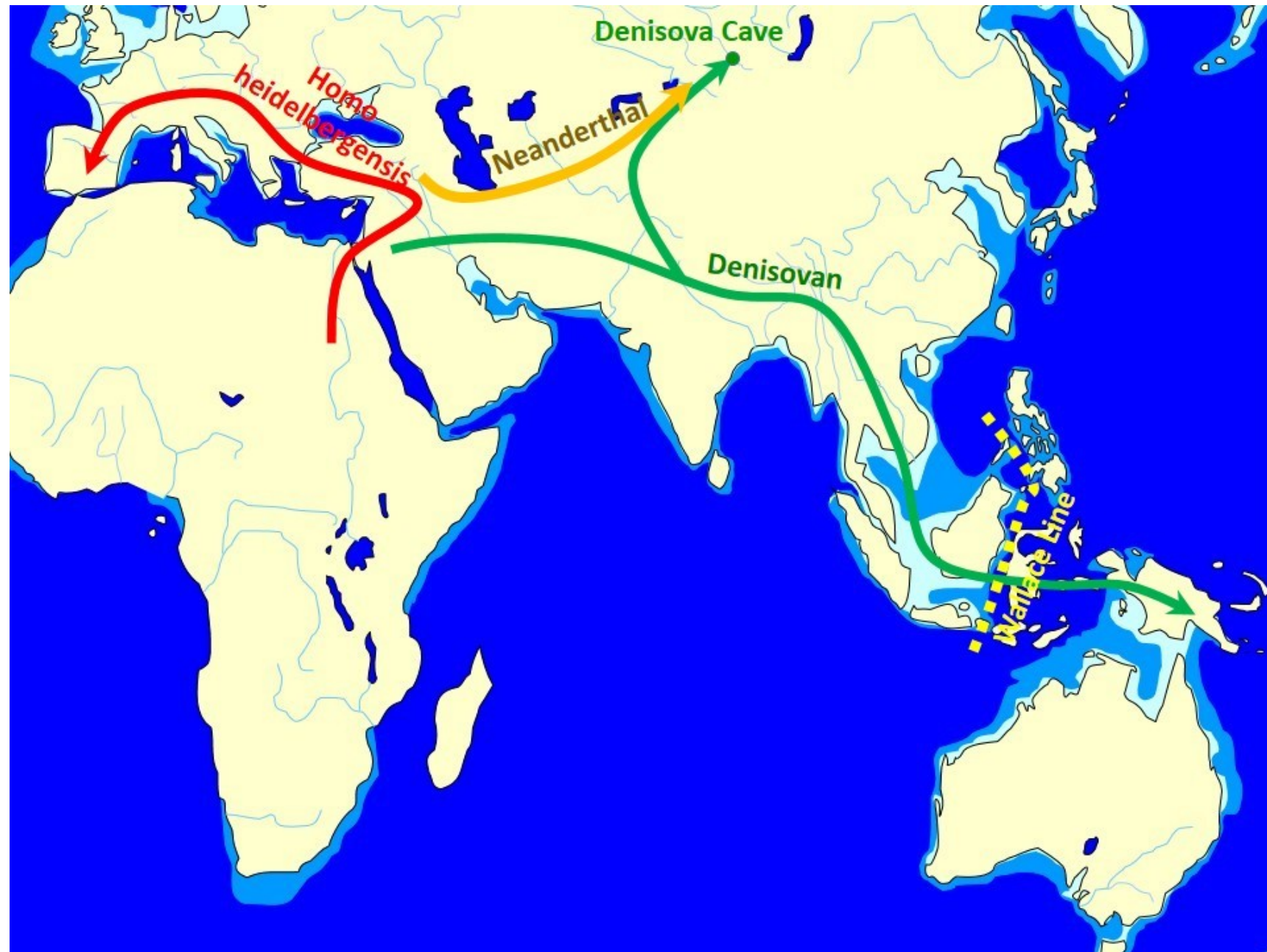


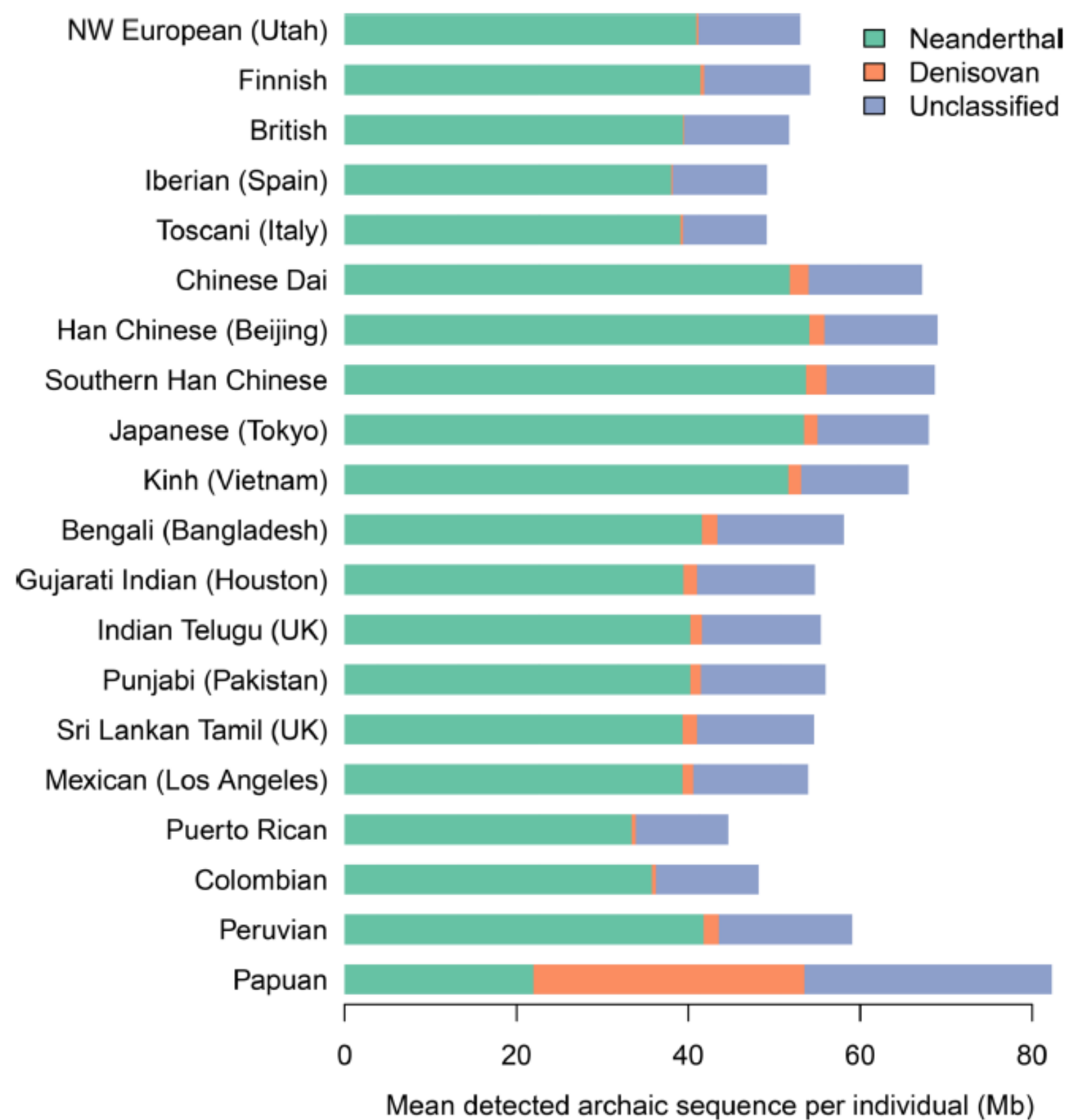




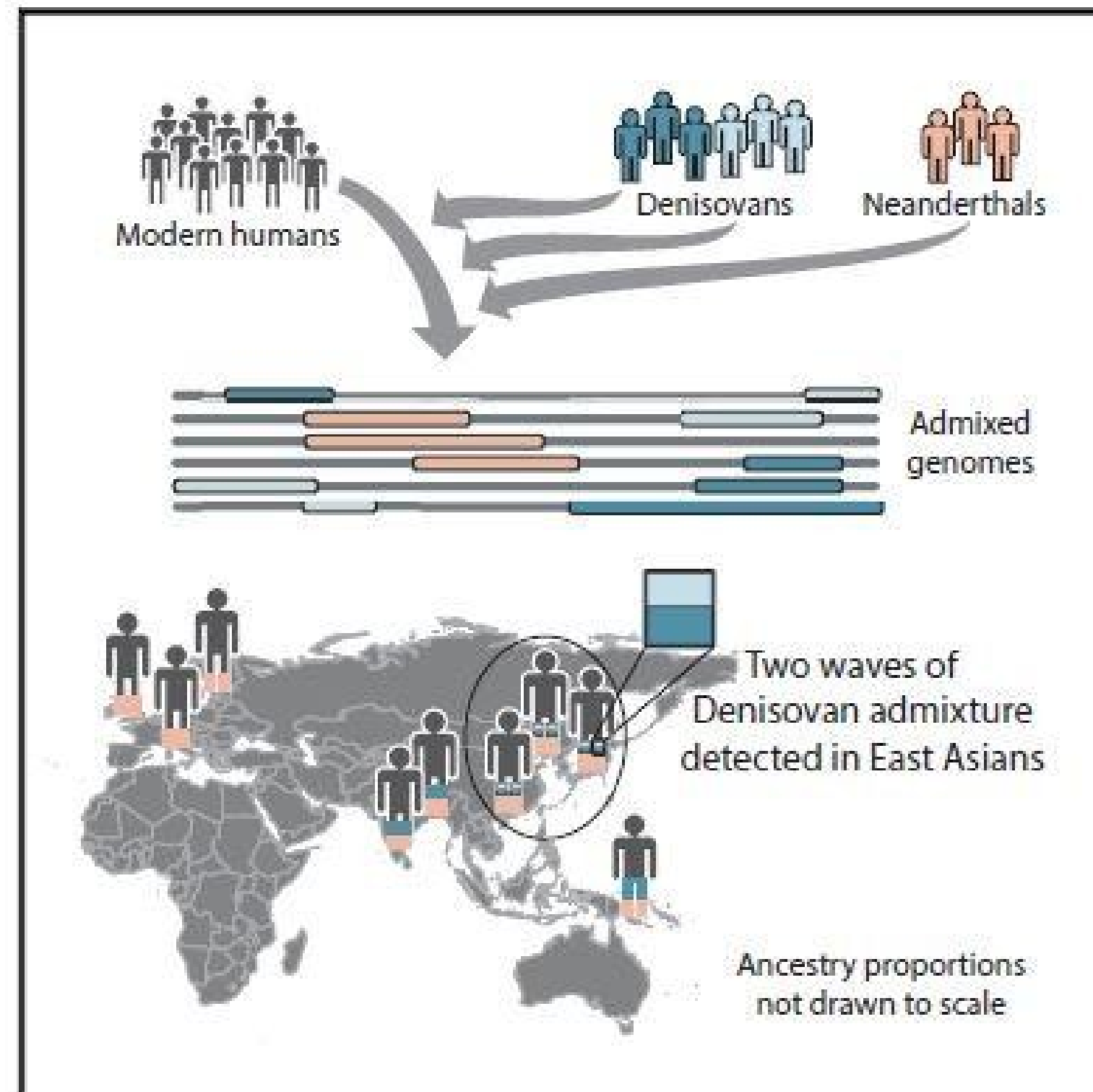
# *Homo denisoviensis*

# Migrace moderního člověka

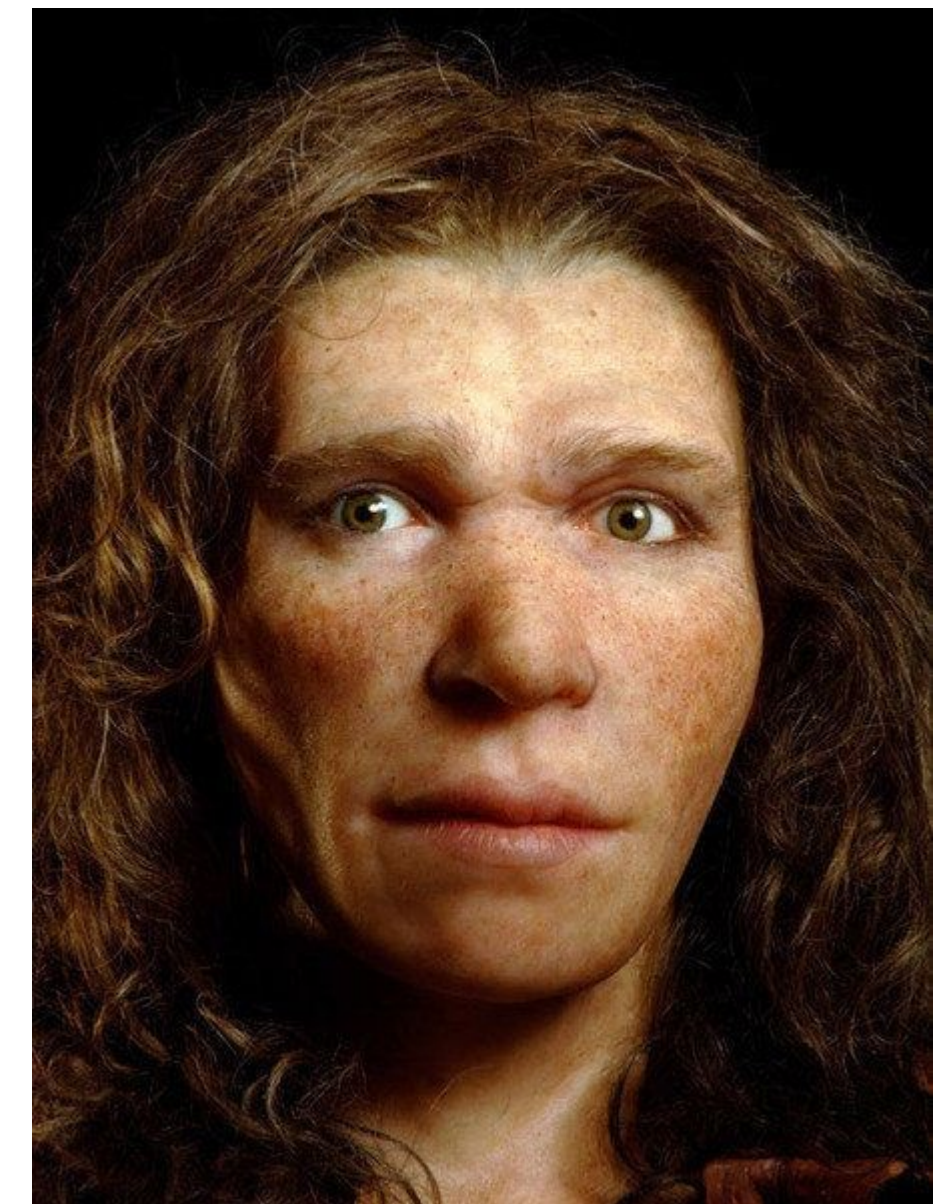




**Figure 5. Mean amounts of detected introgressed material per individual, classified by affinity to the Altai Neanderthal and Altai Denisovan genomes**  
 Definitions of the affinity groups are given in Methods. Unclassified material includes segments that are too short to be confidently classified into an affinity group, as well as longer segments that have low levels of affinity to the archaic genomes.



# Adaptace neandertálců na klima v Evropě a co jsme po nich zdědili



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*Science*. Author manuscript; available in PMC 2016 August 12.

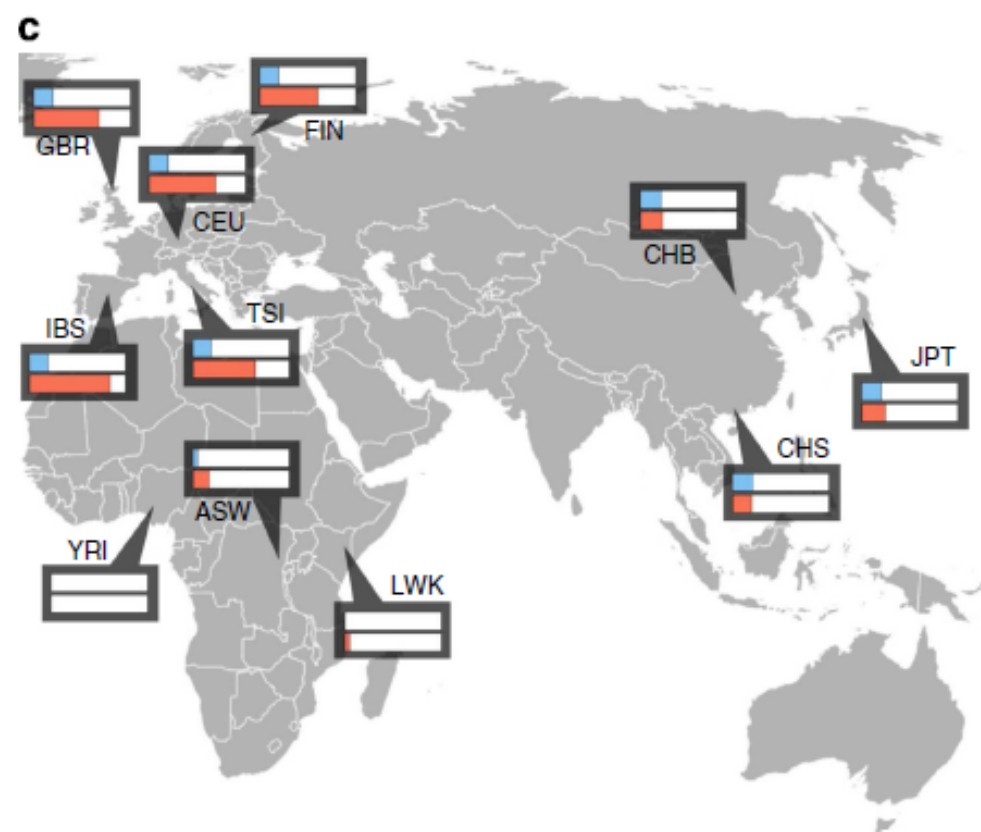
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*Science*. 2016 February 12; 351(6274): 737–741. doi:10.1126/science.aad2149.

## The phenotypic legacy of admixture between modern humans and Neanderthals

Corinne N. Simonti<sup>1</sup>, Benjamin Vernot<sup>2</sup>, Lisa Bastarache<sup>3</sup>, Erwin Bottinger<sup>4</sup>, David S. Carrell<sup>5</sup>, Rex L. Chisholm<sup>6</sup>, David R. Crosslin<sup>2,5</sup>, Scott J. Hebring<sup>7</sup>, Gail P. Jarvik<sup>2,5</sup>, Iftikhar J. Kullo<sup>8</sup>, Rongling Li<sup>9</sup>, Jyotishman Pathak<sup>10</sup>, Marylyn D. Ritchie<sup>11,12</sup>, Dan M. Roden<sup>13,14</sup>, Shefali S. Verma<sup>11</sup>, Gerard Tromp<sup>15,16</sup>, Jeffrey D. Prato<sup>3</sup>, William S. Bush<sup>17</sup>, Joshua M. Akey<sup>†,2</sup>, Joshua C. Denny<sup>†,1,3,13</sup>, and John A. Capra<sup>1,3,18,19,\*</sup>





ARTICLE

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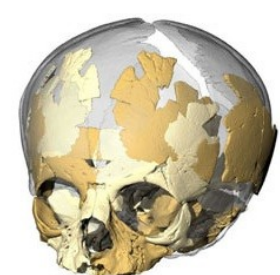
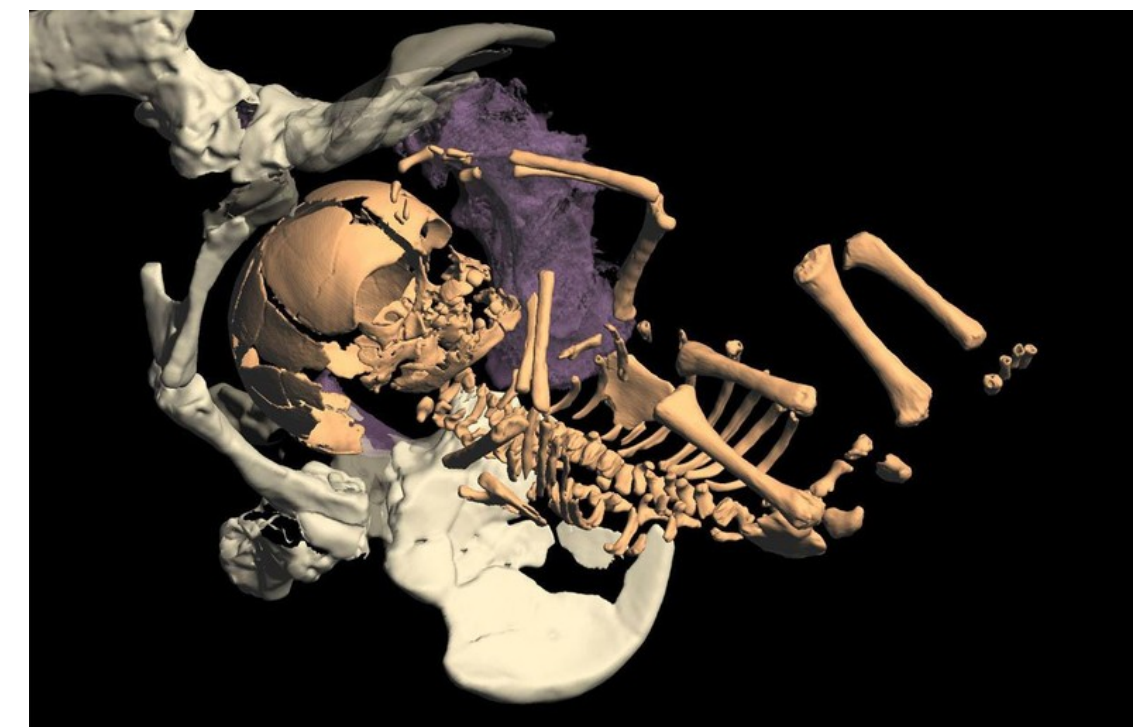
## Neanderthal ancestry drives evolution of lipid catabolism in contemporary Europeans

Ekaterina E. Khrameeva<sup>1,2</sup>, Katarzyna Bozek<sup>1,3</sup>, Liu He<sup>1</sup>, Zheng Yan<sup>1</sup>, Xi Jiang<sup>1</sup>, Yuning Wei<sup>1</sup>, Kun Tang<sup>1</sup>, Mikhail S. Gelfand<sup>2,4</sup>, Kay Prufer<sup>3</sup>, Janet Kelso<sup>3</sup>, Svante Paabo<sup>3</sup>, Patrick Giavalisco<sup>5</sup>, Michael Lachmann<sup>3</sup> & Philipp Khaitovich<sup>1,3</sup>

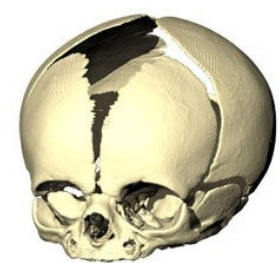
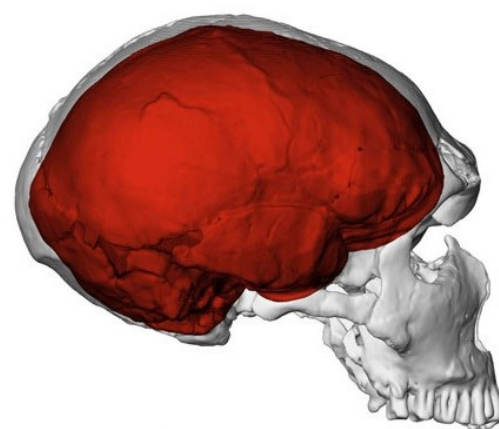
# Tuková tkáň



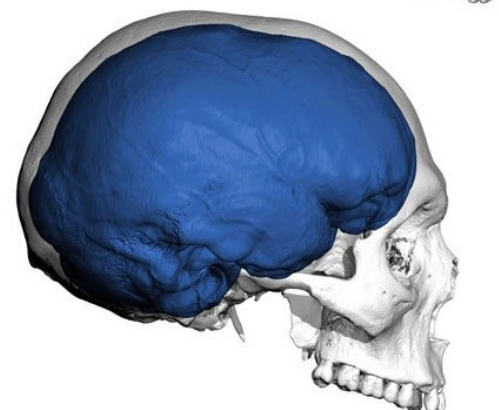
## Víc dětí a méně potratů



Neanderthal neonate



Homo sapiens neonate



## The Neanderthal Progesterone Receptor

Hugo Zeberg <sup>\*,1,2</sup> Janet Kelso,<sup>1</sup> and Svante Pääbo<sup>\*,1,3</sup>

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Associate editor: Daniel Falush



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**Report**

## **A Neanderthal Sodium Channel Increases Pain Sensitivity in Present-Day Humans**

Hugo Zeberg,<sup>1,2,6,\*</sup> Michael Dannemann,<sup>1</sup> Kristoffer Sahlholm,<sup>2,3</sup> Kristin Tsuo,<sup>1</sup> Tomislav Maricic,<sup>1</sup> Victor Wiebe,<sup>1</sup> Wulf Hevers,<sup>1</sup> Hugh P.C. Robinson,<sup>2,4</sup> Janet Kelso,<sup>1</sup> and Svante Pääbo<sup>1,5,\*</sup>

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### Evidence that RNA viruses drove of adaptive introgression between Neanderthals and modern humans

David Enard<sup>1,2,\*</sup> and Dmitri A Petrov<sup>3</sup>



- Odolnost či náchylnost k virovým infekcím

#### Article

### The major genetic risk factor for severe COVID-19 is inherited from Neanderthals

<https://doi.org/10.1038/s41586-020-2818-3> Hugo Zeberg<sup>1,2,\*</sup> & Svante Pääbo<sup>1,2,3</sup>

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Published online: 30 September 2020

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A recent genetic association study<sup>1</sup> identified a gene cluster on chromosome 3 as a risk locus for respiratory failure after infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). A separate study (COVID-19 Host Genetics Initiative)<sup>2</sup> comprising 3,199 hospitalized patients with coronavirus disease 2019 (COVID-19) and control individuals showed that this cluster is the major genetic risk factor for severe symptoms after SARS-CoV-2 infection and hospitalization. Here we show that the risk is conferred by a genomic segment of around 50 kilobases in size that is inherited from Neanderthals and is carried by around 50% of people in south Asia and around 16% of people in Europe.

### A genomic region associated with protection against severe COVID-19 is inherited from Neandertals

Hugo Zeberg<sup>a,b,1</sup> and Svante Pääbo<sup>a,c,1</sup>

<sup>a</sup>Department of Evolutionary Genetics, Max Planck Institute for Evolutionary Anthropology, D-04103 Leipzig, Germany; <sup>b</sup>Department of Neuroscience, Karolinska Institutet, SE-17177 Stockholm, Sweden; and <sup>c</sup>Human Evolutionary Genomics Unit, Okinawa Institute of Science and Technology, Okinawa 904-0495, Japan

Contributed by Svante Pääbo, January 22, 2021 (sent for review December 21, 2020; reviewed by Tobias L. Lenz and Lluís Quintana-Murci)





## LETTER

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### Altitude adaptation in Tibetans caused by introgression of Denisovan-like DNA

Emilia Huerta-Sánchez<sup>1,2,3\*</sup>, Xin Jin<sup>1,4\*</sup>, Asan<sup>1,5,6\*</sup>, Zhuoma Bianba<sup>7\*</sup>, Benjamin M. Peter<sup>2</sup>, Nicolas Vin<sup>2</sup>, Xin Yi<sup>1,5,6</sup>, Mingze He<sup>1,8</sup>, Mehmet Somel<sup>9</sup>, Peixiang Ni<sup>1</sup>, Bo Wang<sup>1</sup>, Xiaohua Ou<sup>1</sup>, Huasang<sup>1</sup>, Jiangbai Luosang<sup>1</sup>, Kui Li<sup>11</sup>, Guoyi Gao<sup>12</sup>, Ye Yin<sup>1</sup>, Wei Wang<sup>1</sup>, Xiuqing Zhang<sup>1,13,14</sup>, Xun Xu<sup>1</sup>, Huanming Yang<sup>1,15,16</sup>, Yingrui Li<sup>1</sup>, Jun Wang<sup>1,15,17,18,19</sup> & Rasmus Nielsen<sup>1,2,20,21</sup>

**Přizpůsobení vysokohorským podmínkám Tibetánů získaných od *Homo denisoviensis***

**Děkuji za  
pozornost!**

