# Microevolution and Macroevolution

- How does Microevolution add up to macroevolution?
- What are species?
- How are species created?
- What are anagenesis and cladogenesis?

# Species Concepts

- **Biological species concept**: Defines species as interbreeding populations reproductively isolated from other such populations.
- **Evolutionary species concept**: Defines species as evolutionary lineages with their own unique identity.
- **Ecological species concept**: Defines species based on the uniqueness of their ecological niche.
- **Recognition species concept**: Defines species based on unique traits or behaviors that allow members of one species to identify each other for mating.

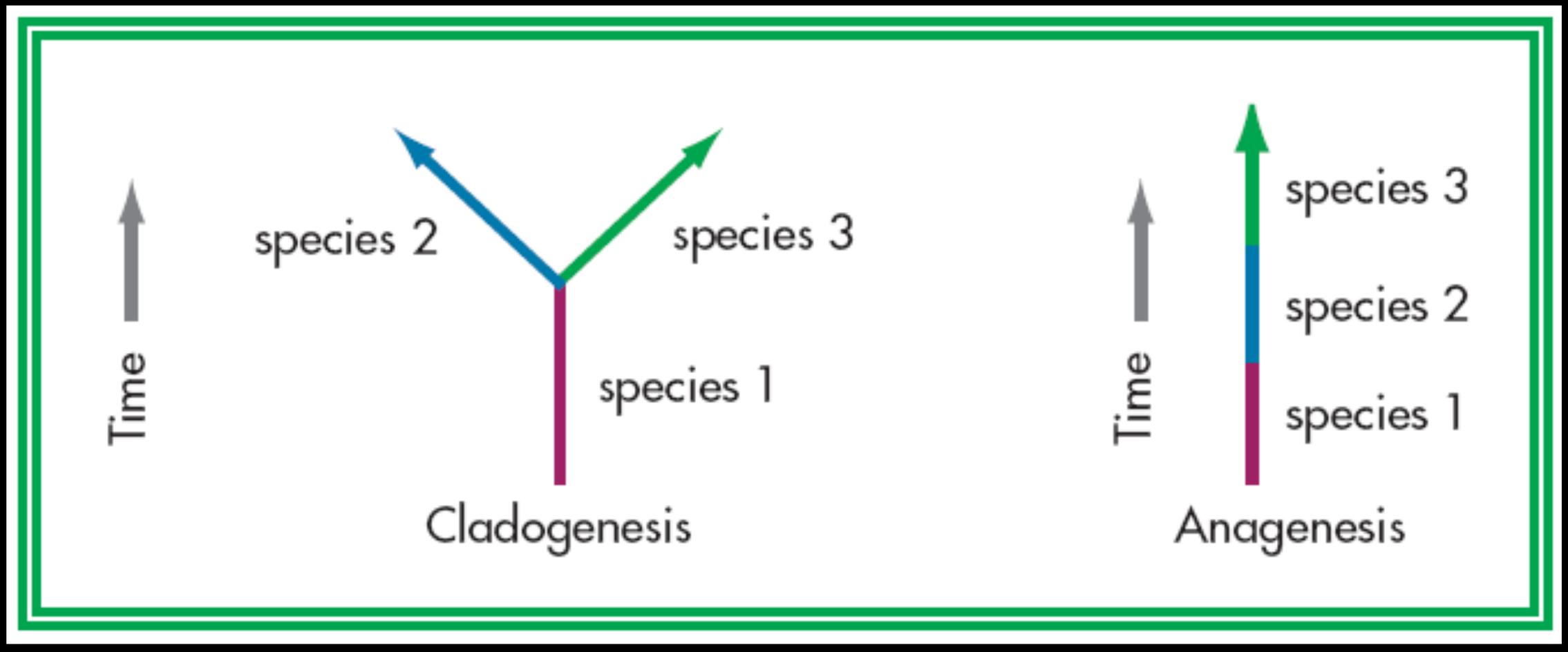
# Reproductive Isolating Mechanisms

- Premating RIMs

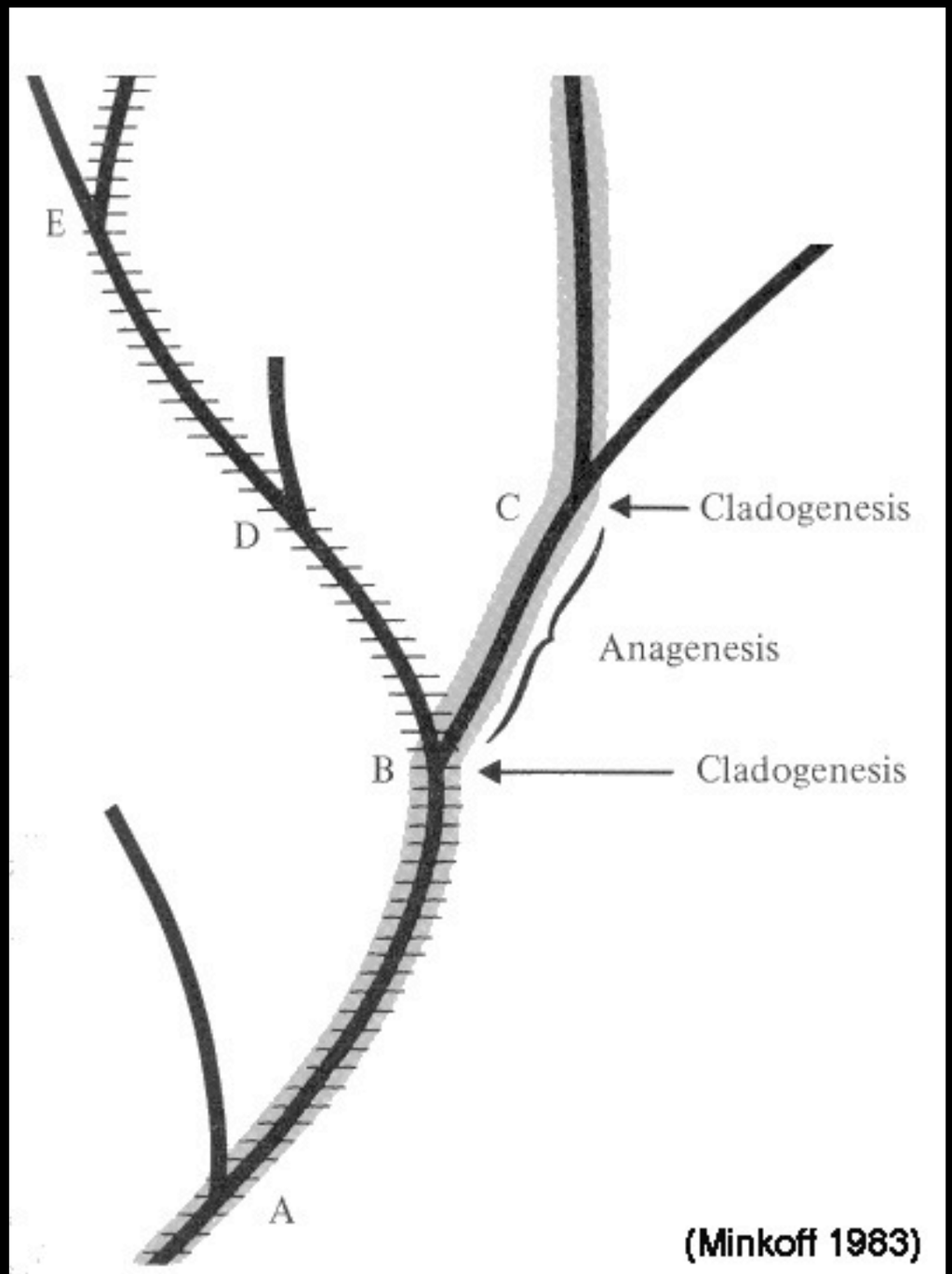
  Habitat isolation
  Temporal isolation
  Behavioral isolation
  Mechanical incompatibility

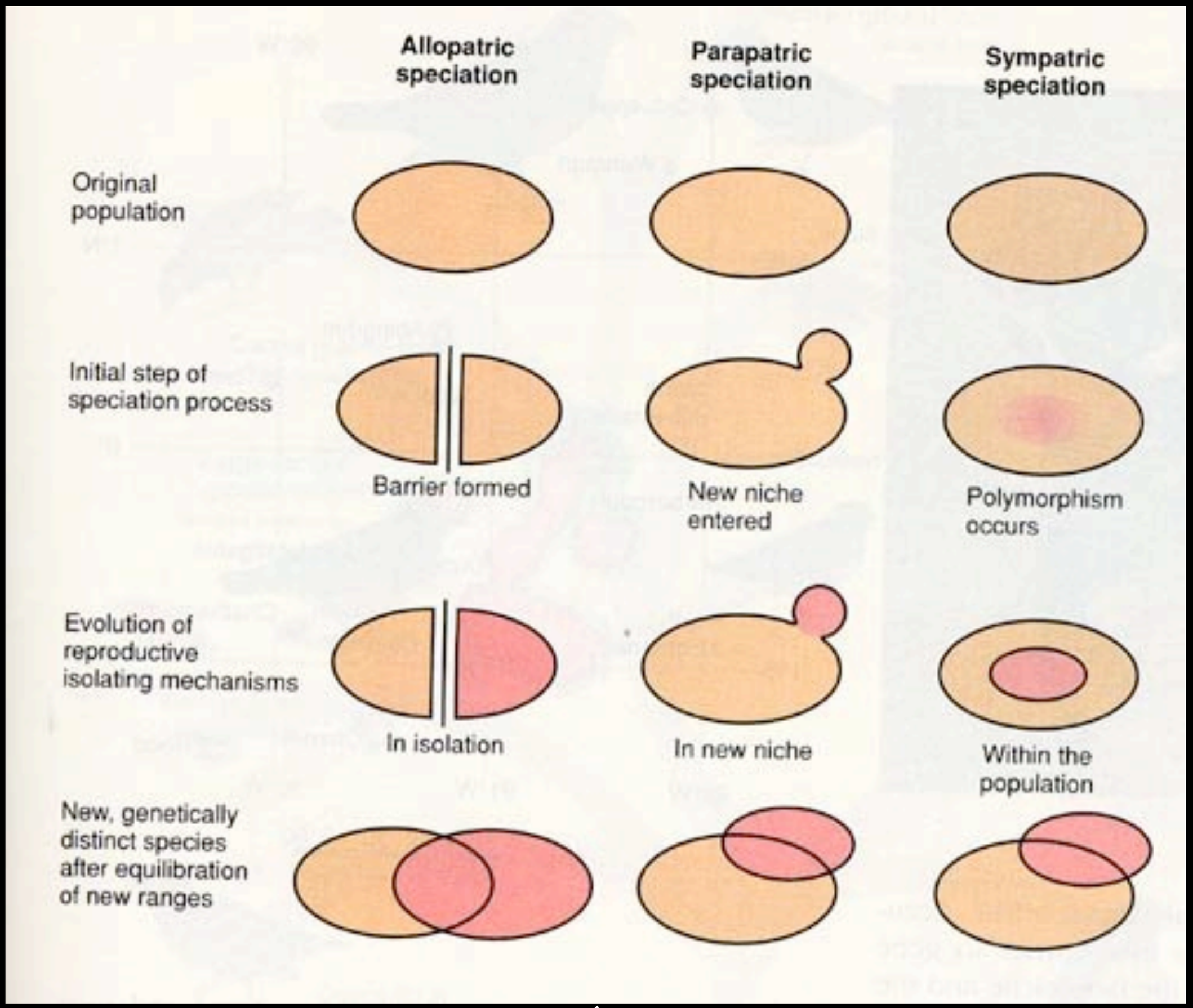
- Postmating RIMs
  Sperm-egg incompatibility
  Zygote inviability
  Embryonic or fetal inviability

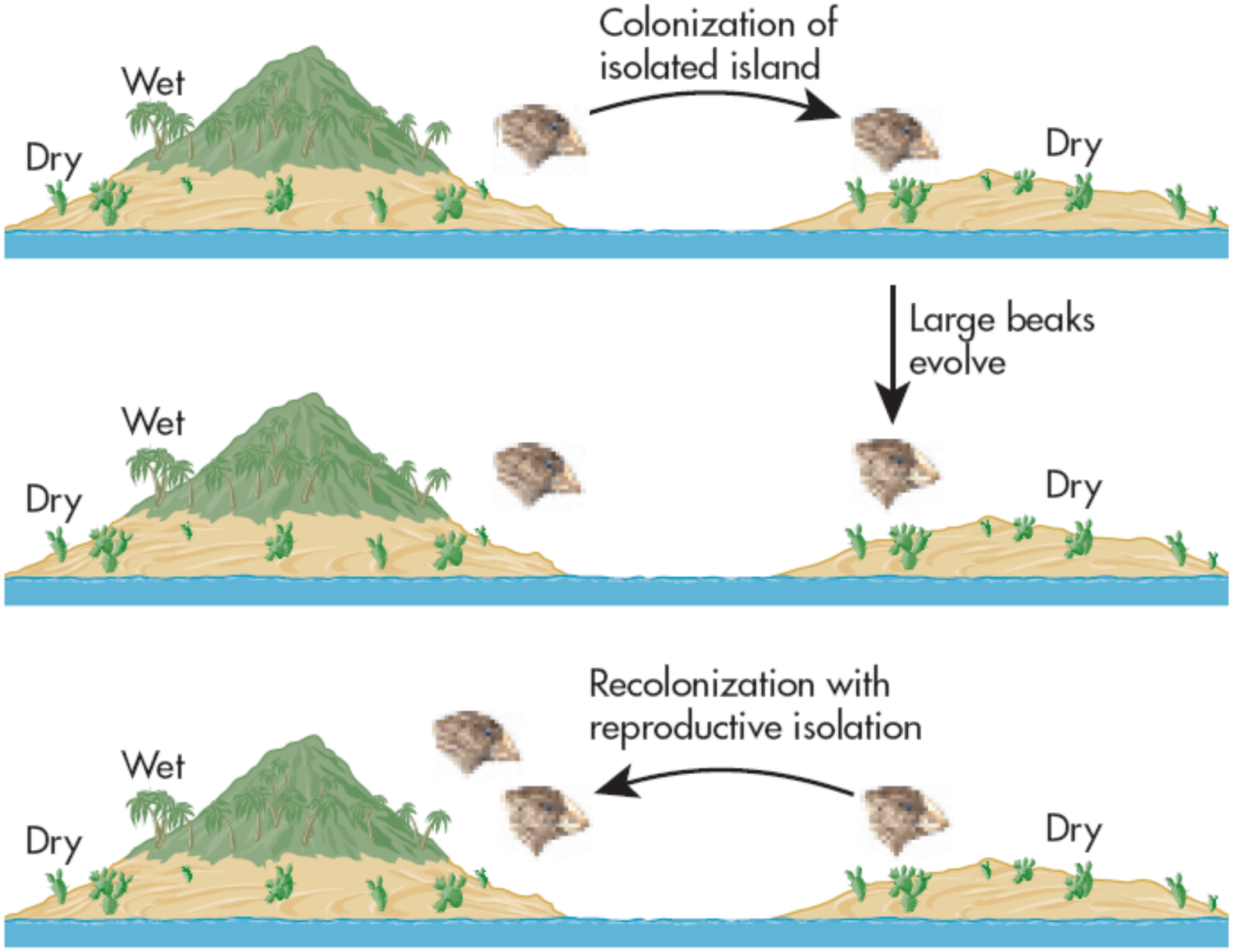
# Modes of Evolutionary Change



# Cladogenesis




Allopatric speciation
Parapatric speciation
Sympatric speciation
Original population
Initial step of speciation process
Barrier formed
New niche entered
Polymorphism occurs
Evolution of reproductive isolating mechanisms
In isolation
In new niche
Within the population
New, genetically distinct species after equilibration of new ranges


Colonization of isolated island
Wet
Dry
Dry
Large beaks evolve
Wet
Dry
Dry
Recolonization with reproductive isolation
Wet
Dry
Dry

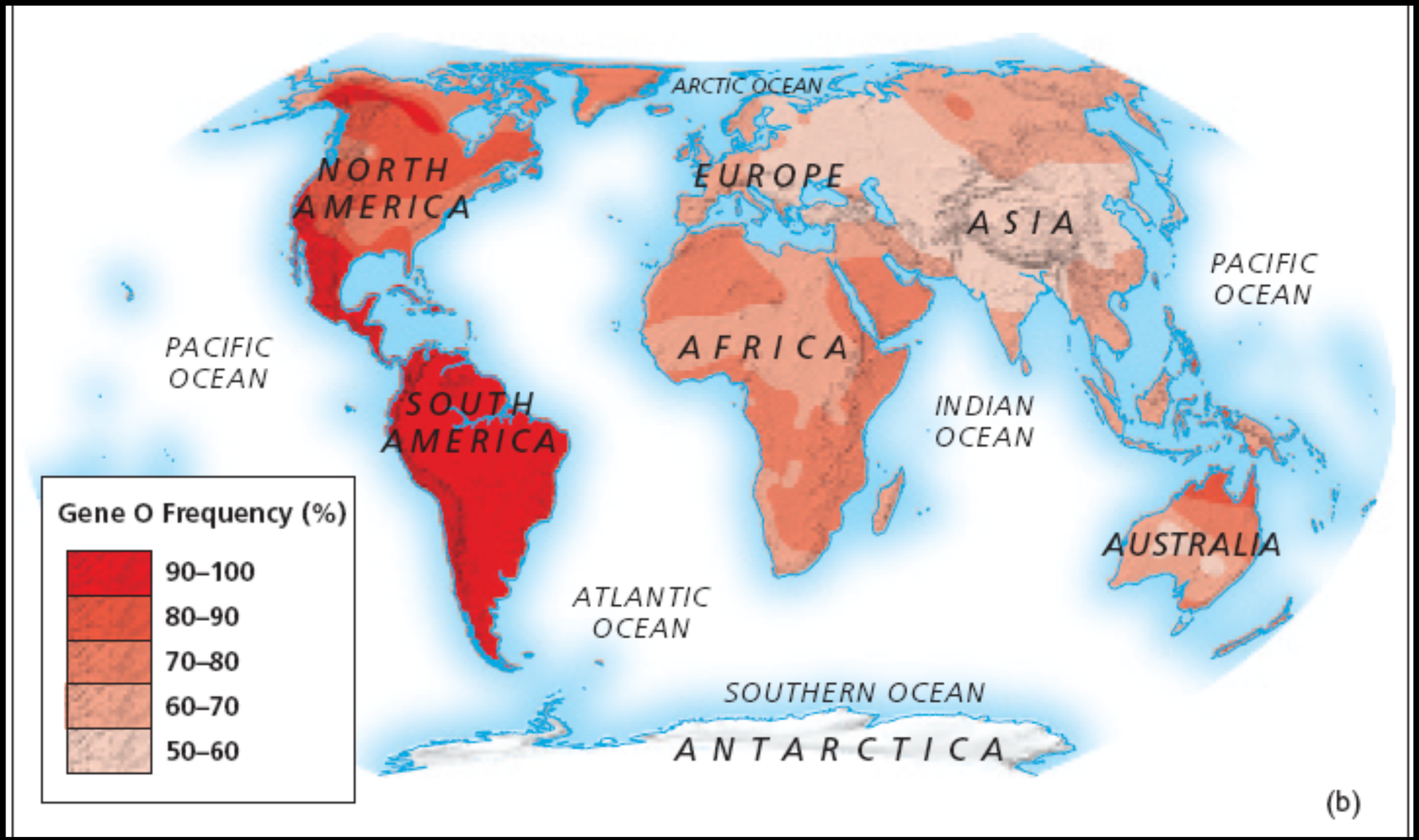
# Evolution is

"the simple way by which species (populations) become exquisitely adapted to various ends"

# All characteristics are due to the four forces

- Mutation creates new alleles - new variation
- Genetic drift moves these around by chance
- Gene flow moves these from one population to the next creating clines
- Natural selection increases and decreases them in frequency through adaptation

# Clines


ARCTIC OCEAN
NORTH AMERICA
EUROPE
ASIA
PACIFIC OCEAN
PACIFIC OCEAN
AFRICA
SOUTH AMERICA
INDIAN OCEAN
AUSTRALIA
ATLANTIC OCEAN
SOUTHERN OCEAN
ANTARCTICA
Gene O Frequency (%)
90–100
80–90
70–80
60–70
50–60
(b)

# Adaptation?

- An adaptation is an evolved phenotypic trait that increases an organism's reproductive success? that increases their fitness

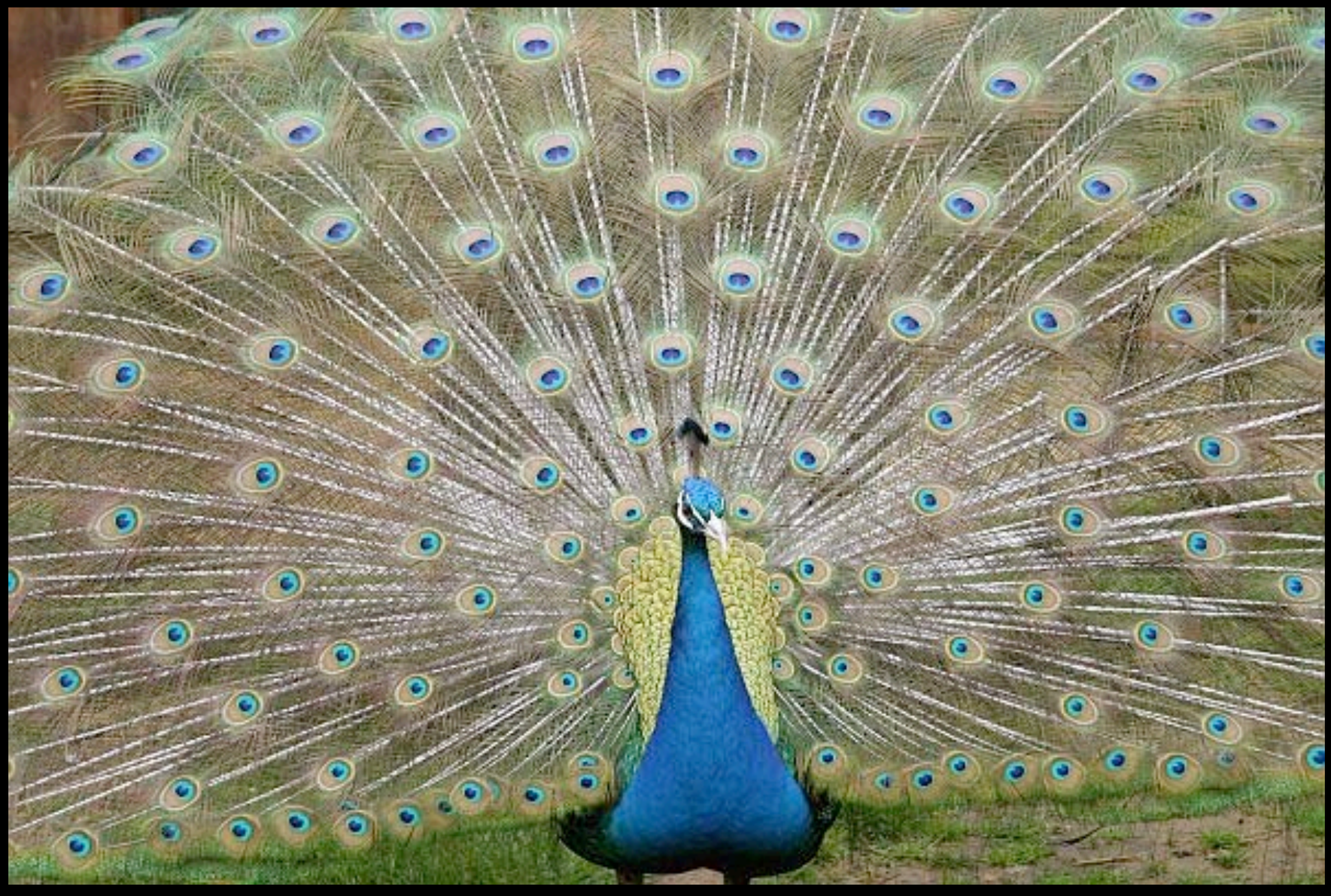
# Success measured as **Fitness**

- Success in natural selection is the ability to put one's genes in the next generation
- This can be directly or indirectly
- Those who put more genes into the next generation are more "fit" than others

# Effects on Fitness

- Own reproduction
  - survivorship
  - health
  - sexual opportunities
    - sexual selection
- Reproduction of relatives
  - kin selection

# Sexual selection



# Kin selection

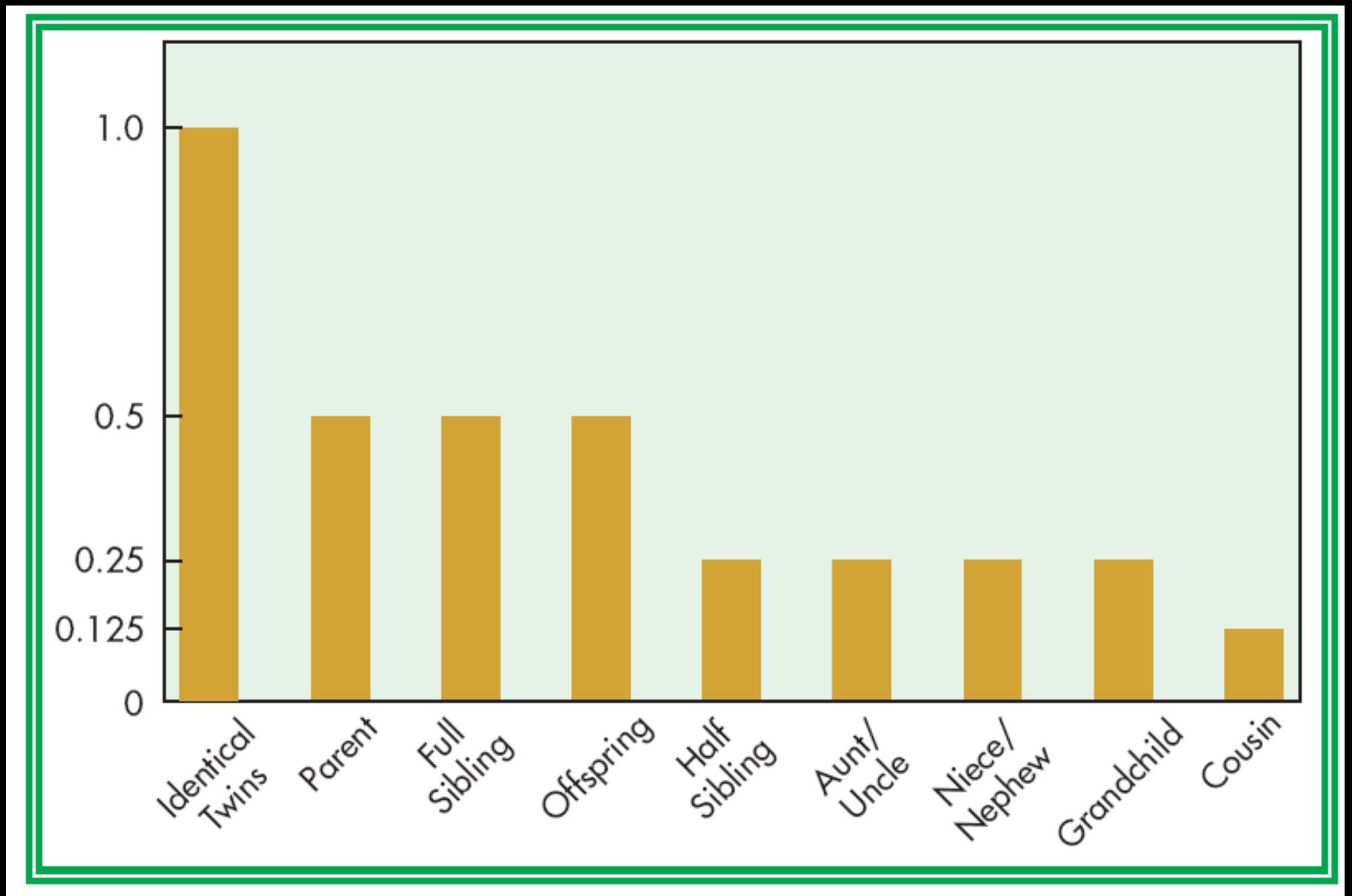
-helping kin helps own genes

-Vervet alarm calls

-Chimp patrols

- bees or ants

# Relatedness

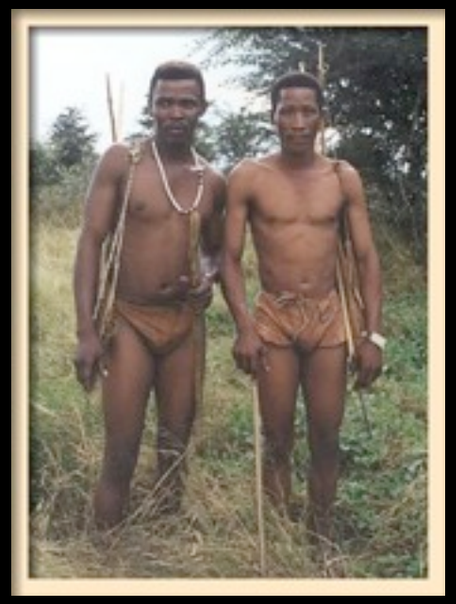


Human variation today is a result of evolution. It is the result of the four forces of evolution shaping our diversity.













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NEW ZEALAND

# Studying Human Variation - a Biocultural approach

Biology is intertwined with human cultural behavior and both shape human diversity

We have evolved through the 4 forces of evolution intertwined with cultural behavior

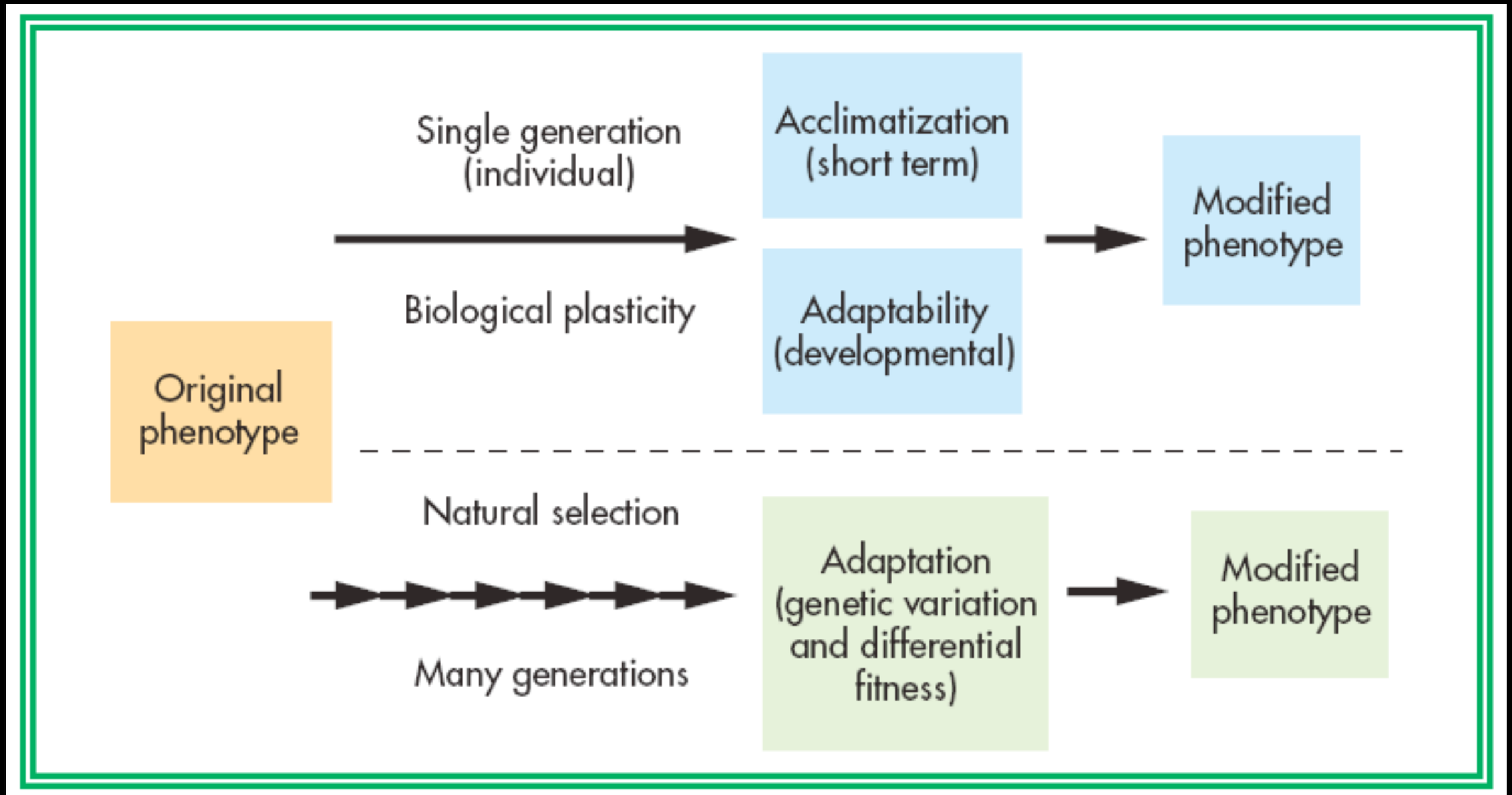
# Adaptation

- any change in an organism, either temporary or permanent, biological or cultural, short or long term, involving physiological, structural, behavioral or structural changes, aimed at improving the organisms functional performance in the face of environmental stress

## Genetic adaptation

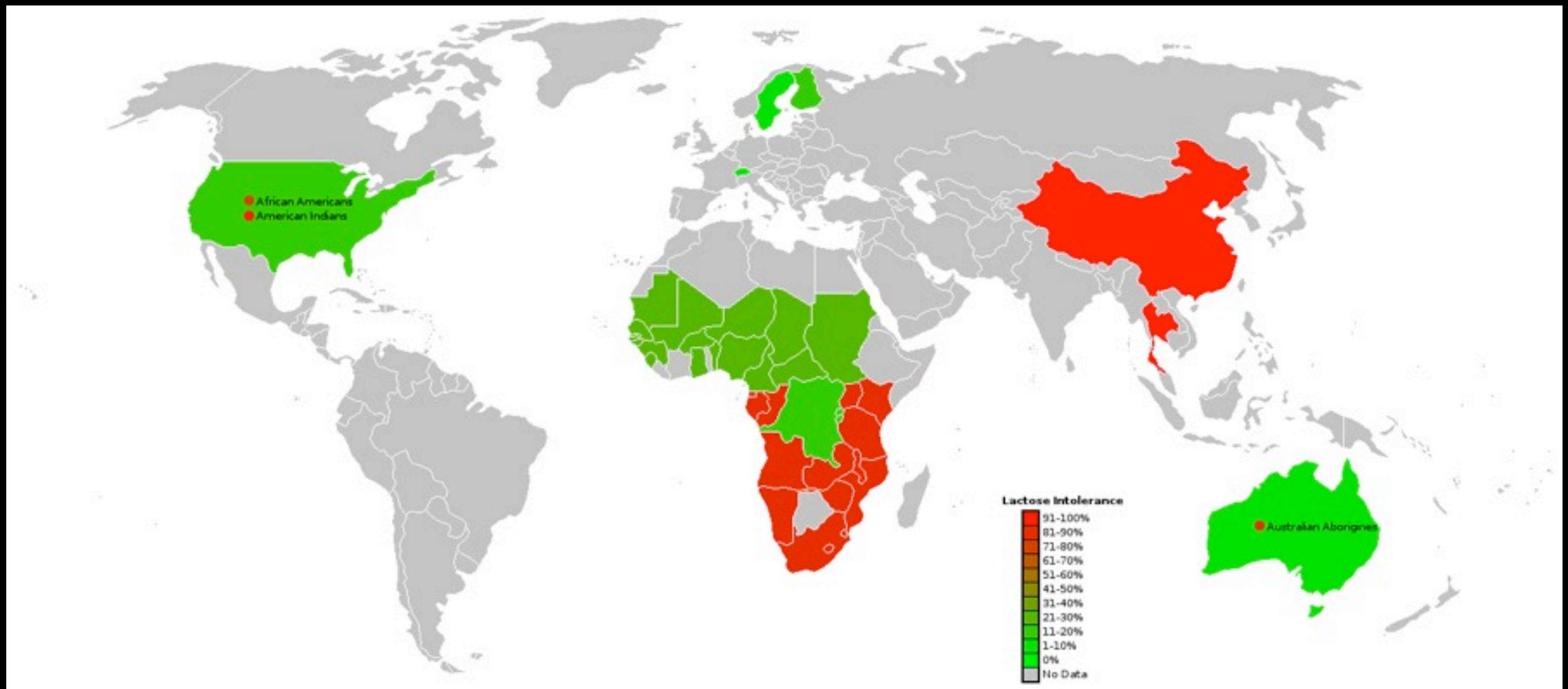
- only such changes that is the result of natural selection

# Adaptability and Acclimatization




# Genetic Adaptation

# Example - lactose tolerance




lactose tolerance is due to the lactase persistence allele (2q21)

# Across the world...

**TABLE 5.2 Lactose Absorption Rates in Different Populations**

| Population | Percentage Lactose Absorbers |
|---|---|
| AFRICA | |
| Bantu (West Africa) | 4 |
| Watutsi (East Africa) | 83 |
| Nilotic (Sudan) | 39 |
| South Africa | 17 |
| ASIA | |
| South India | 33 |
| Japan | 0 |
| Thailand | 2 |
| Taiwan Chinese | 0 |
| EUROPE | |
| Britain | 94 |
| Germany | 85 |
| Sweden | 100 |
| Italy | 25–50 |

# Across the world...

| | |
|---|---|
| NORTH AMERICA | |
| European American | 80–94 |
| African American | 25–30 |
| Apache | 0 |
| Chippewa | 30 |
| PACIFIC | |
| Fiji | 0 |
| New Zealand Maori | 36 |
| Australian Aborigines | 16 |
| Papua New Guinea | 11 |

*Sources:* Allen & Cheer (1996), Molnar (2002).

| | |
|---|---|
| Southeast Asians | 98% |
| Asian Americans | 90% |
| Alaskan Eskimo | 80% |
| African Americans Adults | 79% |
| Mexicans from rural | 73.8% |
| North American Jews | 68.8% |
| Greek Cypriots | 66% |
| Cretans | 56% |
| Mexican American Males | 55% |
| Indian Adults | 50% |
| African American Children | 45% |
| Indian Children | 20% |
| Caucasians of N. European and Scandinavian decent | 5% |

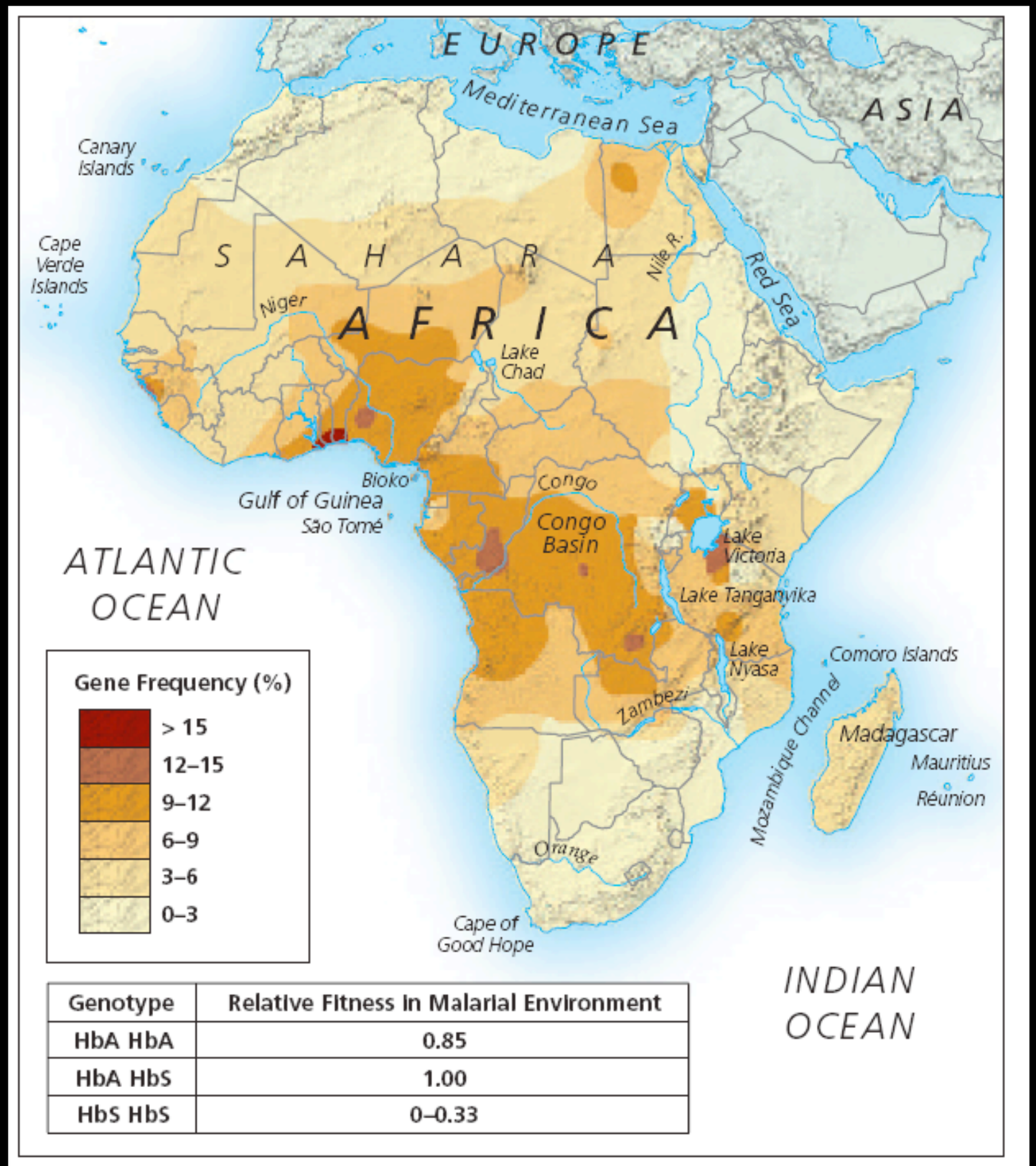
The A haplotype conferring lactose tolerance has an 86% frequency in the northern European population, **but only 36% in southern European populations**.

# WHY?

- high frequency in populations with a long history of dairying and using milk
- tolerance selected for in populations with dairy in diet
- even a modest selective advantage (5 -10%) could result in high frequencies in just 6000 years

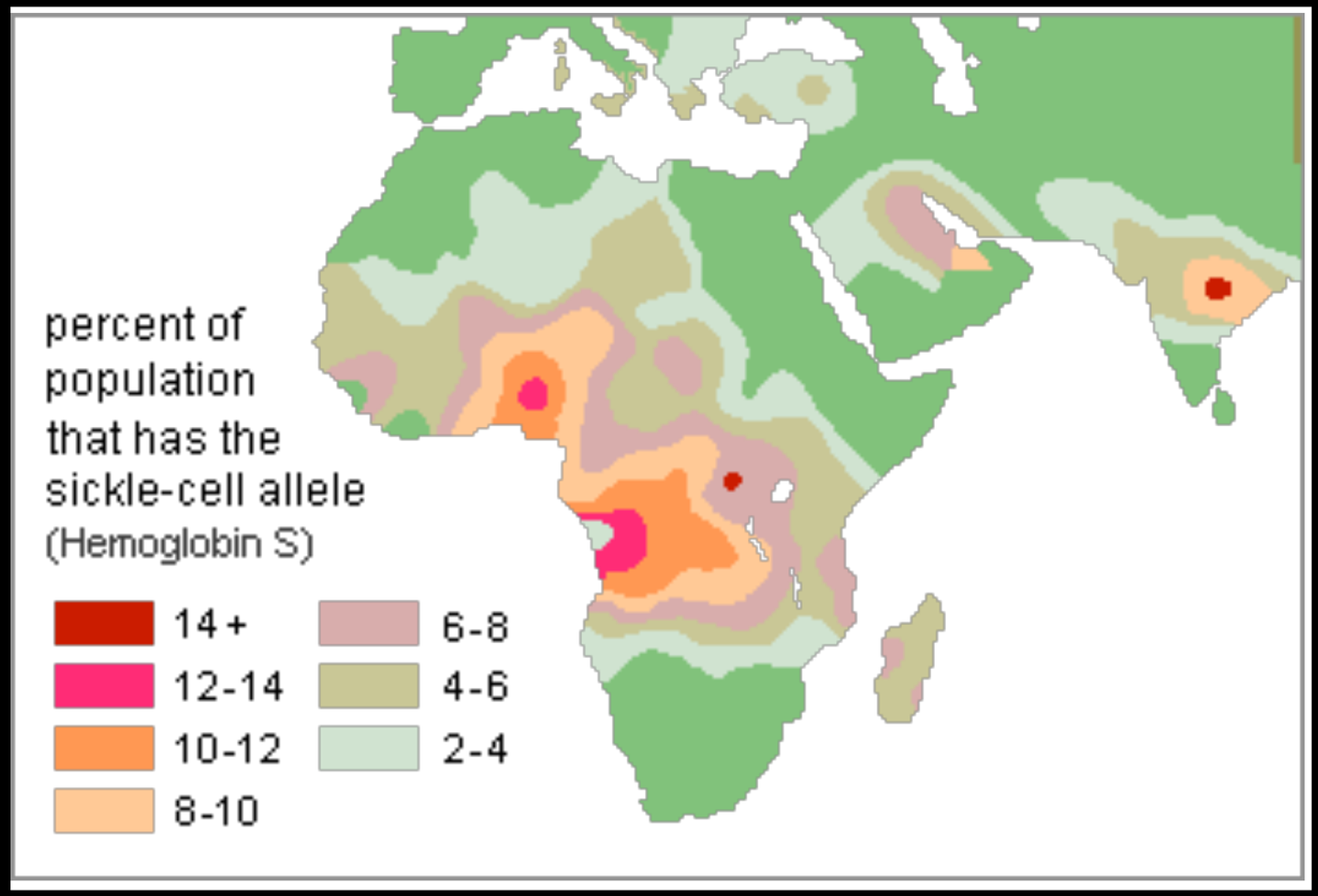
# Example: Sickle cell

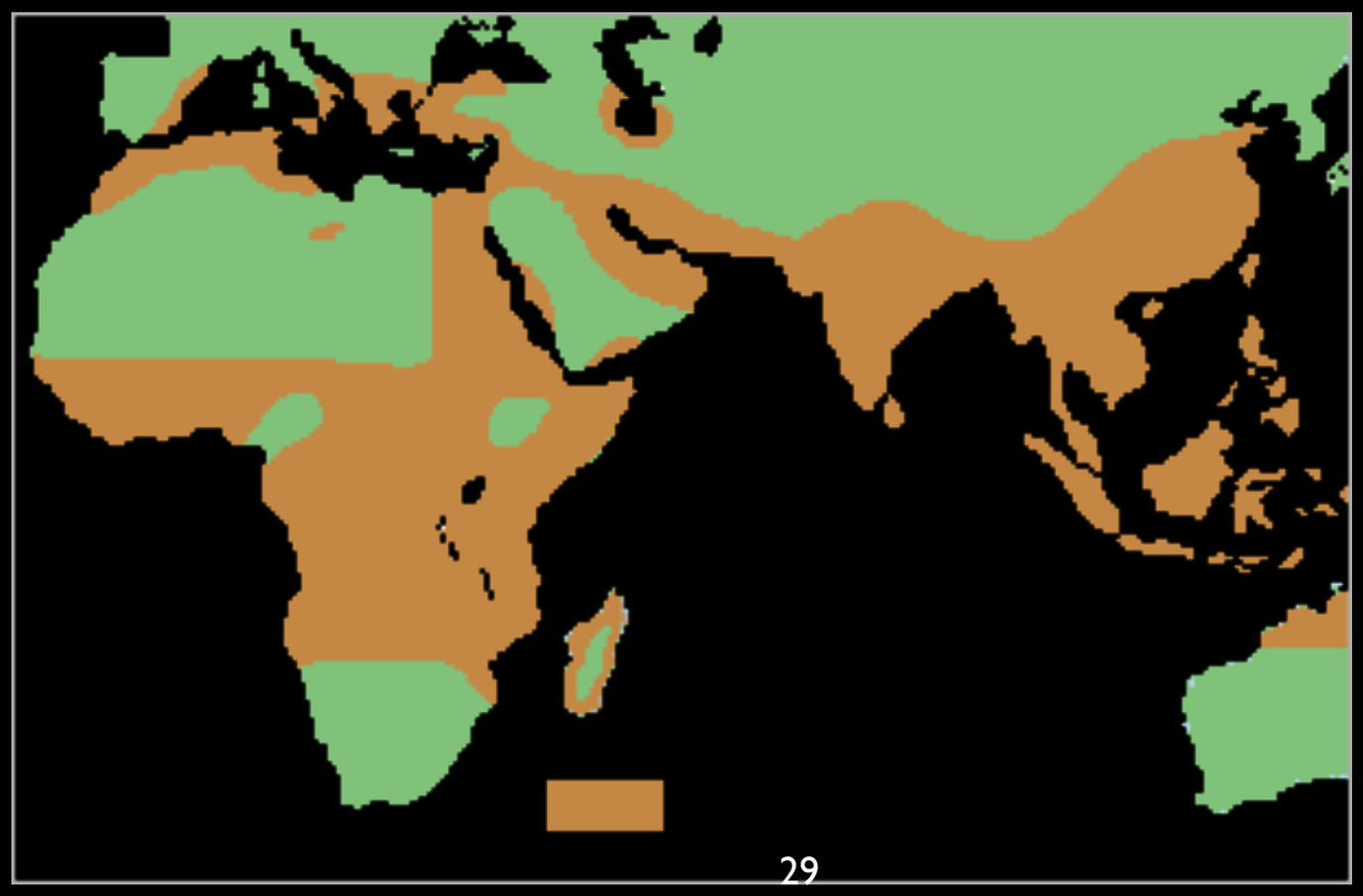
# Clinal map of Sickle Cell




| Genotype | Relative Fitness in Malarial Environment |
|---|---|
| HbA HbA | 0.85 |
| HbA HbS | 1.00 |
| HbS HbS | 0–0.33 |

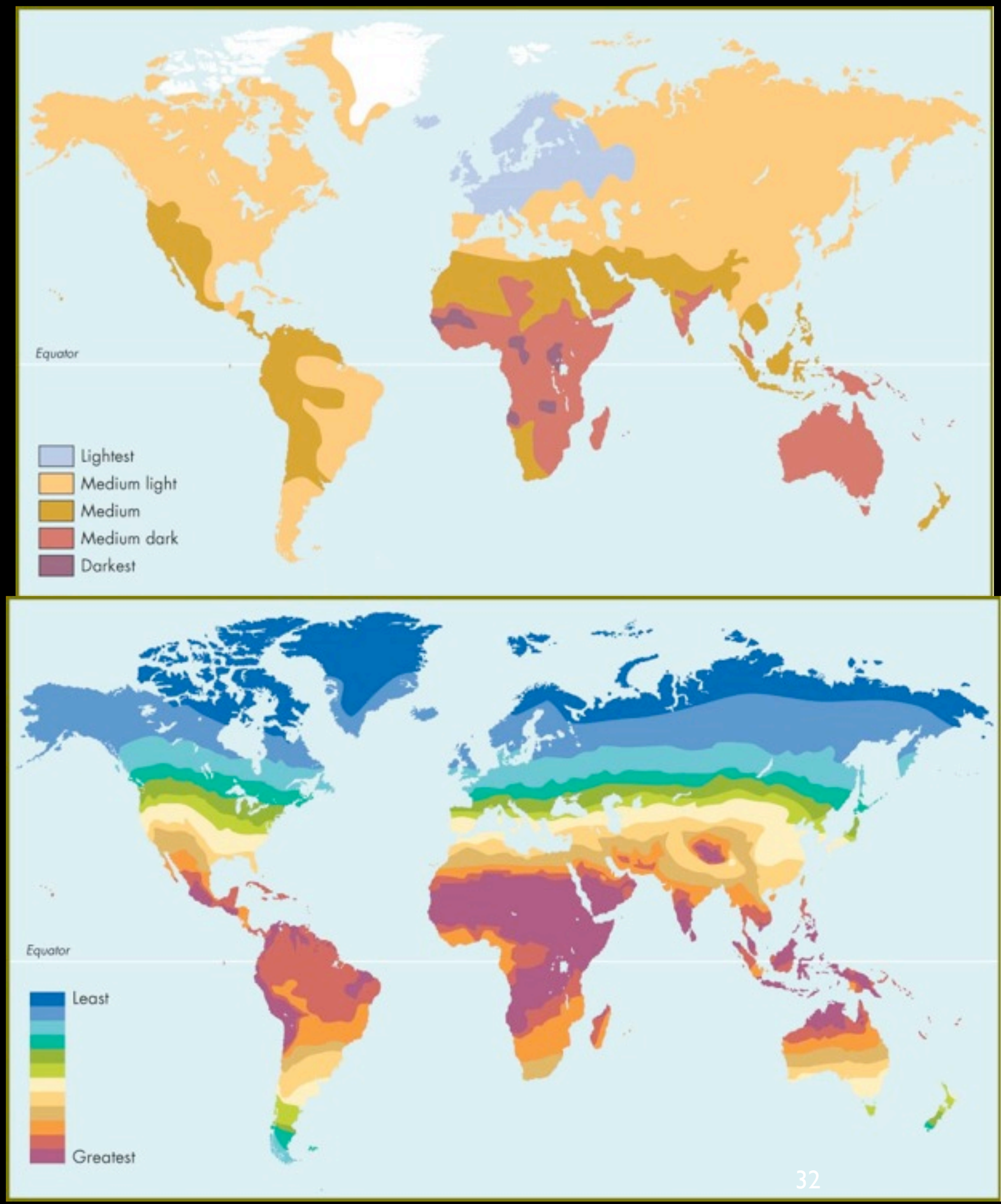
# Sickle Cell and Malaria



| | Relative fitness |
|---|---|
| HbAHbA | 0.85 |
| HbAHbS | 1.00 |
| HbSHbS | 0-0.33 |

What do humans need to adapt to?




# Skin color and solar radiation