GENA Final Report

Erin Pittman-Biology-SciTech High School Harrisburg, PA

The GENA lesson that we originally developed was broken up and taught in two separate lessons on sequential days. The lessons were taught in a tenth grade biology class as a culmination to the genetics unit and as a precursor to a unit on evolution. Classes were each 90 minutes long taught on a semester schedule. Populations of each class ranged from 18-23 students. Demographically students are 98% minority and more than 90% of the student population receives free or reduced lunch. The school is an urban, public school that is part of the Harrisburg School District.

Each day began with a writing prompt to engage students followed by a student discussion. Discussions were first held between partners and then together as a whole class discussion. This enabled me to identify misconceptions before the lesson began and therefore, revisit those misconceptions to clear them up with students in summary.

Because race is an issue that my students confront daily, they were fully engaged in discussion, participation and learning throughout the lessons. I would argue that students of all "racial" backgrounds, however; will find the topic of these lessons enthralling. Students were assessed throughout the lessons by the depth and content of their questions to determine understanding.

My students were already aware of how to code DNA sequences, so if yours are as well, this section can be modified to save time. I broke up the sequences given by putting the kids in groups of three and assigning each member of the group one sequence to code. They then broke into common groups (students with sequence 1, sequence 2, etc) so they could check them with the members of the other groups and validate translation. This seemed to work well and it saved time while still giving all students the information for all three sequences.

Another modification possible occurs on day two. If you do not want to assign homework or if you are wary of assigning a full paper, students can answer the culminating question in a paragraph or more. They can easily provide the supporting pieces of evidence that are required, limiting themselves on detail. You can also reduce the amount of evidence you require them to include.

After the lessons concerning human variation in skin color, I used the evidence that students had cited in their papers to lead into a discussion concerning evolution. Their evidence easily supported evolution and its merits without stimulating the usual debates when this topic is broached. I found that this was a very useful and practical way to segue between these units.

Possible problems encountered that could be encountered in the future would include, initial debate about the origin of race, determining migration patterns using the map of skin color, and not just addressing misconceptions students have concerning evolution, but creating a paradigm shift in their understanding of this. Difficult parts of the lesson

for them to understand were the differences between melanosomes and melanocytes, students initially used the terms correctly, but interchanged them as the lesson continued. Background concerning Pangea and the creation of the continents could prove helpful in the discussion regarding migration patterns.

As far as comprehension, students answered the culminating question with ~90% correctness. Students were able to include three supporting facts to answer the essay question, these facts came from the class lectures, so it was evident that they comprehended the material and did not just regurgitate it.

Compared to the typical lesson taught in biology, these lessons had similarities and differences. The GENA lessons contained more lecture than I normally have in my room. In order to make the lessons more student centered, pair/share and class discussions were held frequently throughout the lessons. Information for the vitamin D and sunlight was disseminated through packets so that students could transact with text and make meaning in small groups.

These lessons will also be taught by Erik Barber in a suburban setting. I shared my results with Erik after teaching and he will do the same after he finishes his unit. We will then convene again this summer to discuss our results after I teach the lessons for a second time to evaluate the lessons and determine our course for next year.

GENA Final Report
Erik Barber – Biology/Biotechnology at Hershey High School, Hershey, PA

Partners:
Erin Pittman, Biology, Sci-Tech High School, Harrisburg, PA
Dr. Keith Cheng, M.D., Ph.D., The Pennsylvania State University College of Medicine

Background:
The GENA lesson plans were designed to exhibit utility in varying grade levels. The base lesson covers two 50-minute periods. In addition to the base material, we have planned for extension activities depending upon course requirements and time constraints. The lessons were taught in ninth grade Biology and Advanced Placement Biology. The lessons will also be taught in a Biotechnology course before the year ends. The depth of information and complexity of activities will vary based on the specific course, however, the core material will remain the same.

After leaving the GENA workshops in August 2008, our group met in September to finalize the information and the design of the lessons. Erin taught the lessons first in December. We met and discussed what went well and what was difficult. During this meeting, we made adjustments to the lessons.

Hershey High School is a suburban school district of approximately 3000 students. Class size ranges from 18-26 students. Roughly 13% of students are minority.

The Lessons:
These lessons are designed toprovide a transition from Genetics to Evolution. This was purposeful to engage students and address misconceptions. Specific misconceptions addressed include:

- all mutations are bad
- being *fit* for selection means being *strong* or *fast*
- There are several races of peoples around the world.

Dr. Keith Cheng's zebrafish research was used as the basis for the specific lesson content. Our goal was to ultimately explain why there are differences in skin color among human populations. Our lessons offer a genetic explanation for different degrees of skin pigmentation around the world. Subsequently, presenting the information immediately after the genetics unit seemed appropriate. Moreover, these lessons provide a springboard into the evolution unit. Below is a reflection of how the GENA lessons we taught in each class setting.

Ninth Grade Honors Biology
The first fifteen minutes of day one were used for a brief introduction to point mutations. Chromosomal mutations including additions, deletions, and translocations were already taught. The word mutation is an example of a student misconception in genetics. Most students correlate genetic mutations with negative results. These lessons aim to show that a point mutation allowed human populations to expand north from Africa and prosper in a different climate. This mutation was advantageous to some!

Students transcribed and translated the zebra fish DNA and the DNA of both human samples. The results showed one particular amino acid that is different. Following this exercise, a longer list of 12 species' amino acid sequences was shown. The only sequence that was different was that of the one human. I asked students which sequence was from an organism probably ***not*** the ancestor to all the other organisms. Students were unanimously in favor of the human mutant allele ***not*** being the ancestor to the other organisms.

I did not have time to include the world map activity. I simply showed a world map of the genotypes and a world map of the phenotypes and asked students to draw conclusions. This was a particularly useful review of these terms. In the future, I aim to construct a Google Earth activity for students to complete online where they can map the genotypic data.

The last part of the lesson seemed to be the favorite among the students. Vitamin D synthesis and folic acid destruction were used to illustrate selective pressures on the humans. During this segment of the two-day lesson, I received the most questions from students. This was a useful way to delve deeper into the idea behind selection. In fact, I led a discussion of modern selective pressures on humans versus selective pressures 10,000 years ago. Consequently, students could accurately discern why a darkly pigment individual could survive easily in northern Europe in 2009.

This discussion was important to address a misconception in the upcoming evolution unit. Most students believe that being "fit" - as in survival of the fittest - means that the organism is stronger or faster. A few days after this lesson, I can reflect back to this point to show that a skin pigment mutation caused two separate biochemical pathways to function differently. Getting students to relate the word fit to reproductive success is difficult. The examples in this lesson helped.

AP Biology

The lessons followed the same format for Advanced Placement Biology, but the material was presented faster and in more depth. For example, out discussion of vitamin D synthesis in the skin led to an informal review of concepts such as cholesterol structure, fat-soluble, UV-induced dimmer formation, and fetal development. Additionally, a calculation exercise adapted from BSCS curriculum was introduced. Two sequences of the *beta globin* gene were shown and any difference in base pairs was noted. The calculations that followed extrapolated this finding to cover the entire human genome. This was done to reinforce that a 0.1% difference between two human DNA samples equals 3 million bases. Billions and millions are tough concepts to grasp, even for AP, and this lesson provides another example.

General comments by students indicated they enjoyed the information in this lesson. Specific comments include:

- "I never thought about the word race like this before."
- "I would not imagine that two Africans might be more genetically diverse than two Europeans."

It is noteworthy to mention that the term "evolution" is purposely withheld. On day one of my evolution unit, I write 'Evolution is a fact" on the board. Next I show students a collection of definitions of evolution from text books and reputable internet sites. I ask students to find the common words among the definitions. Ultimately, I assure that we agree that a succinct definition of evolution is "a change in genetics over time." Finally, I rewrite the original statement on the board and ask "Are there genetic changes in populations over time?" I usually receive a resounding, unanimous "yes." The attempt is to get students to realize they were analyzing (and accepting) human evolutionary data without formally following an evolution unit.

Lesson Follow up

Dr. Cheng visited the school to provide a talk about his zebra fish research. This occurred three weeks after the classroom lessons. Dr. Cheng's talk went above-and-beyond the lesson materials to provide additional insight to the socio-biological impacts of the zebra fish data. Students responded with many questions. This visitation will continue in the future.

The Future:

This year served as the trial run for these lessons. My experiences and collaboration with Erin and Keith will help to hone the lessons. I intend to make several adjustments for the upcoming academic year.

1. I will provide a pre-lesson test and a post-lesson as formative assessments. This will help to precisely identify students' misconceptions prior to the lessons and check to see if their misconceptions were addressed. This year the evidence was qualitative and observed. I recorded notes and transcribed student reactions.
2. The timing of the lessons will remain the same next year, however, I will include the material in the summative end-of-unit assessment. I did not include the material in this year's exam.
3. I will construct a computer-based Google Earth activity to incorporate geography into the lessons. Students will be required to plot the genotypes on a map based on the city form which the DNA came. This is one-half complete.
4. I also anticipate the list of student misconceptions growing over the next few years. With 10 years experience, I can correctly identify several misconceptions, however, I cannot foresee all of them.
5. I will construct an extension lesson with a Social Studies teacher to further explore how the term "race" is a social construct and bears no biological basis. This is an attempt to make these lessons multidisciplinary, while retaining rigorous biological content.

Geneticist-Educator Network of Alliances

GENA Partnership Planning Worksheet

Each geneticist-educator alliance will find a schedule, relationship, and communication style that works best; however, it is important to first establish some expectations that each of you can agree on. While nothing is set in stone, this will provide your alliance with a framework to assist you in your planning and completed teaching plan. Feel free to provide additional components on other sheets. On day 3 of the workshop, we will photocopy your template and return one to you. We expect a final copy to be emailed to us by 9/12/08. When you have finished teaching the components in your plan, please revise it to fit your actual experience and send the modified copy to Mike Dougherty EMAIL. Please prepare this in an electronic form that can be emailed.

Day 1: Teaching Plan Development Outline

- Provide a name or title for your lesson or set of lessons.

Fishing for the Origins of Human Skin Color Variation

- List any misconceptions that students commonly have about these concepts. Make suggestions as to how you will address each of these misconceptions through your teaching plan.

Mutations are always bad.
All variation is selected for.
Evolution explains the origin of life.
European skin color was the origianal skin color.
Humans had their current range of skin color from the beginning

- Identify the State Standard(s) that you intend to address through your teaching plan. Include standards that relate to genetics and other areas of the curriculum (inquiry, skills etc.).

3.3.10.C Describe how genetic information is inherited and expressed (2nd bullet)
3.3.10.D Explain the mechanisms of the theory of evolution (2nd and 3rd bullet)

- List the major science concept(s) that you intend to address.

Genetic variation, inheritance, selection, evolution, mutation

- Identify your objectives in terms of learning outcomes, i.e., what the students will be able to do.

Explain how populations evolve, not individuals
Illustrate how living organisms share many genes and their function
Use data from other vertebrates to answer questions about humans
Be able to explain how lighter skin populations evolved from darker skinned populations through mutation and selective pressure
Distinguish between alleles and genes

Day 2: Teaching Plan Development (Continued)

- List the skills students will use in your teaching plan.

Research, Evaluate, Analyze, Synthesize, Coding, Decoding, Prediction, Brainstorming, Examination, Observation, Make connections between curricula

- Identify by name and source the curriculum materials that will form the basis of your teaching plan. If you use more than one set of materials, please provide information on all of them.

Miller, Ken and Levine, Joseph. Biology. New Jersey: Prentice Hall, 2006.

BSCS, Biology: A Human Approach. Dubuque, Iowa: Kendall / Hunt, 2005.

Hall, Ron, and Keith Cheng. Racism in the 21st Century. New York, NY: Springer, 2008.

Lamason, R.L., et. al. and Keith Cheng. "SLC24A5, a Putative Cation Exchanger, Affects Pigmentation in Zebrafish and Humans." Science 310(2005): 1782-1786.

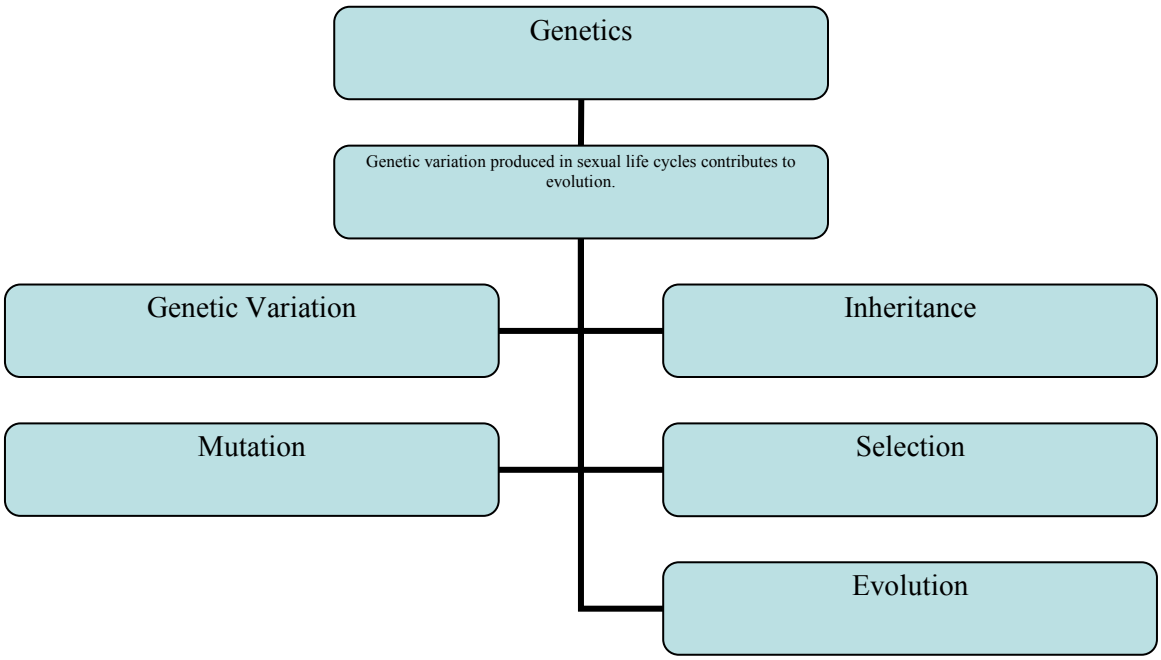
"A New Look At Race Through Three Lenses." Race: Are We So Different?. 2007. American Anthropological Society. 6 Aug 2008. <http://www.understandingrace.org/home.html>.

"Black in America: The Black Man." Black in America. 2008. Turner Broadcasting System, Inc. 6 Aug 2008. <http://www.cnn.com/SPECIALS/2008/black.in.america/index.b.html

"How similar or different are we from each other?" Living Genomics Knowledge Modules. 2007. Gemini. 5 Aug 2008 <http://livinggenomics.org/index.php?page=Module&geno=1&id=48

"What is Race?" Race: The Power of an Illusion. 2003. Public Broadcasting System. 6 Aug 2008.<http://www.pbs.org/race/000_General/000_00-Home.htm

- Use a diagram or flow chart to illustrate where the concepts you are addressing fit into a conceptual sequence. This diagram should illustrate the concepts that will be introduced and any concepts that should naturally follow. Below your chart, list any essential prerequisite knowledge or skills students will need to tackle this work.



Prerequisite knowledge:
The events of transcription
The events of translation
DNA replication
Structure of DNA and RNA
Principles of inheritance
  - Fertilization, genes, alleles, gamete
  - Homozygous, heterozygous, probability, Punnett squares

Incomplete dominance, codominance, multiple alleles
Everything about Meiosis (sort of)
Autosomes vs. Sex Chromosomes
Karyotypes, sex-linkage, pedigrees
The types of mutations
  - Point mutations
    - Substitutions, insertions, deletions
  - Frameshift mutations

Gene Regulation

- Provide a brief outline of your teaching plan. You may use your school district's planning format for this section. Attach this and other supplementary sheets to this document. **See Lesson Plan also attached**

- Provide information on:
  - The learning cycle you intend to use.

  E-Essential Question
  A-Activating Lesson
  T-Teaching
  S-Summary

  - Each step of the learning cycle. (You may consult the 5E model information sheet provided)
    See above
  - Duration of each step in the learning cycle.
    See lesson plan
  - Preparatory and post-lesson work, including homework and possible extensions (web information, other reading etc.)
    See lesson plan
  - Identify any modifications you have made to the materials you have chosen. Include modifications of the procedure that enhance the inquiry nature of these materials.
    - See optional lesson plan extensions

  Graphics will be modified to include only necessary information
  Marbles (black, brown, white)

- Outline your assessment strategy. Where appropriate, add quiz questions and others along with the appropriate rubrics.

  - Formative assessment

  Using predictions about "Science" cover
  Class discussion of skin pigmentation
  Review of STOP codons, genetic code and amino acid sequence
  Questioning: What type of mutation is this, Which sequence is "ancestral"?
  Map for plotting the geographic distribution of the alleles SLC24A5
  Answer to question: Using the lecture notes, map, background information on folic acid and vitamin D answer the following making sure to address selective pressure, random and adaptive mutation, migration, and survival: Why do human populations have differences in skin color?

  - Summative assessment (Be sure to match these to your objectives/learning outcomes.)

Using what you have learned throughout these lessons, answer the following in a well constructed essay that cites at least 3 pieces of evidence: Explain how mutation and selection affected human skin color?

Day 3: Partnership Planning

- Specifically, when do you expect to implement your teaching plan?

Erin: end of November/beginning of December 1st semester and end of April/ beginning of May 2nd semester
Eric: January

- When will you finish designing the components of your teaching plan?

By the end of October

- What will be involved in completing your teaching plan? *Think about whether someone will need to design worksheets or laboratory resources; who will design the assessment, etc.*

We will need to complete presentations, compile the folic acid & vitamin D handout, create the map, create the sequence bank and modify the graphics.

- How often will you communicate? (*Do you plan on communicating throughout the year? Only when you need to work on your teaching plan?*)

We plan on communicating throughout the year. Specifically to complete our teaching plan and presentations and to reflect after Erin's delivery in November and then Eric's delivery in January and finally a summative meeting after the May presentation. Plans and new ideas will also be submitted to each other as developed for approval.

- How will you communicate? Telephone? E-mail? In person?

All of the above and dinner ☺

- Can you foresee trying to write a paper on your work for a science education journal? If so, have you considered the steps required in this process, including receiving Institutional Review Board (IRB) approval?

We would like to consider it. Keith is just starting with IRB but we would like to obtain copies of prior educational IRBs for information on compiling ours.

- Do you plan on writing grants for funding to continue your partnership and expand outreach effort? Some examples are CCLI, GK12, MSP, Integrative Biology.

No

- If feasible, enumerate the next steps in your planning and create a timeline for that planning.
    - Finalize by October

Teacher: Pittman	Course: Biology	Date(s): 11/ 30- 12/ 5, 2008	LFS Lesson Format ☒ Acquisition ☒ Extending/Refining
Title: Race and Genetics		Resources: Science Article, HapMap, Sequences (provided by Dr. Cheng's lab), Demystifying Skin Color &Race Websites on Race	PSSA Math, Reading, & Science Eligible Content Addressed .3.10.C.2 3.3.10.D.2 3.3.10.D.3

E - Essential Question ?		Why do human populations have differences in skin color?
DO NOW - "The hook" B	**TIME** **2-4**	Students will be shown the cover of Science magazine from December 16, 2005 and asked to predict what is this graphic trying to convey. Students should not limit their answers to the discipline of Science.
A – Activating OR **Other** **M – Mini-Lesson**	**TIME** **10-15**	**Students will pair/share their answers and create a brainstorming web of their observations. The class will then continue discussion as a whole concerning observations and will note these in order to return to them at the commencement of the project.**
T – Teaching / Tasks **Activities -** D **Acquisition Strategies** Collins Writing Graphic Organizer Independent Reading Other: ( ) **Extending/Refining Strategies** Constructing Support Other: ( )	**TIME** **10-15** **20-30** **15-20** **5-15 depen. on act.**	*****(Note: The use of the word "evolution" is not necessary throughout the lesson. The concepts covered in this lesson are those necessary for an understanding of evolution, the study of which would follow these lessons.)** *****Examination of skin pigmentation using the graphic of Zebrafish and melanocytes containing melanosomes. Using this graphic the class will observe and examine the differences in the #, size, & density of pigment.** *****Compare Zebrafish with 2 human DNA seq. to review amino acid & stop codons. Students will work in partnerships to compare & determine where the diffences in the bases and amino acids of the seq. are and what the meaning of these similarities & differences might be. (What type of mutation is present?)(Which amino acid seq. is "ancestral" (of vertebrates)? A: We can't tell. Students then examine expanded chart of vertebrate sequences & make a determination.** ****Data concerning allele frequencies in populations across the world will be distributed and & students will plot the distribution of SLC24A5 on a blank world map. Explain how each derived allele contributes to lighter skin color. Master map will be examined and both will be used to ensure students understand the affect of the gene on phenotype & implications of this on humans & their migration/distribution across continents.** *****Folic acid and vitamin D background info. concerning folic sensitivity to sunlight and requirement of sunlight for vitamin D synthesis will be examined. Using previous info. & on folic acid & vitamin D answer the following making sure to address selective pressure, random & adaptive**

PLN Lenses Focus
- ☒ Meaning-Centered
- ☒ Language-Based
- ☒ Social
- ☒ Human

PLN Five Critical Experiences Focus
- ☒ Transacting with Text
- ☒ Composing Text
- ☒ Investigating Language
- ☒ Extending Reading and Writing
- ☒ Learning to Learn

		mutation, migration, and survival: Why do human populations have differences in skin color? *****Optional Extension Activity (Can be completed after seq. exam.)** **Use the variation calculation handout (BSCS Human Genetic Variation - Master 2.3) to calculate the amount of variation in the DNA in the beta globin gene between two people.** **Note: The actual # of base differences between 2 people likely is somewhat higher than this because the estimate, based as it is on the approx. size of the human genome (1 copy of each of the autosomes, plus the X, ZY, and the mitochondrial chromosomes), does not take into consideration the fact that humans are diploid.** *****Additional Optional Extension Activity (Can do after Mapping Activity)** **Goal: illustrate selection for different populations** **Materials:Black, brown & white marbles, in approx. equal #, bowls/plates.** **1) As a rep. of ancient African populations, start with a bowl (bowl 1) of black marbles plus about 1/4 brown.** **2) To recreate the 1st northerly migrations, take a handful that includes brown marbles and place them in bowl 2.** **3) From bowl 2, take turns taking out the black marbles (selection), one by one, and add brown marbles (pop. growth).** **4) Add a few white marbles (mutation)** **5) Grab a handful of marbles from bowl 2 that includes white marbles and put them in bowl 3.** **6) From bowl 3, take turns taking out brown marbles until they are gone (selection), and adding more white marbles (population growth).** **7) The last ice age ending ~15,000 years ago left much of the globe covered in ice, including nearly all of Europe. Give your most plausible explanation, using this info. for the origin of human pops. with lighter skin in northerly latitudes.**	
Assessment(s)		☒ **monitoring/observation** ☒ **graphic representation** ☒ **performance** ☒ **writing** ☒ **authentic creation** ☒ **formal assessment** ☐ **other ( )**	
Assignment(s)	**TIME 5-7**	Using what you have learned throughout these lessons, answer the following in a well constructed essay that cites at least 3 pieces of evidence: Explain how mutation and selection affected human skin color?	
S – Summary/ Sharing Ⓐ **Other**	**TIME 3-5**	**Student summary …** ☐ **Looking back at the Science cover, what were the authors trying to convey with the graphic?**	

Why do Human Populations Have Differences in Skin Color?

What is this graphic trying to convey? Answer in your journal, 10 lines or more

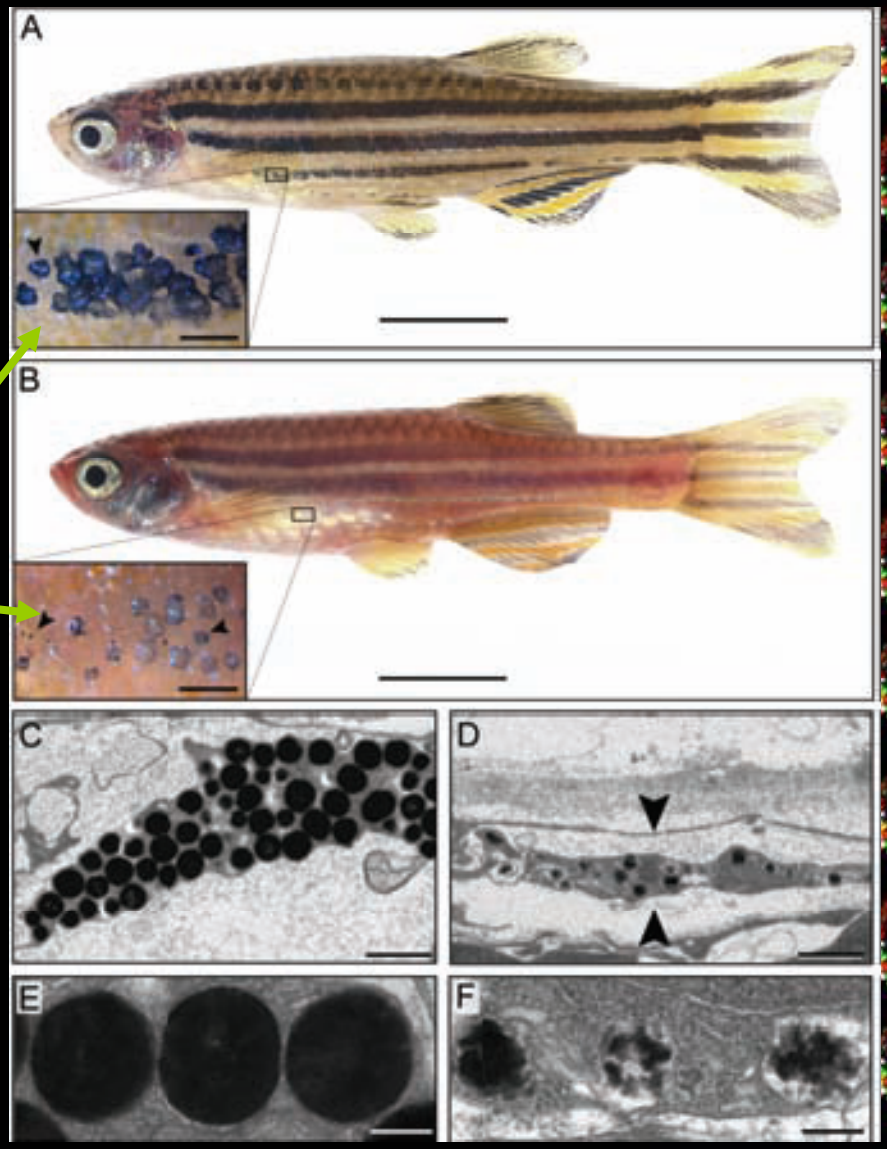
Here's what you know:

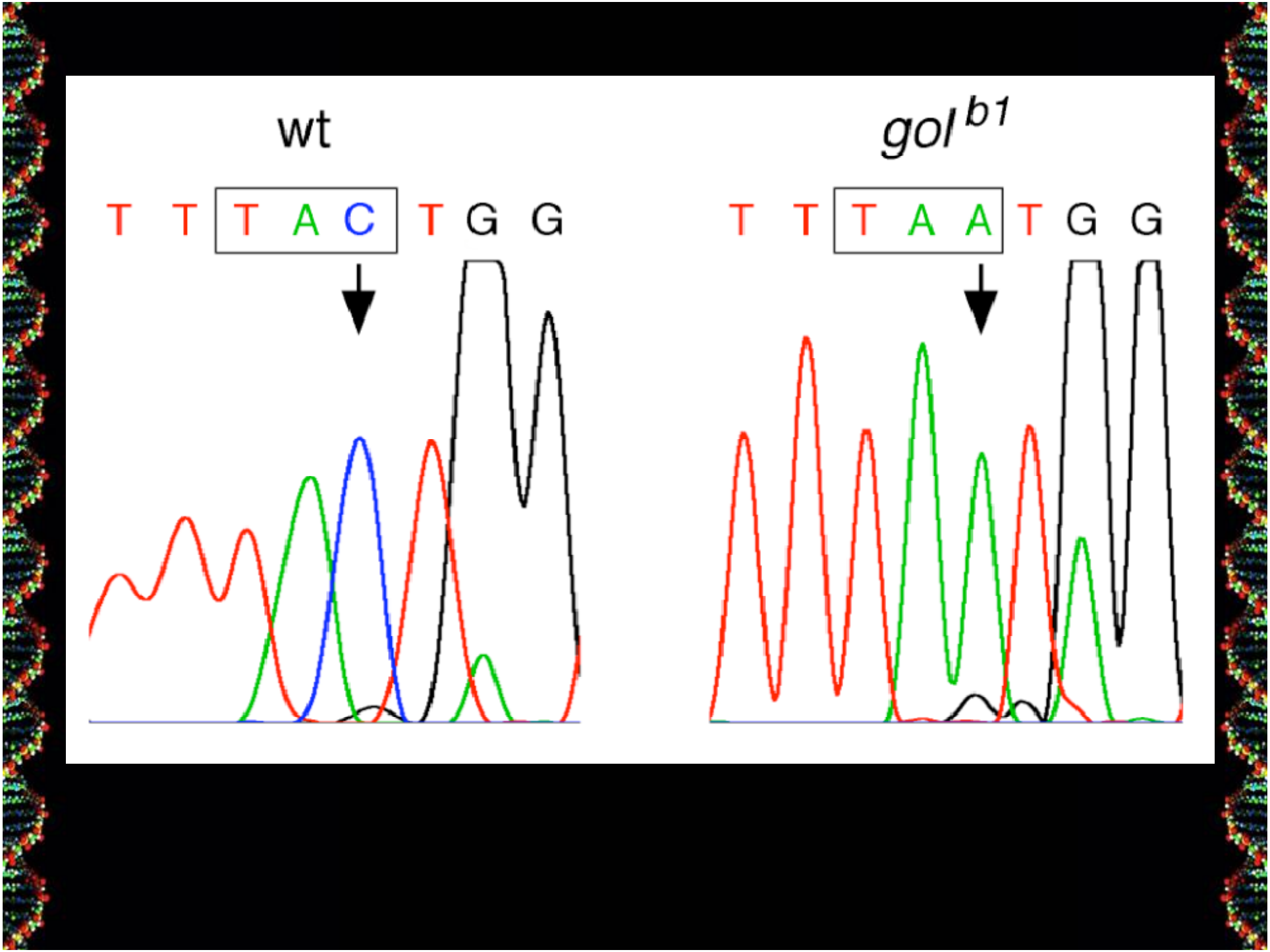
- The structure of DNA & RNA
- DNA replication
- The events of transcription
- The events of translation
- The types of mutations
  - Point mutations
    - Substitutions, insertions, deletions
  - Frameshift mutations
- Gene Regulation

Here's more of what you know:

- Principles of inheritance
  - Fertilization, genes, alleles, gamete
  - Homozygous, heterozygous, probability, Punnett squares
- Incomplete dominance, codominance, multiple alleles
- Everything about Meiosis (sort of)
- Autosomes vs. Sex Chromosomes
- Karyotypes, sex-linkage, pedigrees

- Have you ever heard of the term “melanoma?”
- Pigments are contained in melanosomes (small organelles inside melanocytes).
- Observe the differences between C & D and E & F. Write these differences in your notebook.




wt
T T T A C T G G
gol b1
T T T A A T G G

Translate the following DNA sequences into the correct amino acid sequences. Use your textbook's code.

1 agc gag cgt ctt ggt ctc tcg cag gat gtt gct gga gcc acg ttt atg gct gcg ggg agt

2 agt gaa tcc ctt gga ttg tct cag gat gtt gca ggc gca act ttc atg gca gcg ggc agt

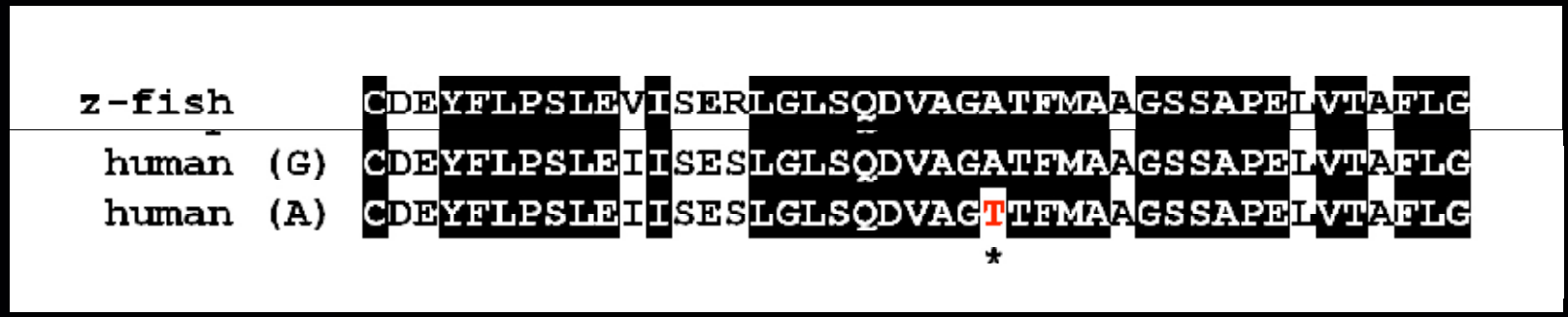
3 agt gaa tcc ctt gga ttg tct cag gat gtt gca ggc aca act ttc atg gca gcg ggc agt

Tomorrow

- Why are these different skin colors found throughout the world?
- What causes skin color?
- Bringing it all together…

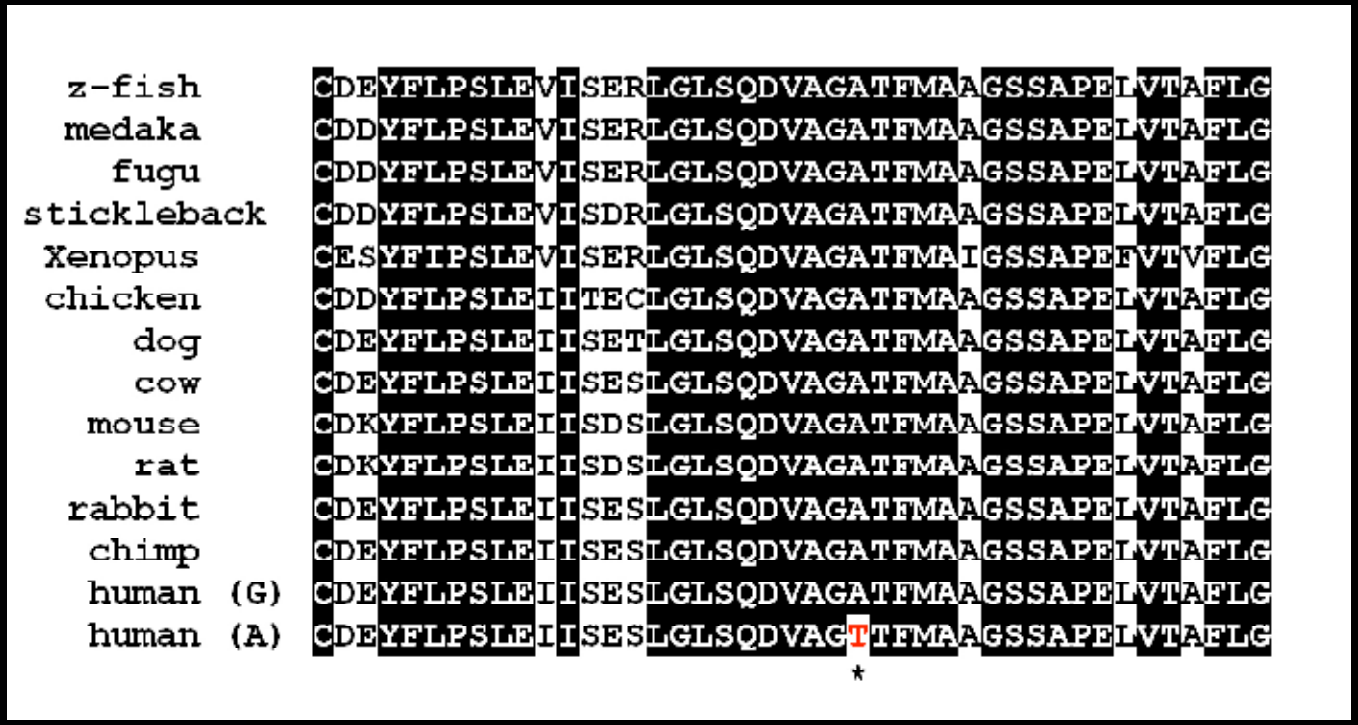
Friday December 12, 2008

- Do Now
  - Predict: Why do you think there are areas of the world that have darker skinned persons compared to other areas of the world? Explain your answer.
- Today
  - GENA Part II
- Closure
  - In a well constructed paragraph(s) answer the following:
  - Using what you have learned throughout these lessons, answer the following in a well constructed paper that cites at least 3 pieces of evidence: Explain how mutation and selection affected human skin color?

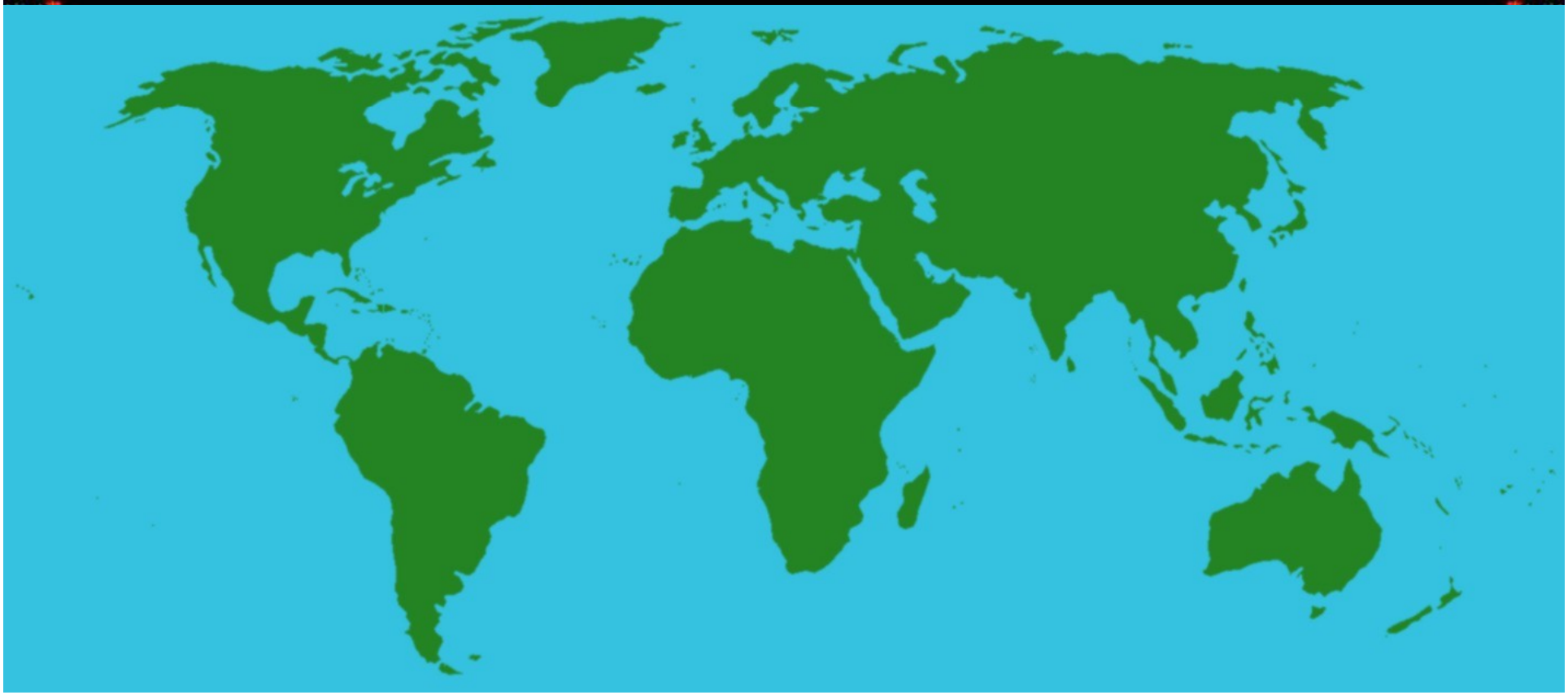


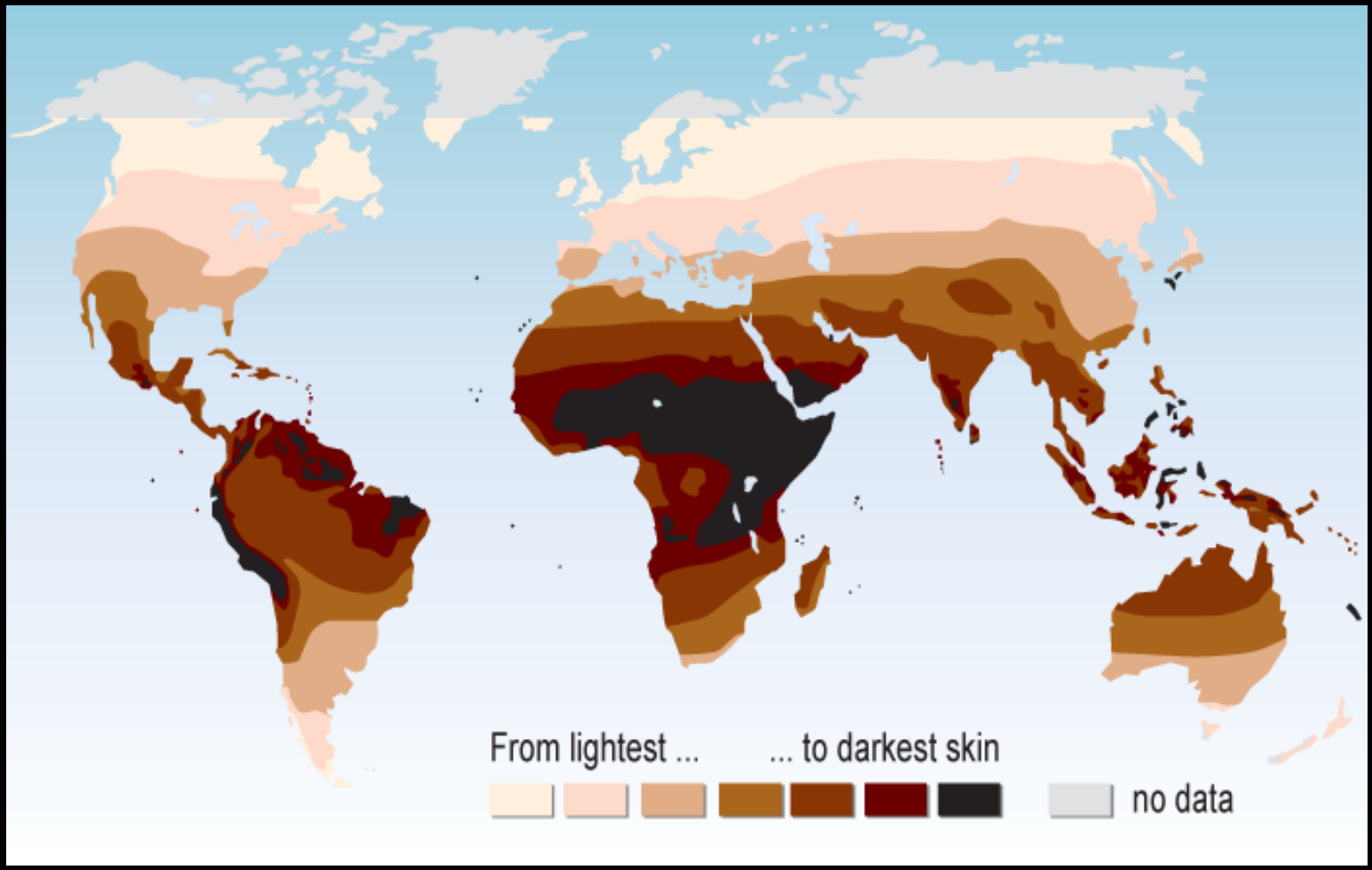
- What type of mutation is this?
- Assuming one of these sequences in the ancestor of all the other vertebrates, which one is it?

- And I'll ask you this again:
- Assuming one of these sequences in the ancestor of all the other vertebrates, which one is it?



Shade your map with the “skin” colors according to where you predict they are located throughout the world.





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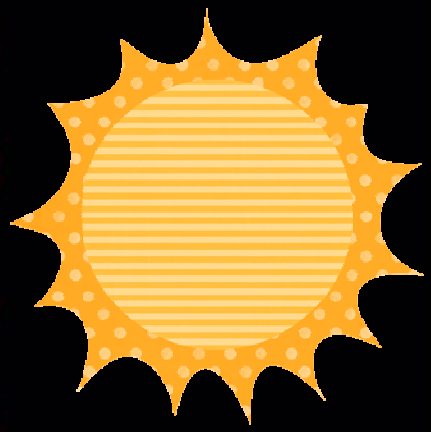
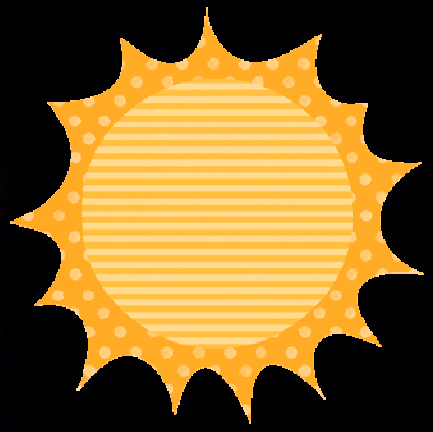
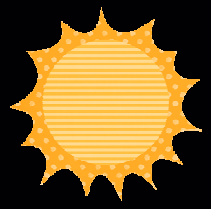


Much Vitamin D + little cancer

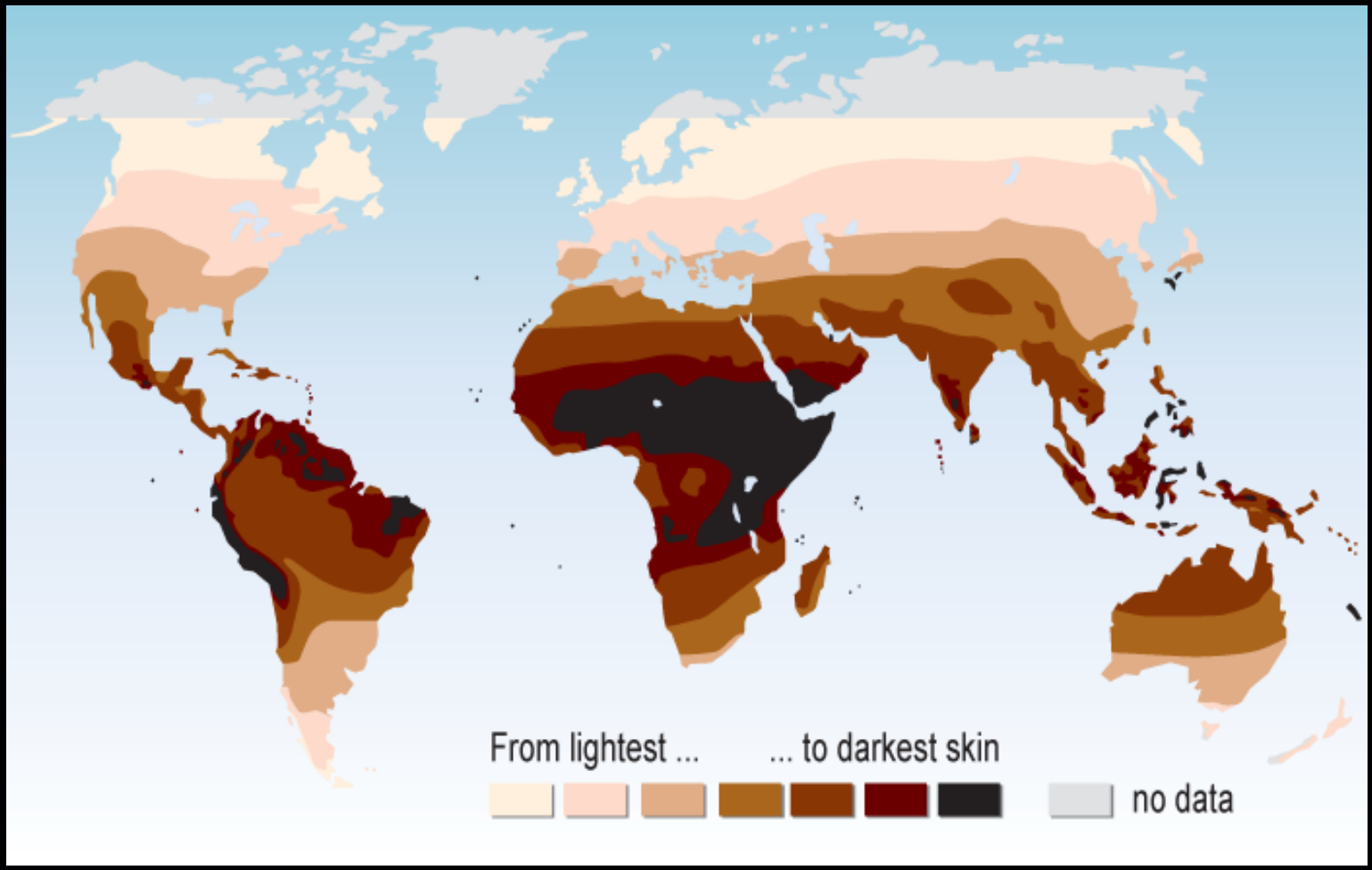
Little Vitamin D



Much Vitamin D, but too much cancer



Much Vitamin D



http://anthro.palomar.edu/

What is this graphic trying to convey?

Here's what you will learn next:

- Darwin's observations
- Evidence for evolution
  - Molecular (Genetic)
  - Paleontology (Fossils)
  - Anatomical (Body structures)

Misconceptions Regarding Evolution

- Evolution: Tricky Topic ☺
  - Let's Learn more about it

Why is scientific literacy important?

- Understanding of scientific principles fosters a sense of control, the making of good choices affecting health, and good decision-making regarding with human impacts on the environment
- Evidence-based approaches are often of critical importance to addressing societal and global problems
- Fear of science is common, and results in the wasting of time that can be otherwise used to solve problems
- Fear of science is grounded in historical fact, and should be properly addressed
- Eliminating fear of science is essential in a democracy in order to find the most effective solutions to solve societal problems
- Scientific literacy will allow more people to contribute to solutions to common problems

Why is scientific literacy about the relatedness between all living things important?

- There exists unnecessary conflict between science and religion regarding “evolution”
- Both scientific and religious theories claiming “separate origins” of human populations (“races”) have been used to justify slavery and other forms of inequality
- Emotional responses to the concept of evolution are endangering scientific approaches to solving societal and global problems by
  - Wasting resources
  - Discrediting valid scientific ideas using tribally-motivated (my group is better than yours) manipulations
- The idea of dominion over the earth was written in a time when the earth was not endangered; the plethora of consistent global climate change data indicates that adjustments must now be made to this idea to increase the probability of our survival

New Approaches to Teaching About the Origins of Human Variation and Group Characteristics

- Start with what we see (group characteristics and variation)
- Start with what we know about DNA sequences (mostly similar, some differences)
- Introduce mechanism underlying variation - MUTATION, which is critical to understanding the creation of human variation
- Connect mechanism, step by step, with what we see
- Picture-oriented (any suggestions for better ones?)
- Understanding whole picture leads to sense of accomplishment
- Uses Lay language, and connects with scientific language on the same picture

Unique Group Characteristics

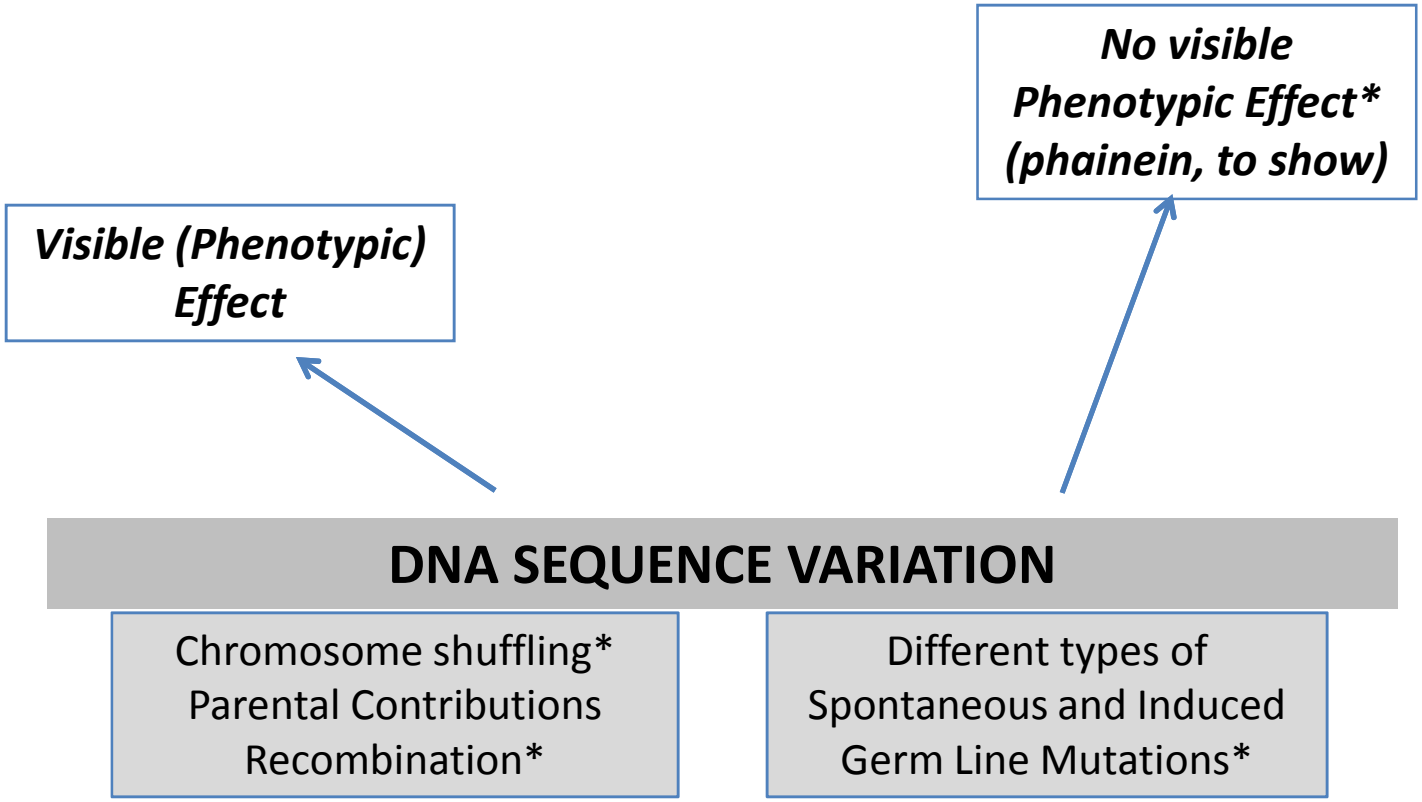
Variation In Groups

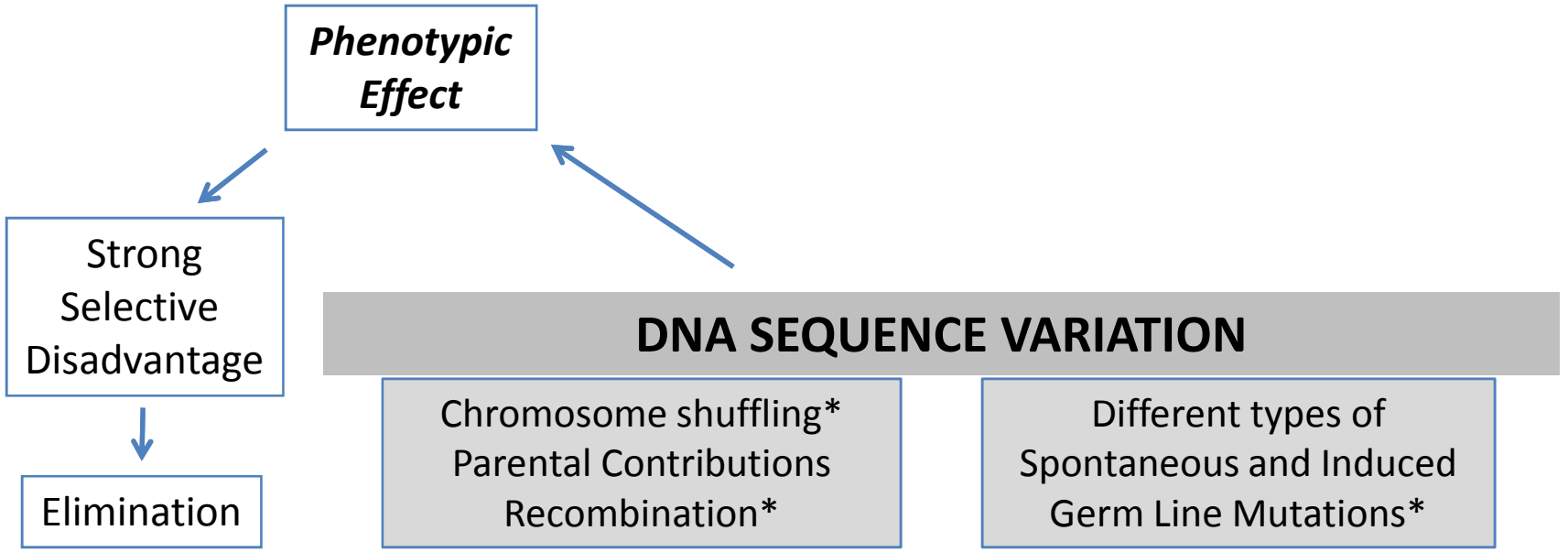
DNA SEQUENCE VARIATION

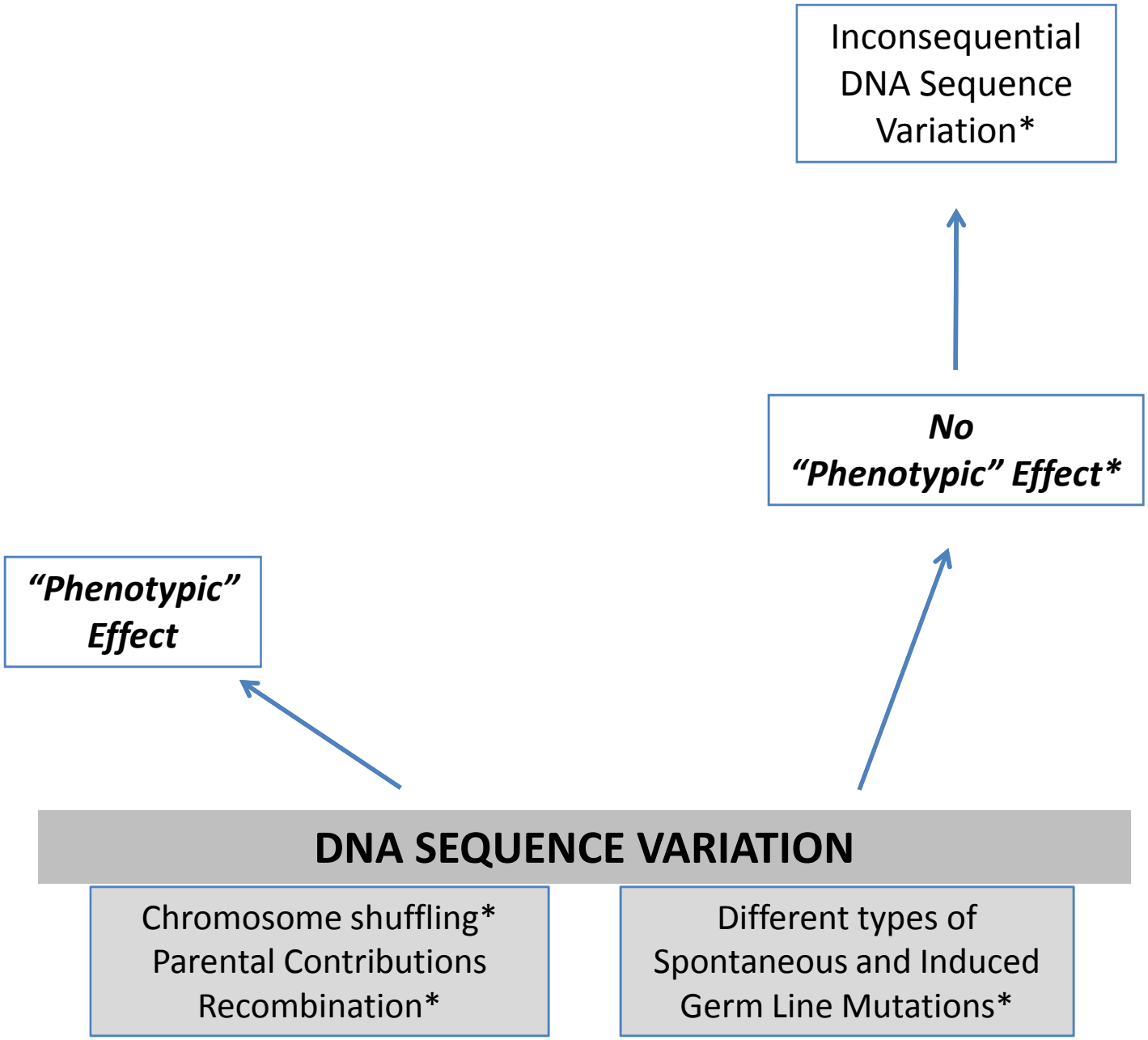
DNA SEQUENCE VARIATION

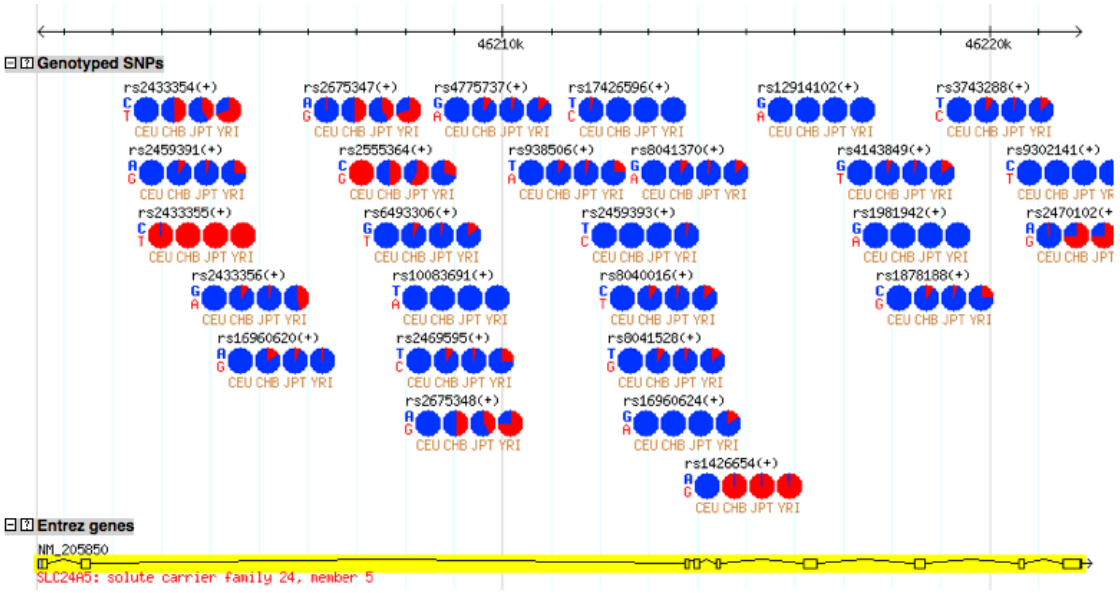
Chromosome shuffling*
Parental Contributions
Recombination*

Different types of
Spontaneous and Induced
Germ Line Mutations*


No visible Phenotypic Effect* (phainein, to show)
Visible (Phenotypic) Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*


Phenotypic Effect
Strong Selective Disadvantage
Elimination
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*


Inconsequential DNA Sequence Variation*
No "Phenotypic" Effect*
"Phenotypic" Effect
DNA SEQUENCE VARIATION
Chromosome shuffling* Parental Contributions Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*



Inconsequential DNA Sequence Variation*

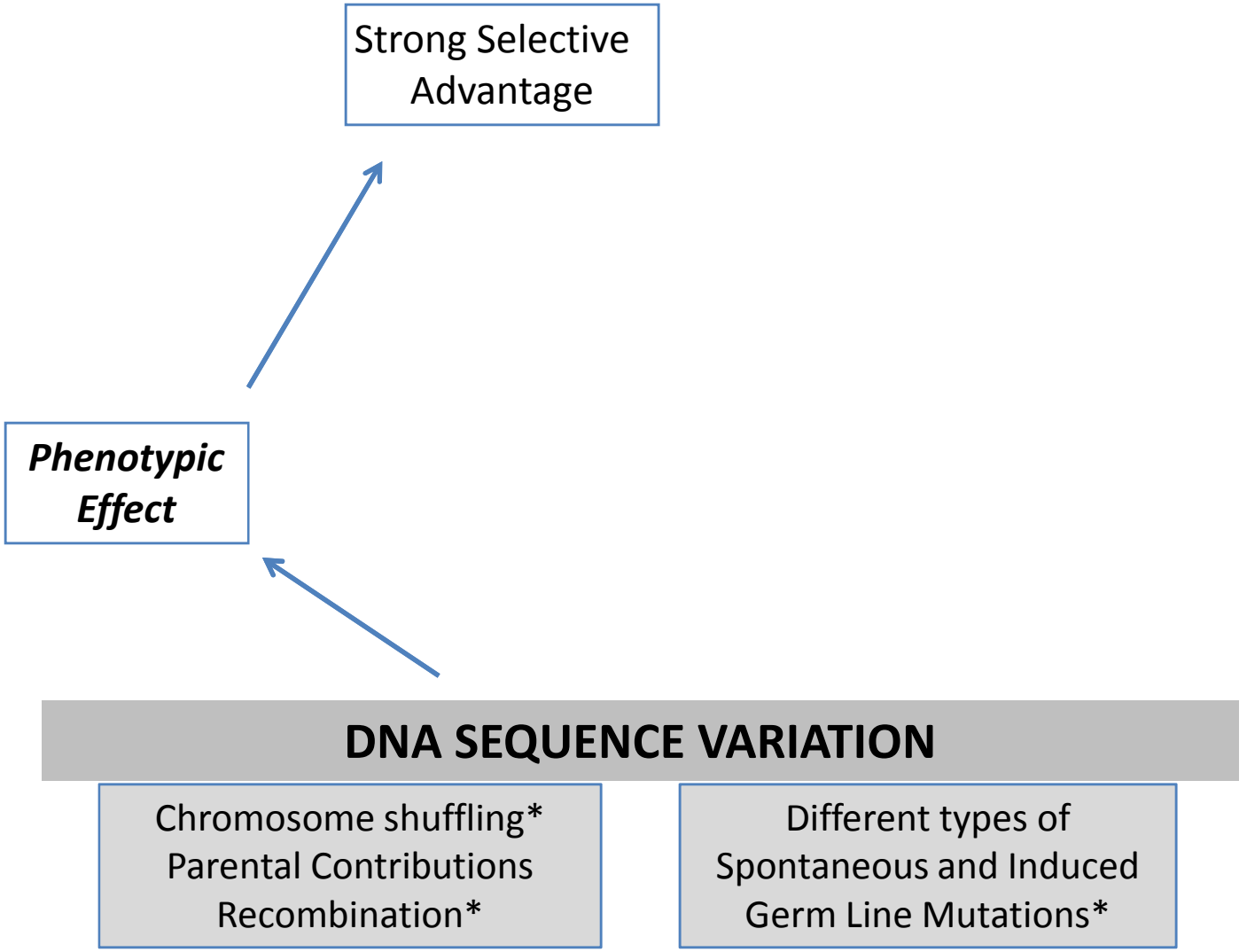
No "Phenotypic" Effect*

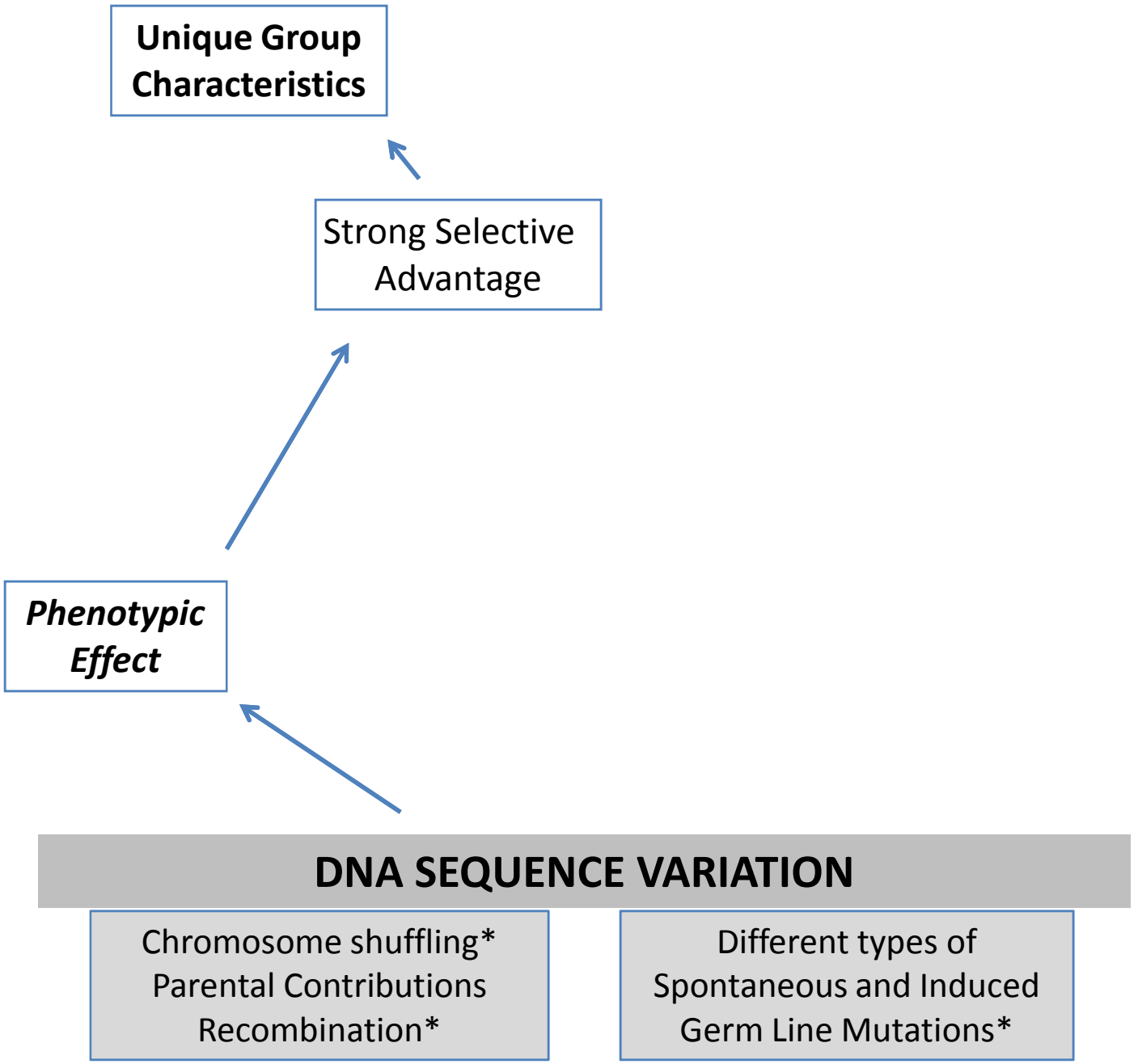
"Phenotypic" Effect

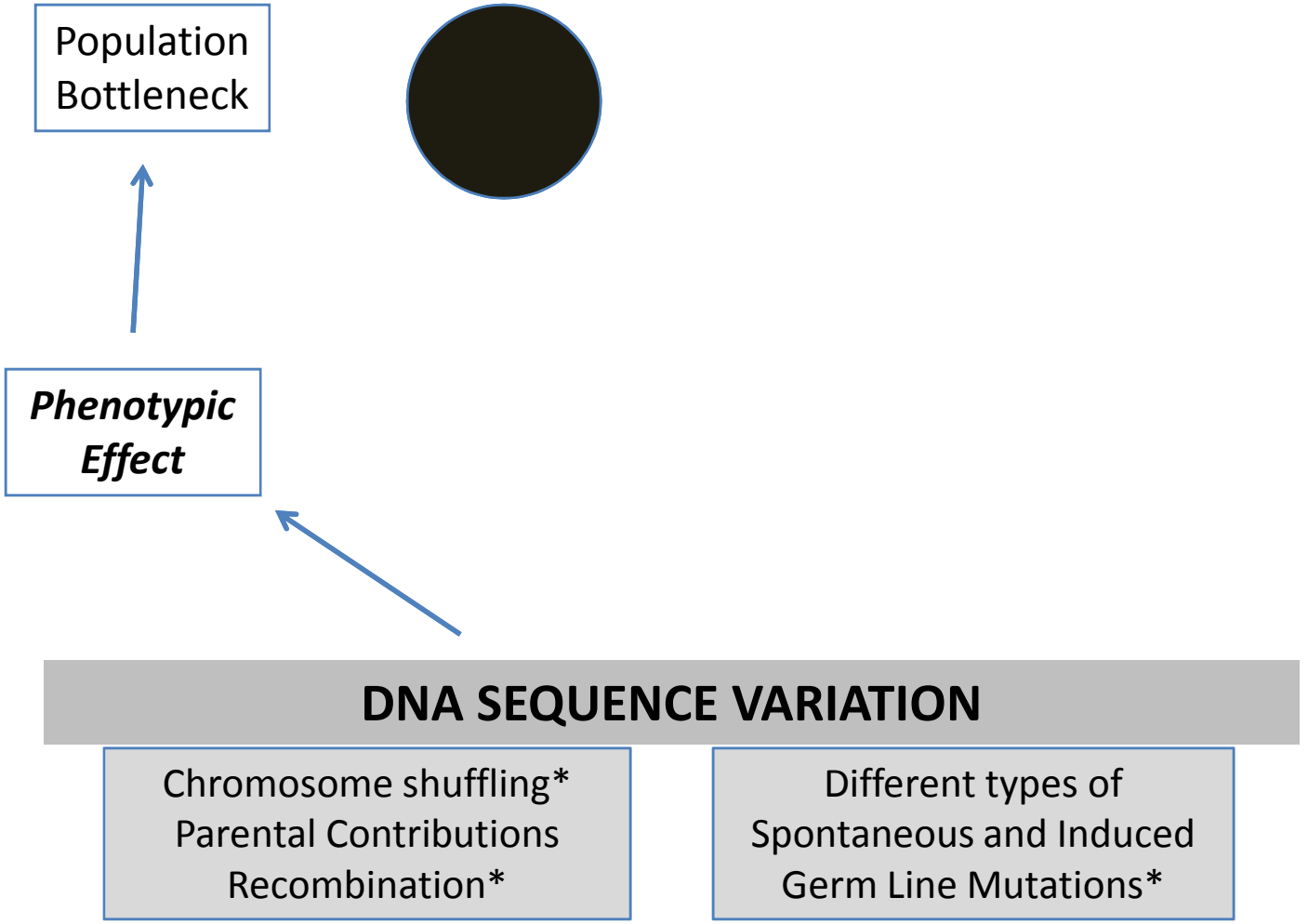
DNA SEQUENCE VARIATION

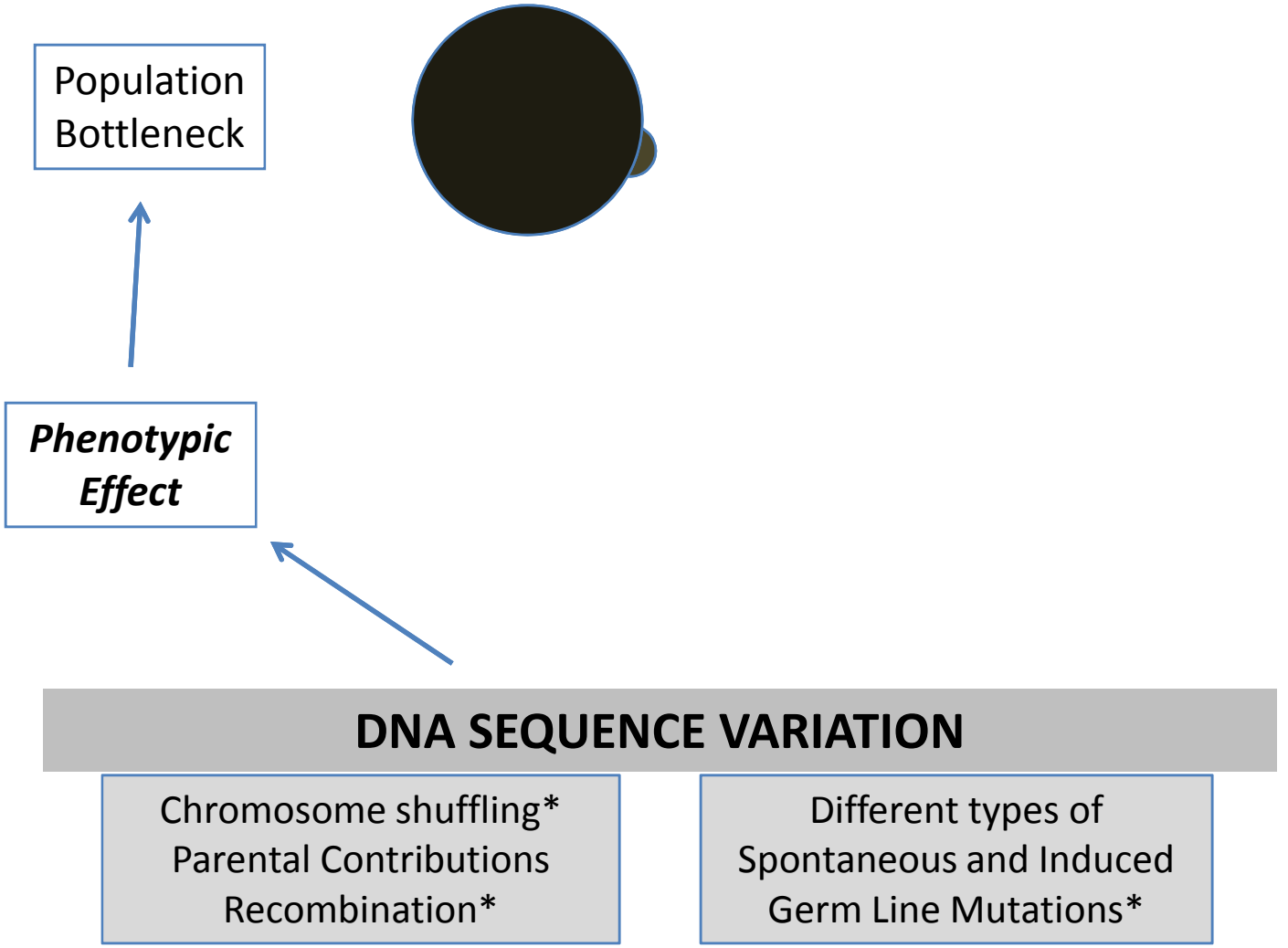
Chromosome shuffling*
Parental Contributions
Recombination*

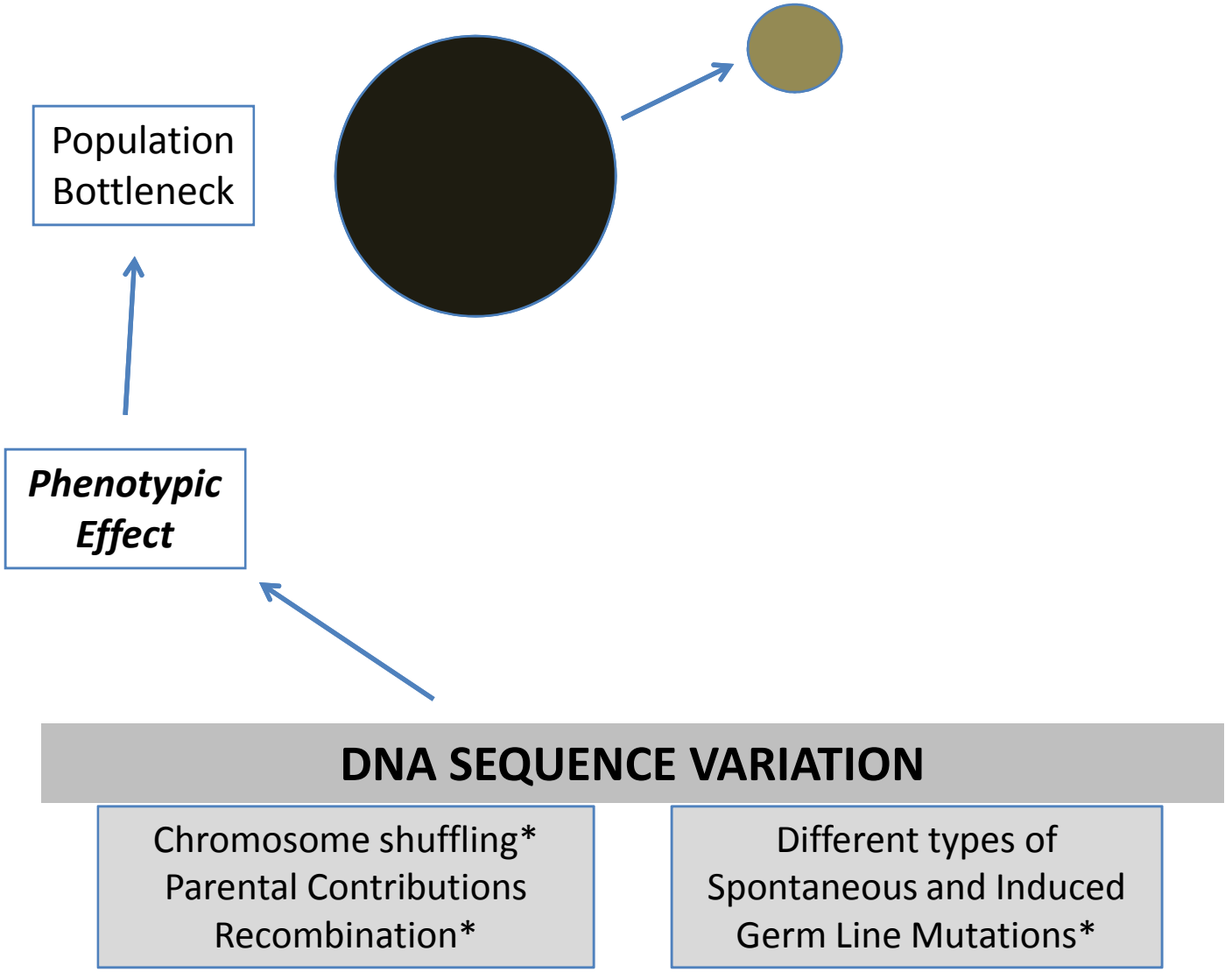
Different types of Spontaneous and Induced Germ Line Mutations*

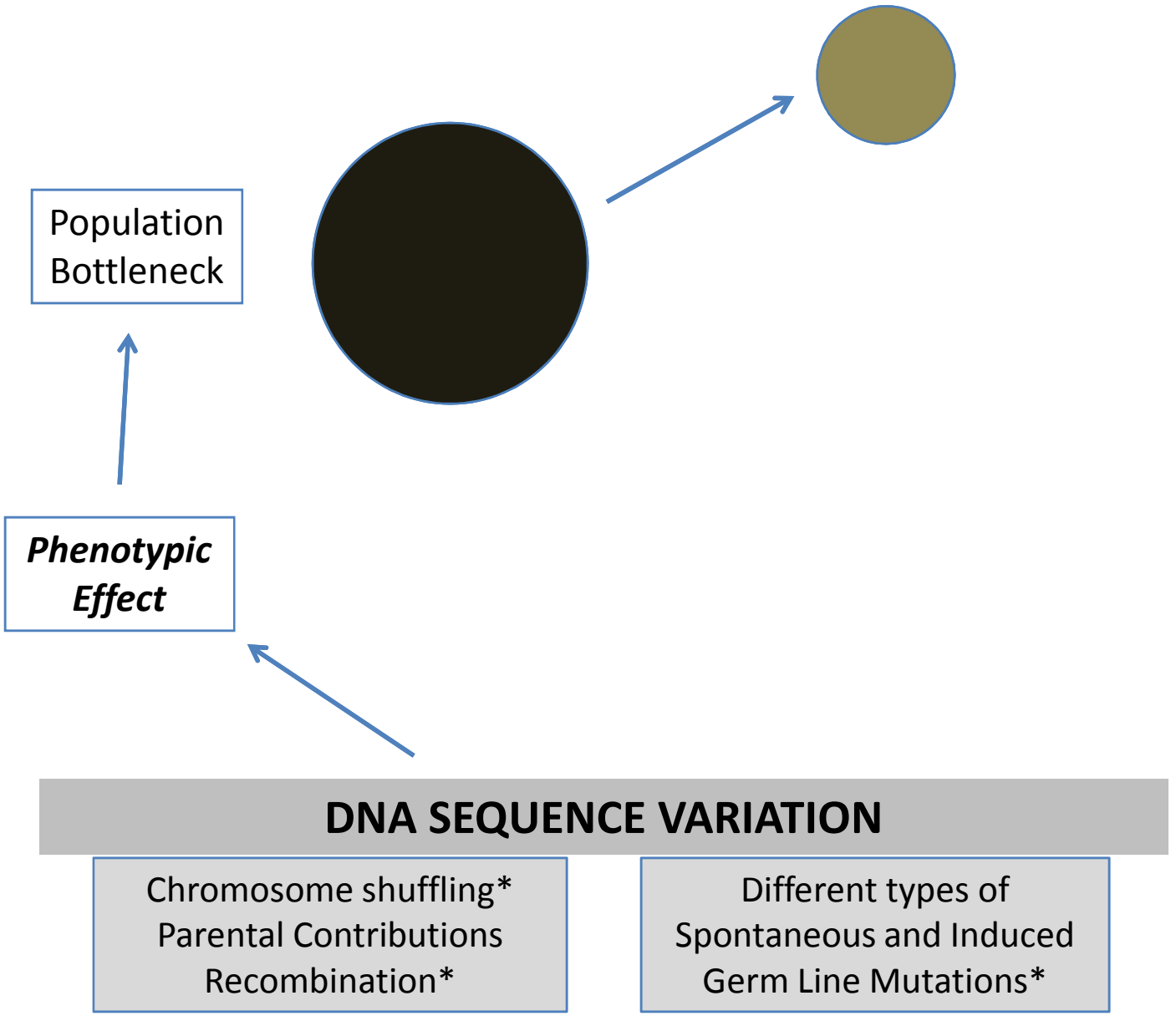

Strong Selective Advantage
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

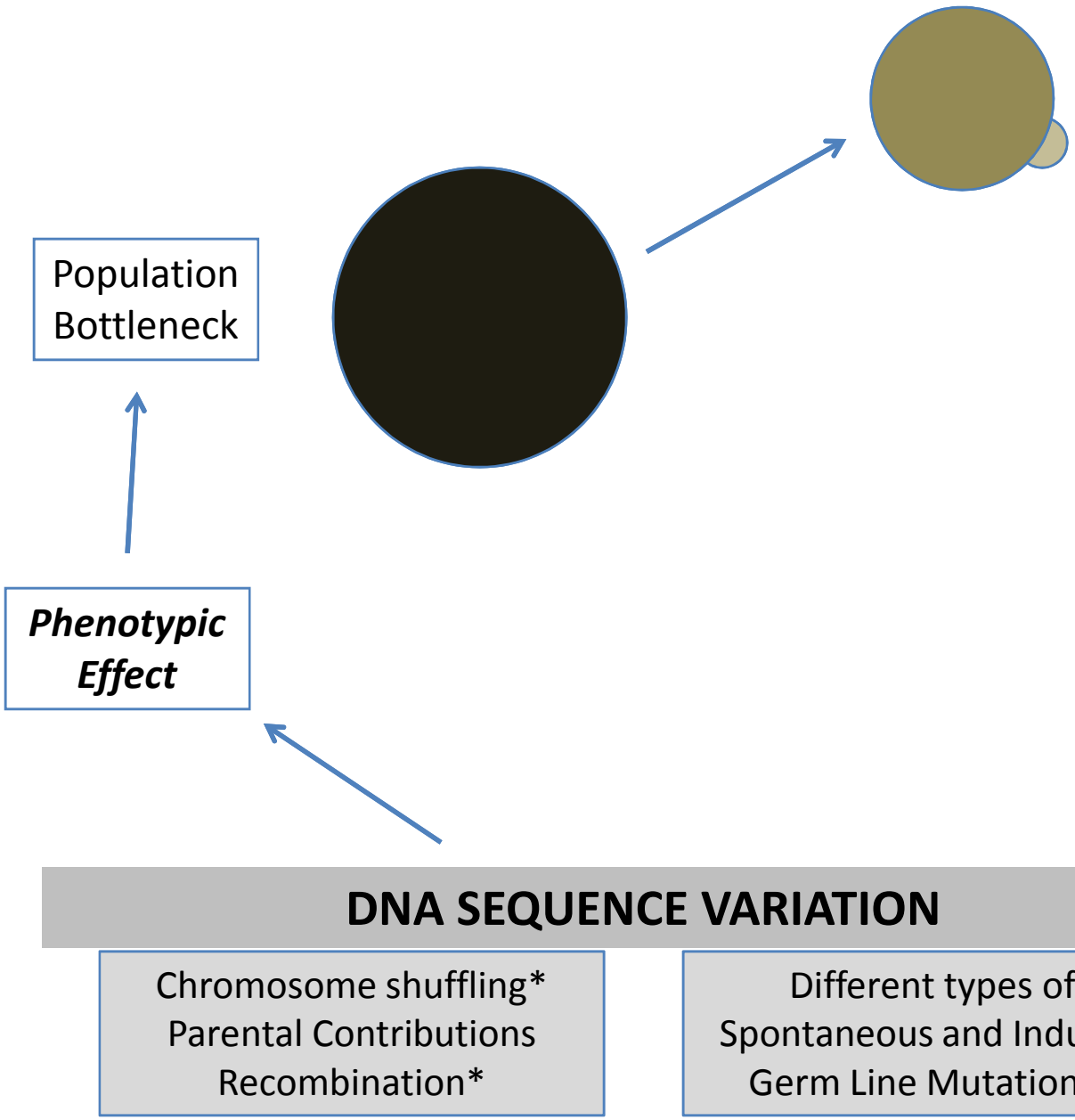

Unique Group Characteristics
Strong Selective Advantage
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

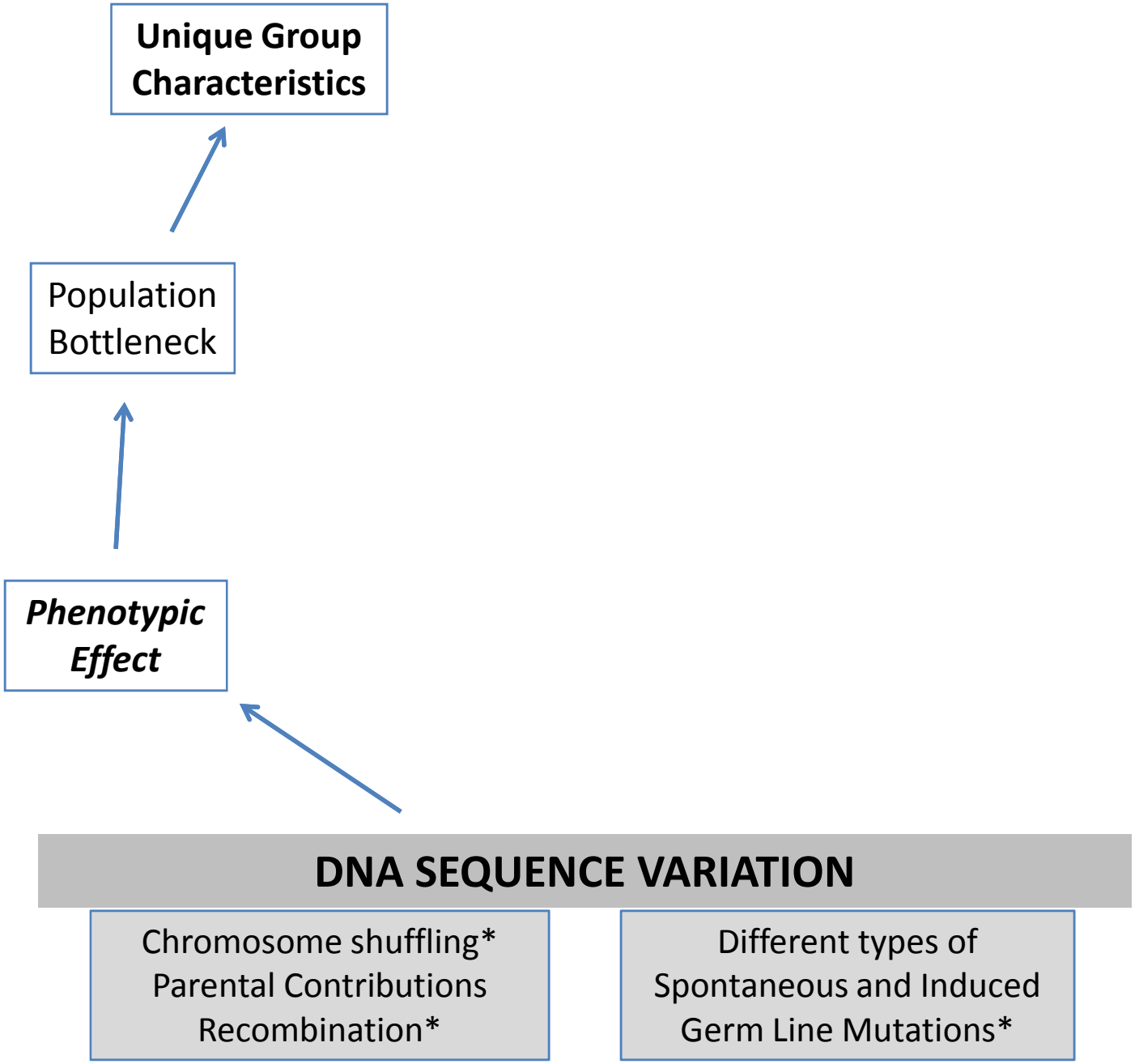

Population Bottleneck
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

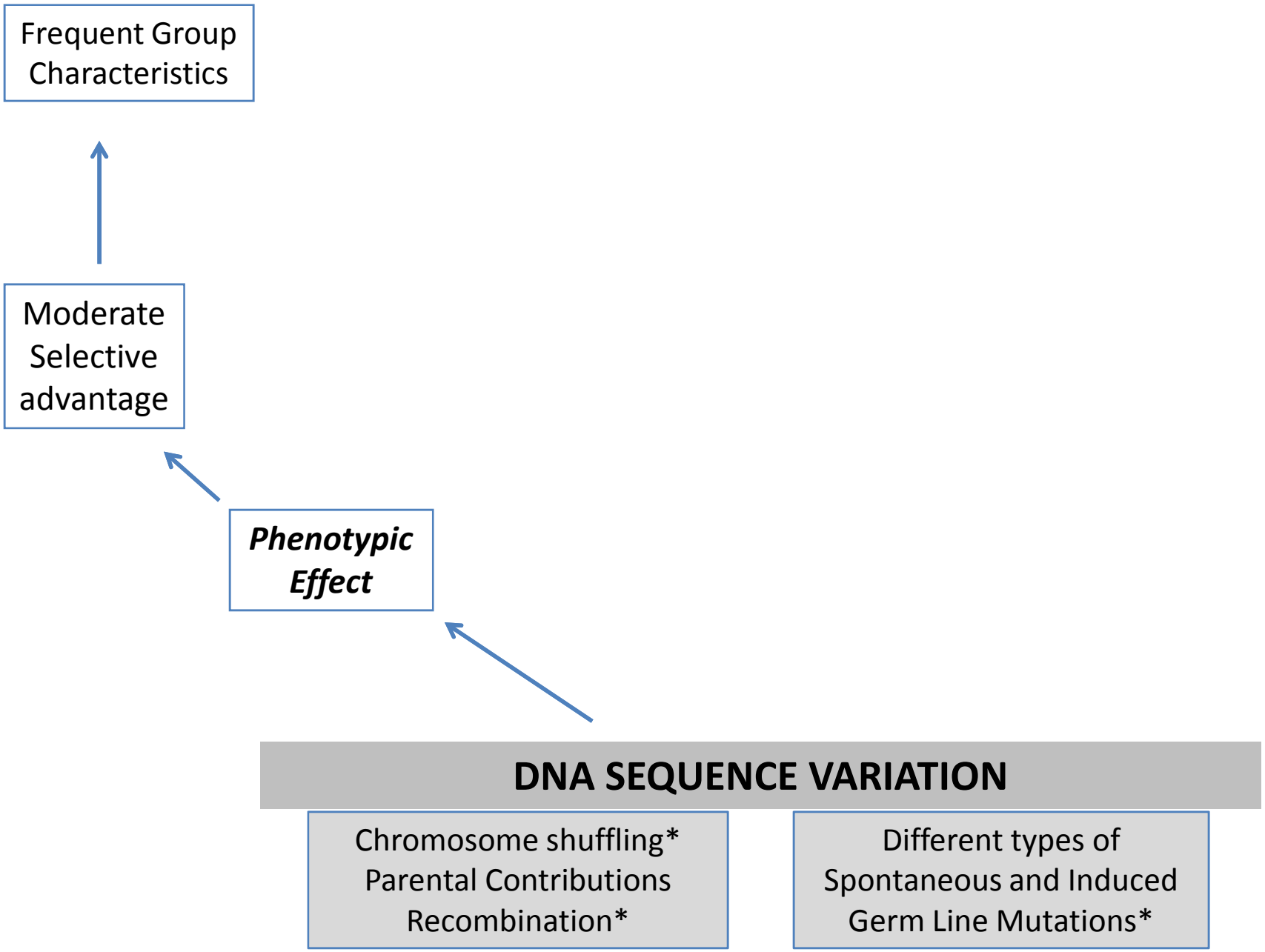

Population Bottleneck
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

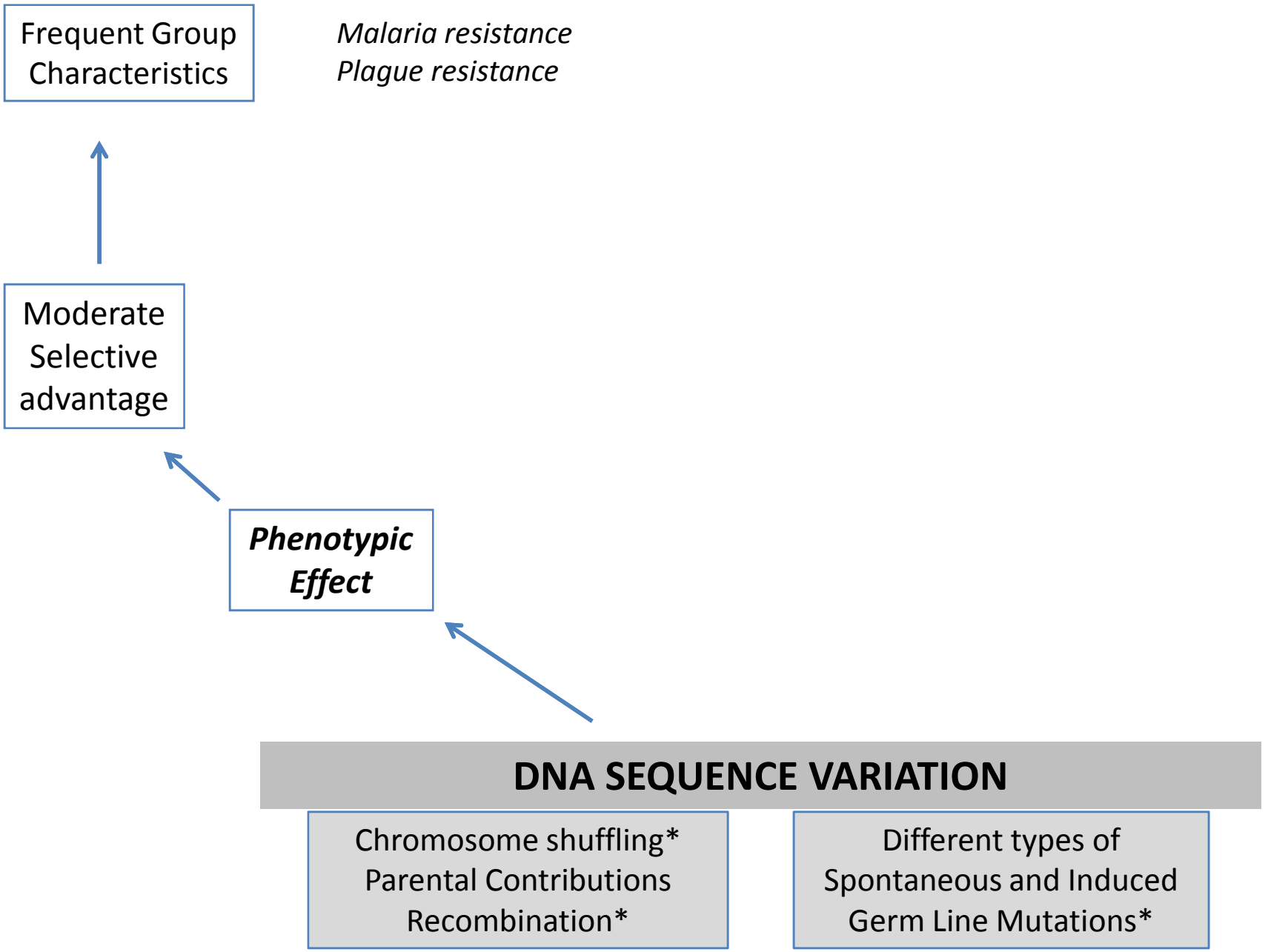

Population Bottleneck
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of
Spontaneous and Induced
Germ Line Mutations*

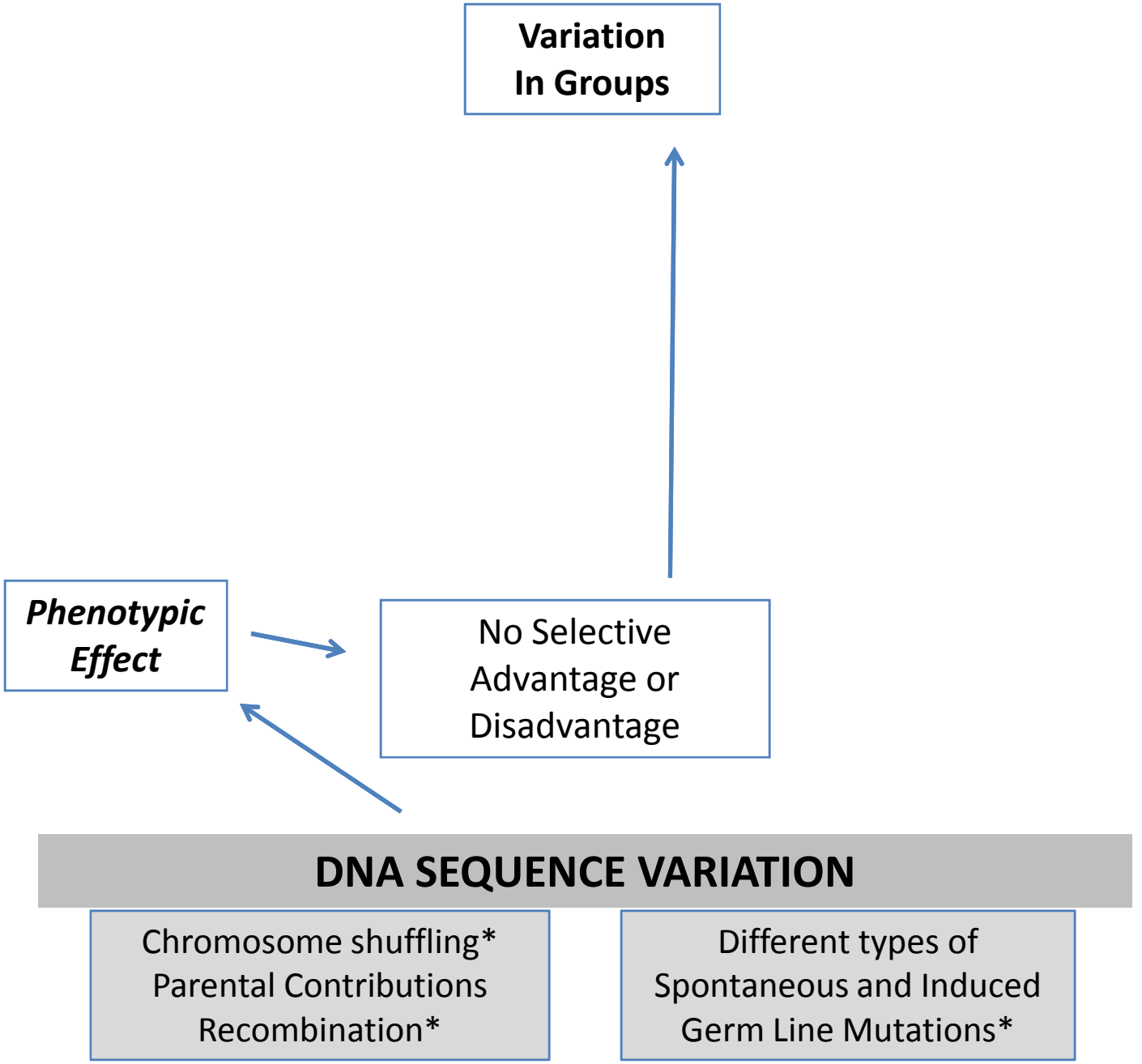

Population Bottleneck
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

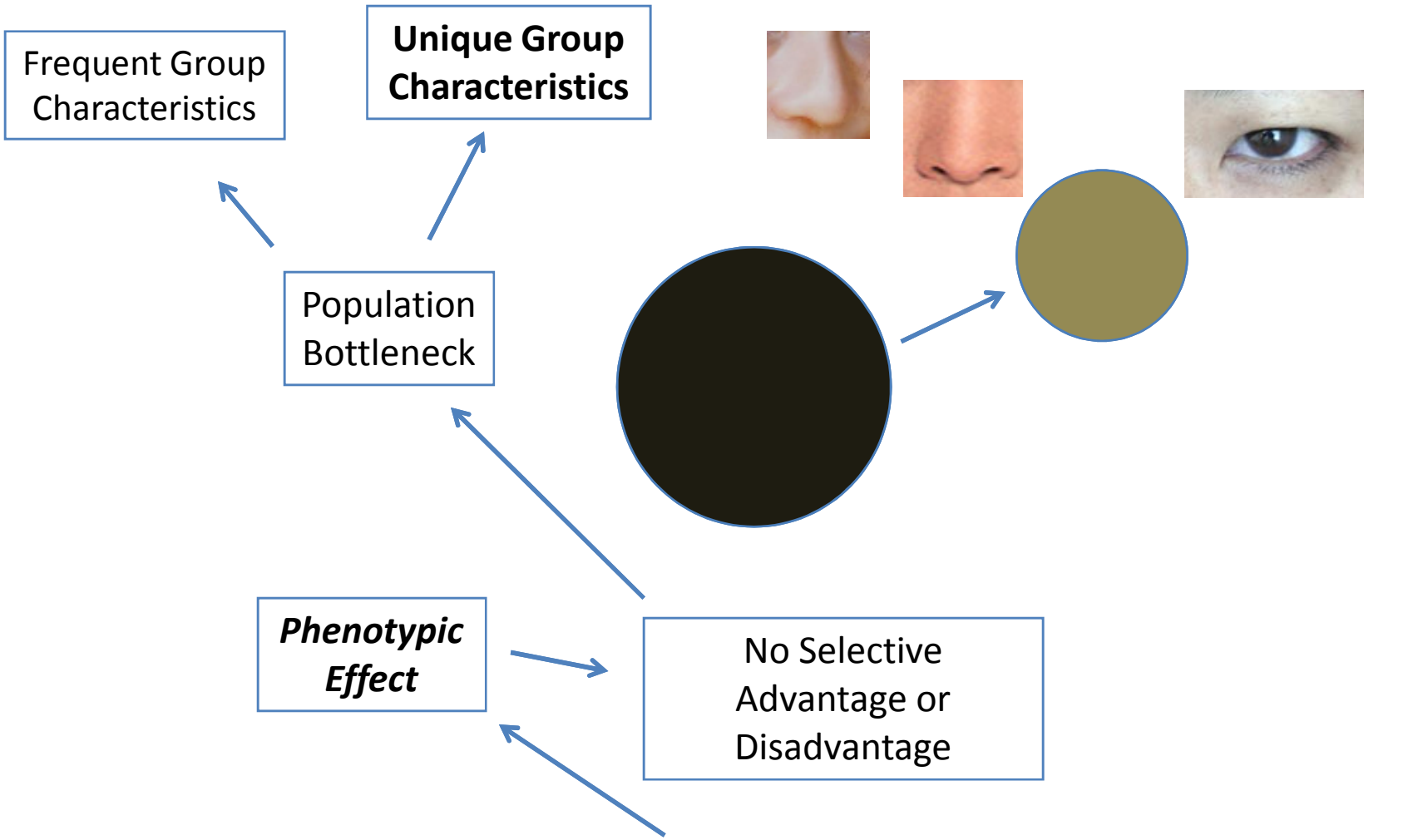

Population Bottleneck
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

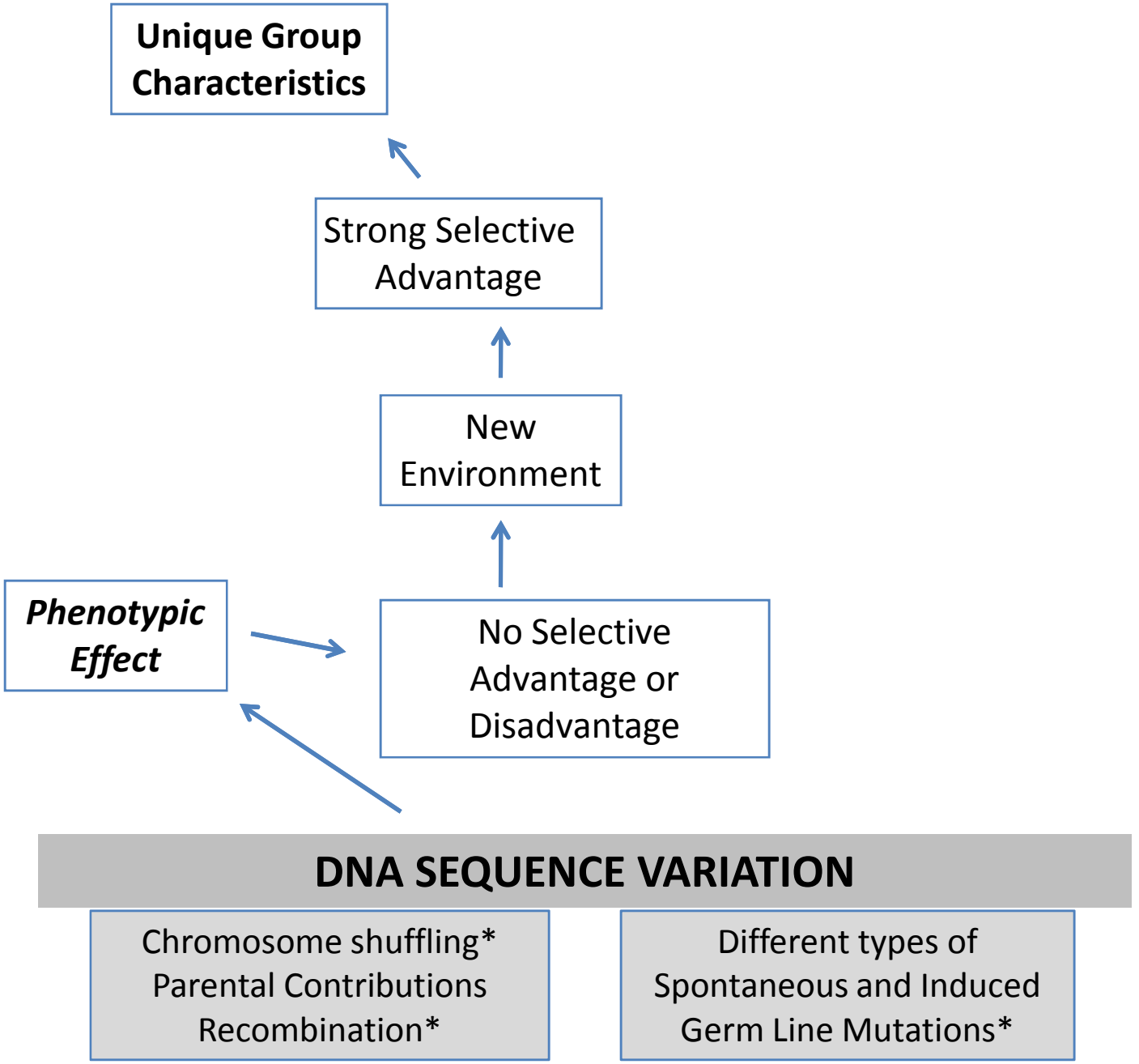

Unique Group Characteristics
Population Bottleneck
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

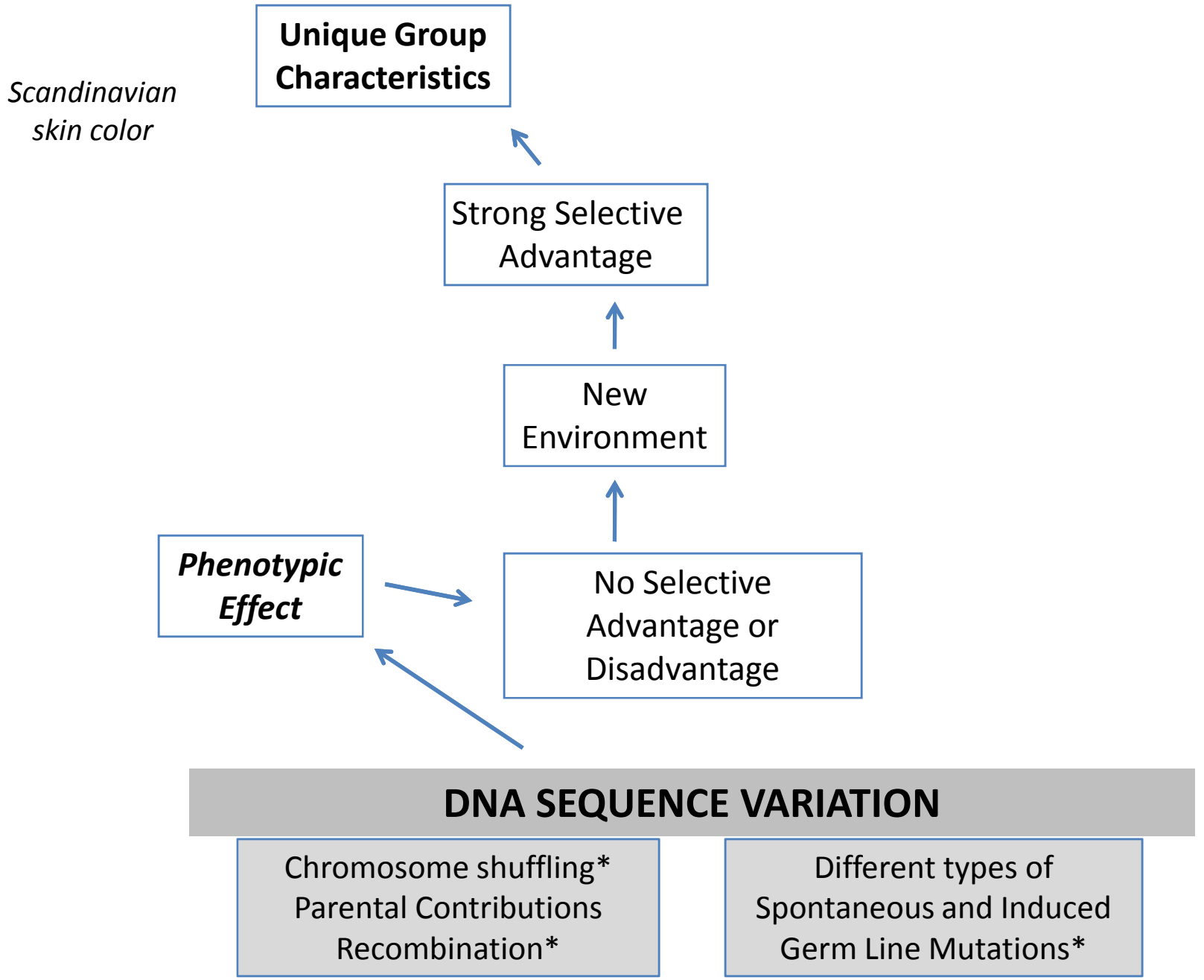

Frequent Group Characteristics
Moderate Selective advantage
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

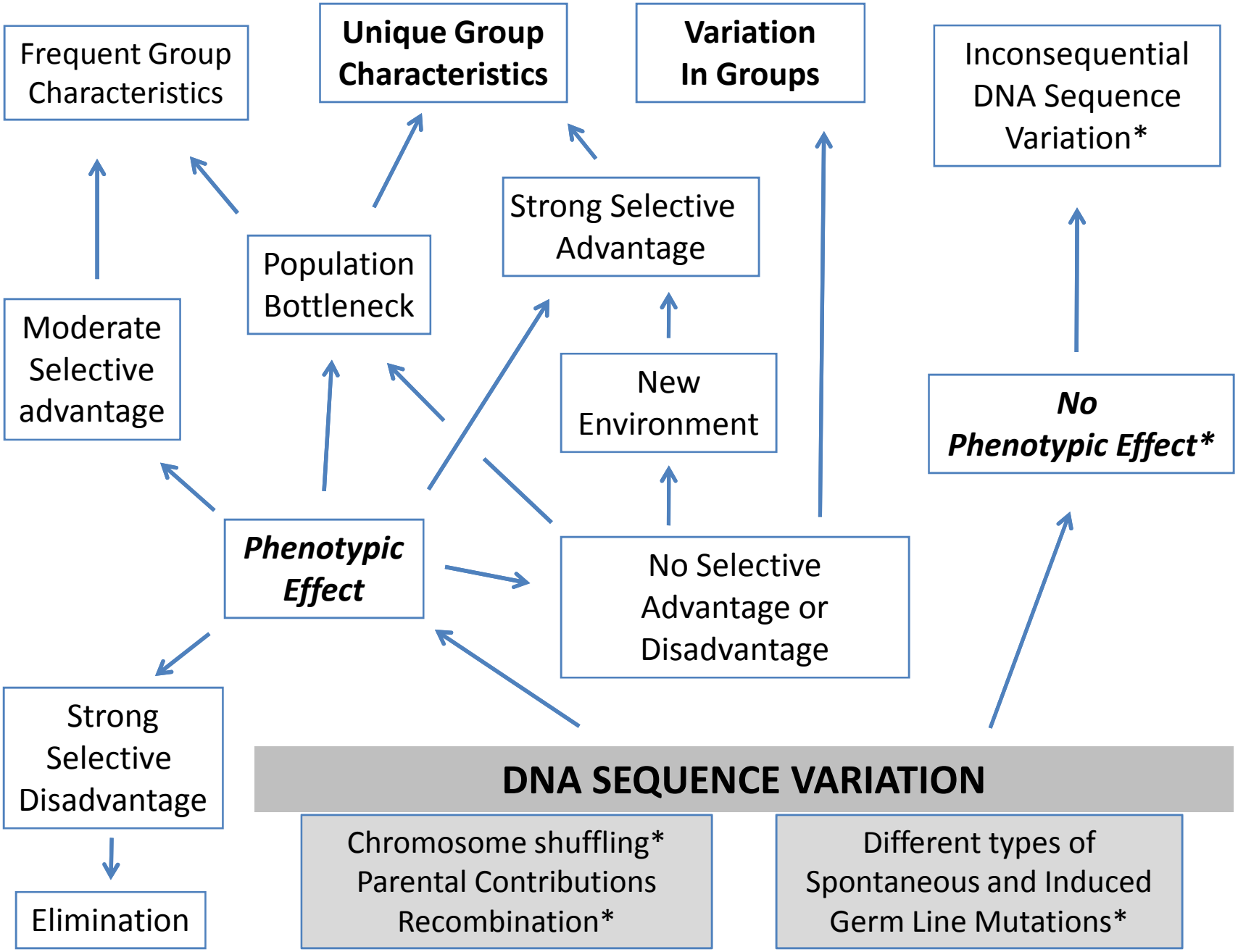

Frequent Group Characteristics
Malaria resistance
Plague resistance
Moderate Selective advantage
Phenotypic Effect
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

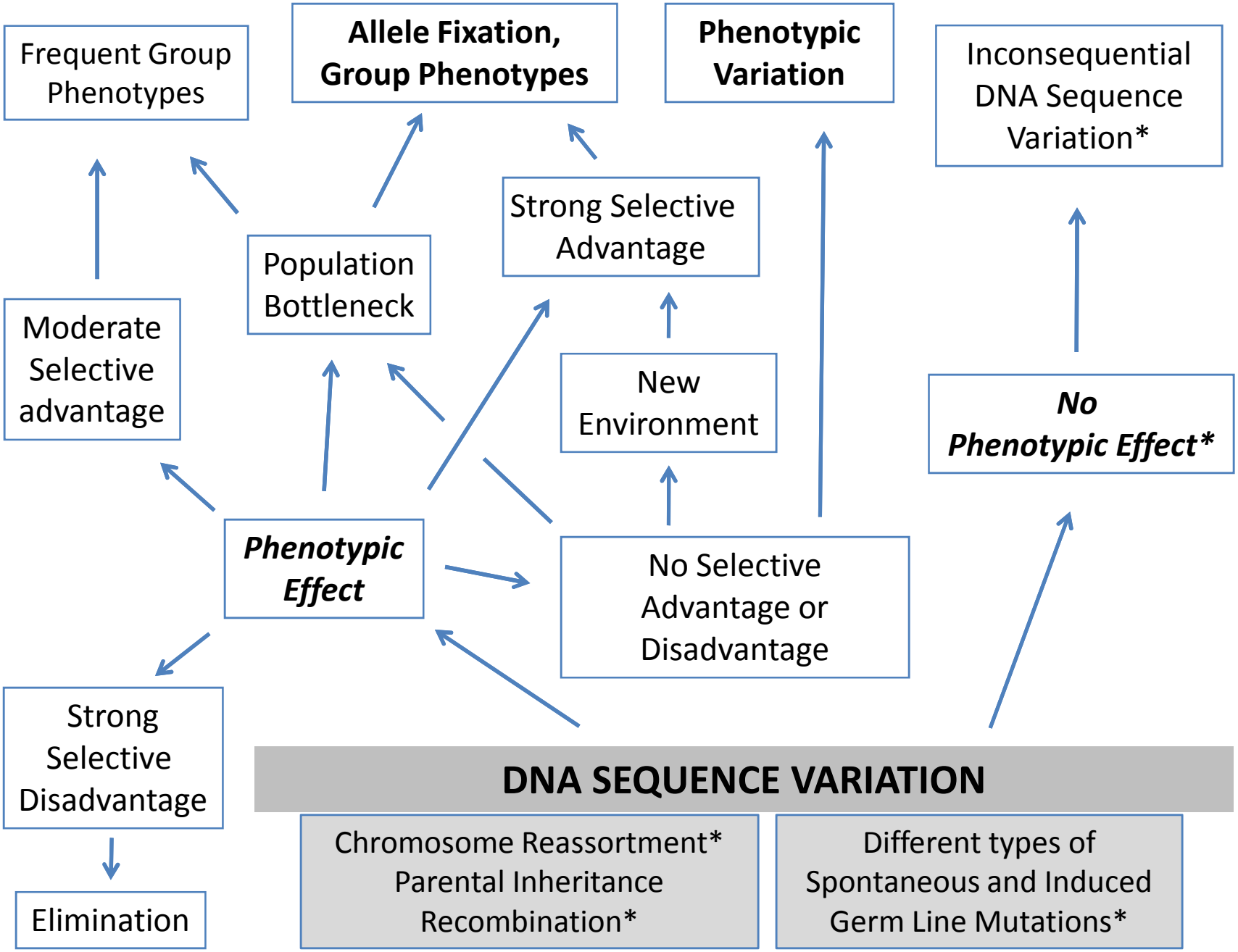

Variation
In Groups
Phenotypic
Effect
No Selective
Advantage or
Disadvantage
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of
Spontaneous and Induced
Germ Line Mutations*


Frequent Group Characteristics
Unique Group Characteristics
Population Bottleneck
Phenotypic Effect
No Selective Advantage or Disadvantage
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*


Unique Group Characteristics
Strong Selective Advantage
New Environment
Phenotypic Effect
No Selective Advantage or Disadvantage
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*


Unique Group Characteristics
Scandinavian skin color
Strong Selective Advantage
New Environment
Phenotypic Effect
No Selective Advantage or Disadvantage
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*


Frequent Group Characteristics
Unique Group Characteristics
Variation In Groups
Inconsequential DNA Sequence Variation*
Strong Selective Advantage
Population Bottleneck
Moderate Selective advantage
New Environment
No Phenotypic Effect*
Phenotypic Effect
No Selective Advantage or Disadvantage
Strong Selective Disadvantage
Elimination
DNA SEQUENCE VARIATION
Chromosome shuffling*
Parental Contributions
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*


Frequent Group Phenotypes
Allele Fixation, Group Phenotypes
Phenotypic Variation
Inconsequential DNA Sequence Variation*
Strong Selective Advantage
Population Bottleneck
Moderate Selective advantage
New Environment
No Phenotypic Effect*
Phenotypic Effect
No Selective Advantage or Disadvantage
Strong Selective Disadvantage
Elimination
DNA SEQUENCE VARIATION
Chromosome Reassortment*
Parental Inheritance
Recombination*
Different types of Spontaneous and Induced Germ Line Mutations*

Following two slides

- These were KC's starting points for thinking (begun 2/22/09)
- Starts with mechanisms we study today
- Connects with what we see

False “scientific” thinking about global warming: “Organisms will adapt anyway…” True or false?

- The answer to the question: False
- If extreme, they die
- If moderate they adjust
- Adjustment becomes less likely as populations shrink
- Darwin might have said “True”, since he and many other scientists of the day believed in Lamarkian inheritance (of acquired traits), which is false!
- Genetic adaptations we know about have occurred over millennia, not tens of years, as is occurring in global climate change
- *Such outdated, erroneous thinking* ***endangers our globe***

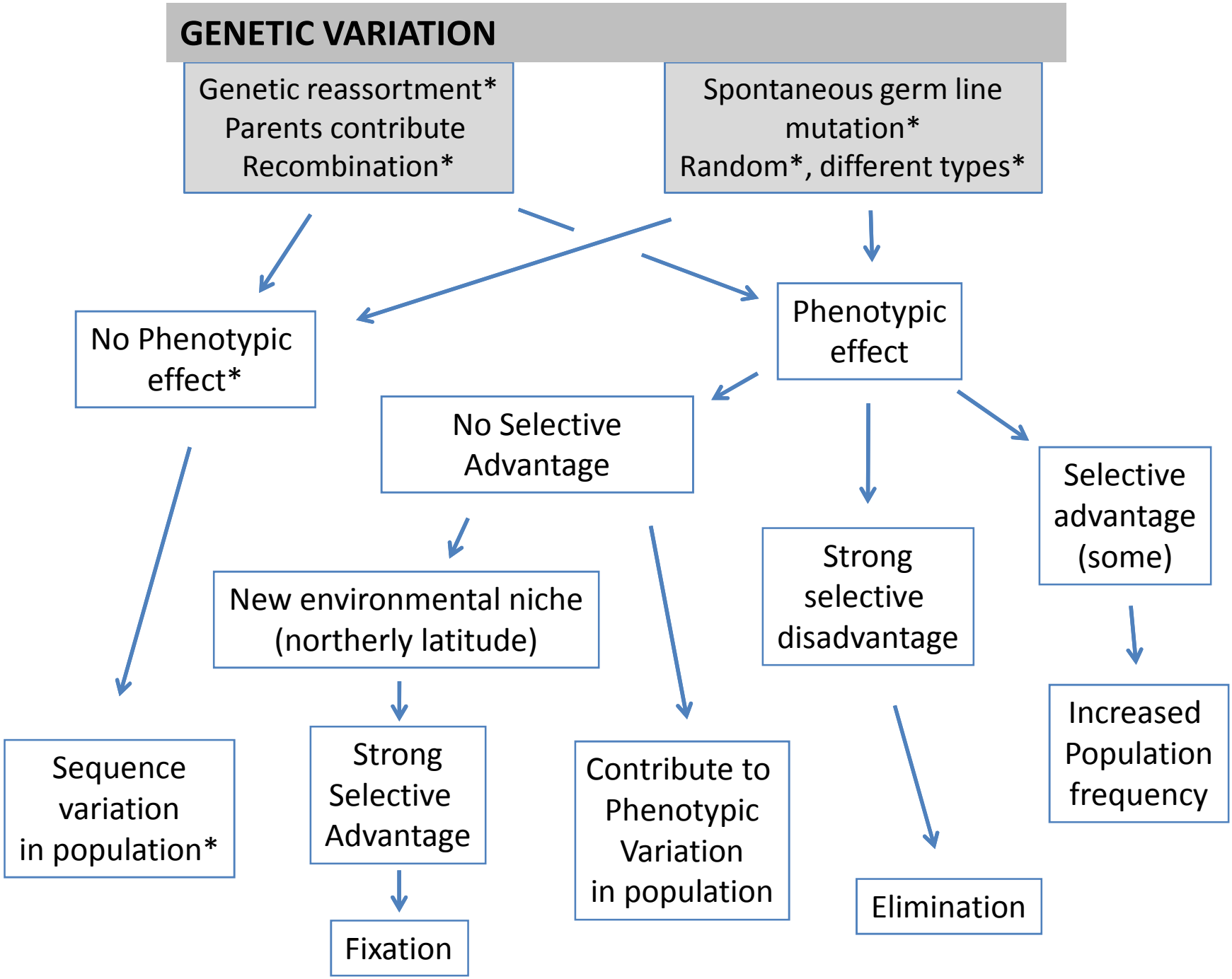
Misuses or denial of science

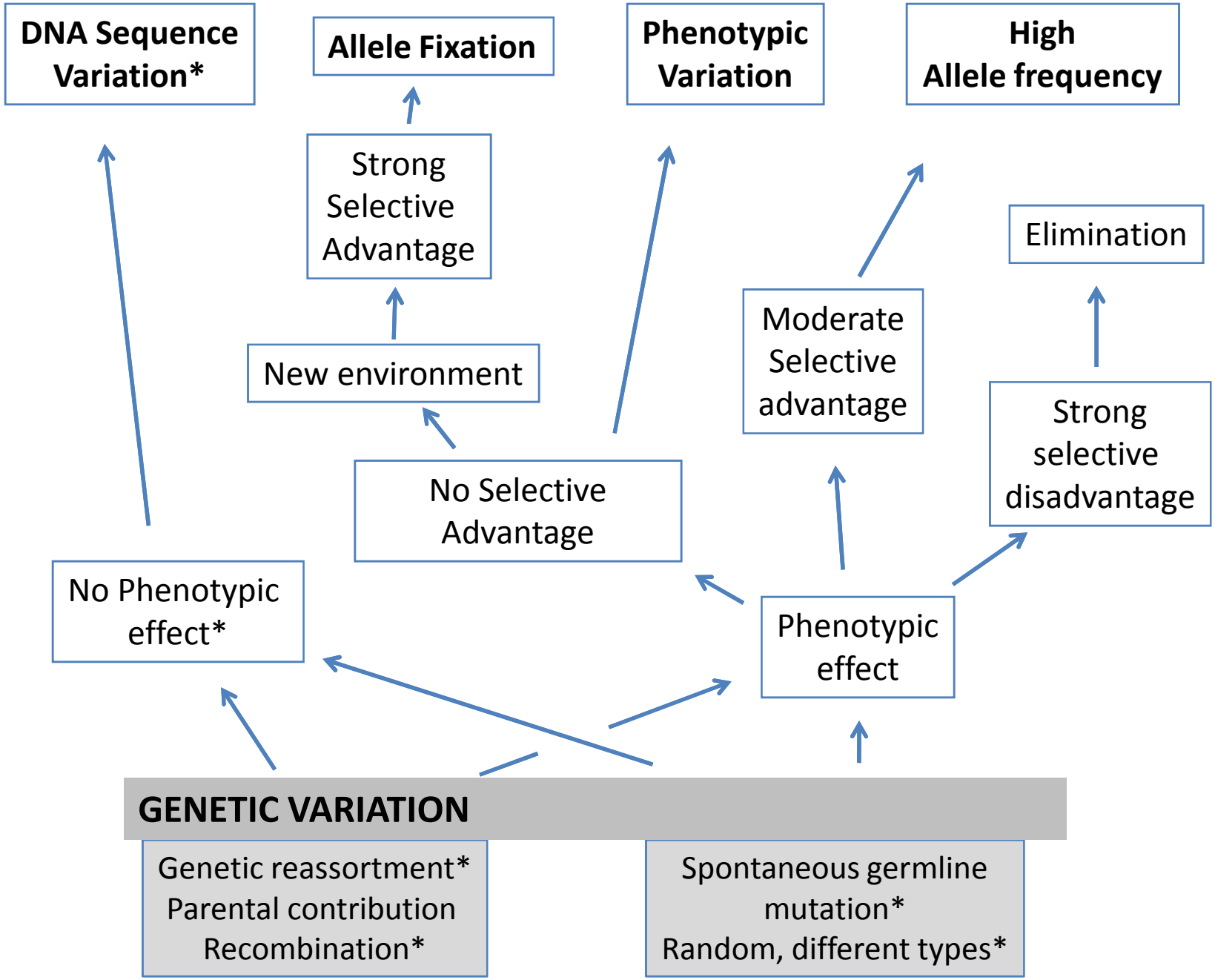
- Eugenics
- Social Darwinism
- Creating conflict where it does not exist for economic/political/"religious" purposes:
  - Denying the link between smoking and lung cancer (Tobacco companies)
  - Denying the link between fossil fuel use and global warming (Oil Industry - same person who argued against the smoking cancer link!)
  - Which do we need more of for increasing population health: Specialty or Primary care?
  - Is National Health or Insurance-based Health better for a nation's health?

When scientists speak of "evolution", they are speaking of something different from creationists

- While a few scientists are interested in whether life can come from some sort of primordial soup…
- When scientists say "evolutionary" they are NOT talking about the origin of life
- Where there is NO DEBATE:
  - humans ARE unique in some ways
  - all living things share genetic and physical units of function
  - the pattern of changes in features and DNA sequences across all organisms makes sense according to how related they are
  - the diversity and relatedness of life is a story of nature
  - the ages of fossils can be measured using unchangeable principles of physics and chemistry

End here


GENETIC VARIATION
Genetic reassortment*
Parents contribute
Recombination*
Spontaneous germ line
mutation*
Random*, different types*
No Phenotypic
effect*
Phenotypic
effect
No Selective
Advantage
Selective
advantage
(some)
Strong
selective
disadvantage
New environmental niche
(northerly latitude)
Sequence
variation
in population*
Strong
Selective
Advantage
Contribute to
Phenotypic
Variation
in population
Increased
Population
frequency
Fixation
Elimination


DNA Sequence Variation*
Allele Fixation
Phenotypic Variation
High Allele frequency
Strong Selective Advantage
Elimination
New environment
Moderate Selective advantage
Strong selective disadvantage
No Selective Advantage
No Phenotypic effect*
Phenotypic effect
GENETIC VARIATION
Genetic reassortment*
Parental contribution
Recombination*
Spontaneous germline mutation*
Random, different types*