



Towards a More Humane Genetics

**Teaching about
human genetic
difference is not
socially neutral.**

THE ISSUE

Racism is a serious problem in the United States. Research has shown that the biology curriculum can affect how students think about race. It can lead students to believe more strongly in **three misconceptions**⁽⁶⁾ :

1. People of the same racial group are genetically uniform.
2. People of disparate races are categorically different.
3. Biologically-influenced abilities cannot change.

Individuals often justify racism with these misconceptions by arguing that it is pointless to try and reduce social inequality, because race biologically determines ability⁽⁴⁻⁶⁾.

OUR FOCUS

How can such beliefs be
(un)learned through
biology education?

WHAT WE'VE LEARNED

Insights from our research have begun to illustrate how biology education affects the development of racism, for better or worse.

We've learned:

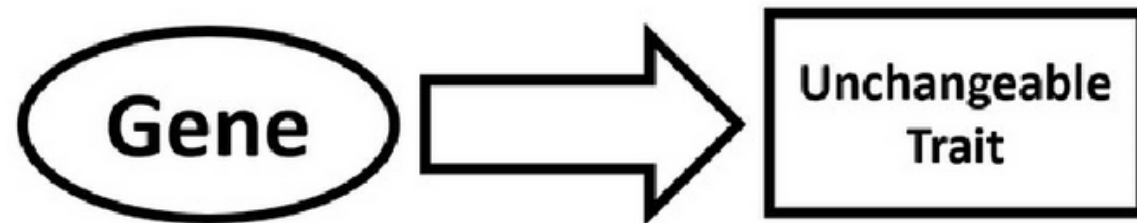
- When biology education causes youth to perceive too much genetic variation between racial groups, it can increase prejudice⁽⁶⁾.
- Conversely, the way we teach biology can reduce racial prejudice by helping students understand that there is more genetic variation within racial groups than there is between them⁽⁵⁾.

ASSOCIATED WITH INCREASED PREJUDICE

ASSOCIATED WITH DECREASED PREJUDICE

Misconception:

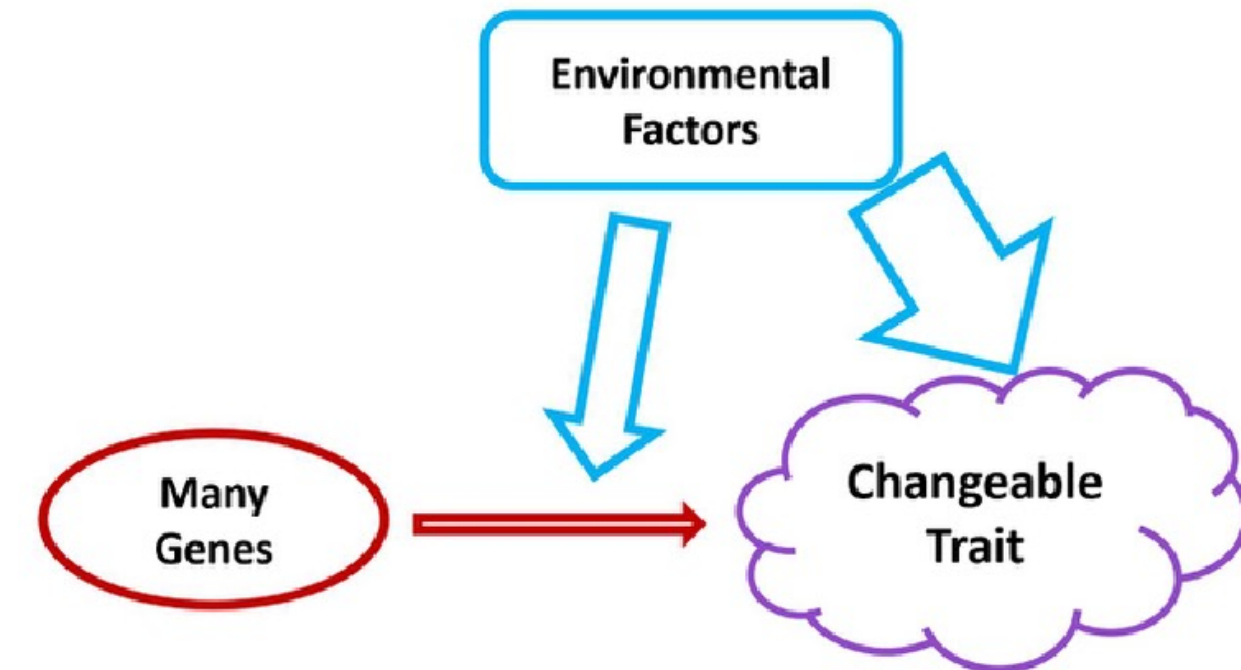
Mendel's simple model of genetics explains complex traits.



Current teaching practices in biology can indirectly increase prejudice and stereotyping by validating naïve understandings of genetics^(1,2). When the curriculum focuses mainly on a Mendelian model of genetics, students may incorrectly explain all human traits with that model⁽²⁾. However, most complex human traits are explained by a multifactorial model of genetics⁽³⁾. Moving students from a Mendelian model to a multifactorial model of complex human traits undermines genetic determinism^(1,2). Since genetic determinism is used to rationalize racial inequality, a more humane genetics education could challenge genetic determinism by teaching students about multifactorial genetics and how genes are used, incorrectly, to justify inequality^(4,5).

Correct Model:

Mendel's simple model of genetics explains complex traits.



Each circle represents the total number of alleles (gene variants) in the human genome found within a particular group.



African Ancestry



East-Asian Ancestry



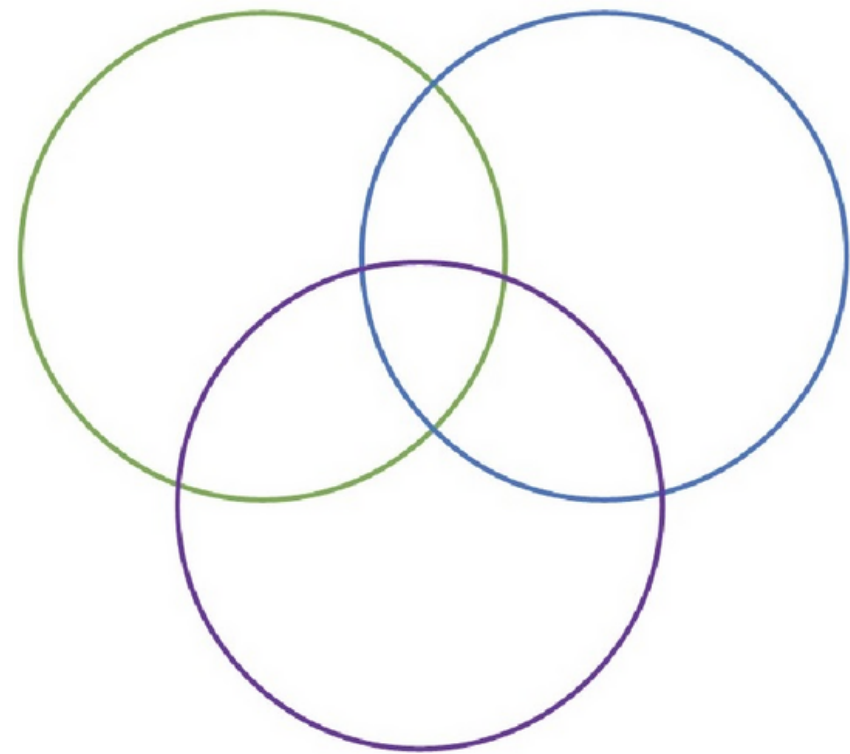
European Ancestry

ASSOCIATED WITH INCREASED PREJUDICE

ASSOCIATED WITH DECREASED PREJUDICE

Misconception:

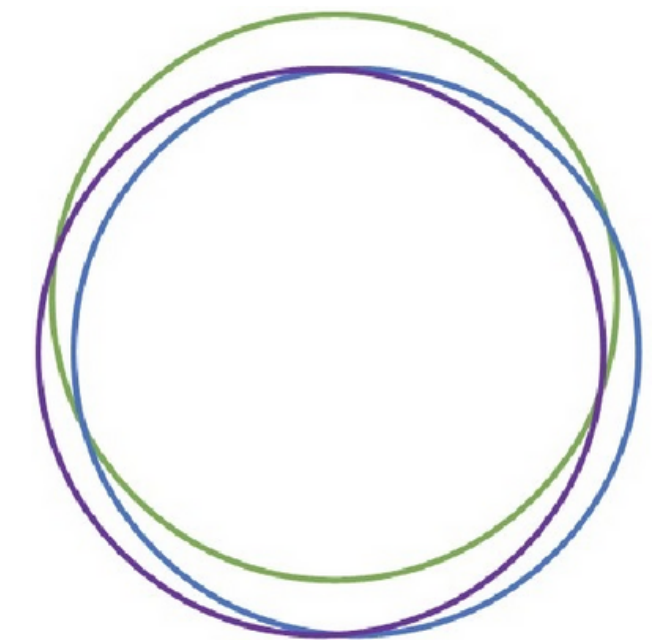
Human ancestral groups do not share many alleles.



Depending on the way in which biology is taught, it can either lead to misconceptions about human biological variation or a more correct understanding of it^(5,6). Biology textbooks can indirectly lead to prejudice by reinforcing the misconception that ancestral groups do not share most alleles⁽⁴⁾. This reinforcement can occur when learning about diseases like sickle cell anemia⁽⁶⁾. However, on average, different ancestry groups are only 4.3% more different from each other than individuals within the same group⁽⁷⁾. When students understand this finding, it can indirectly reduce their prejudice⁽⁶⁾. Additionally, our current research suggests that understanding multifactorial genetics helps students understand human genetic variation. Since misconceptions about genetic variation are used to justify racism⁽⁴⁾, a more humane genetics education could confront racism by teaching students a more correct model of human genetic variation and by helping students understand how findings about human genetic variation are distorted to justify racism⁽⁴⁾.

Correct Model:

Each region contains a majority of the alleles found worldwide.



Each circle represents the total number of alleles (gene variants) in the human genome found within a particular group.



African Ancestry



East-Asian Ancestry



European Ancestry

IMPLICATIONS FOR TEACHING

What genetic concepts can I teach biology students?

- ▶ Scientists agree that race and racism are socially real, but race has little biological validity, because ^(3,4,8):
 - Individuals of the same racial group are genetically different ^(7,8).
 - U.S. racial groups are genetically alike because they share similar sets of differences ^(7,8).
 - Human genetic diseases are not race-specific (e.g. sickle cell anemia occurs in African, European, and Middle Eastern populations) ⁽⁴⁻⁶⁾.
 - Complex human traits are best explained by a multi-factorial model, not a Mendelian model ⁽¹⁻³⁾.

What social science concepts can I teach biology students?

- Genetic claims about racial difference historically have been used to rationalize genocide and discrimination ^(4,5).
- Racial inequalities are not consequences of genetics. They are, in part, consequences of incorrect beliefs about genetics ⁽⁶⁾.
- People tolerate and/or perpetuate social inequalities when they believe these inequalities are caused by genes ⁽⁴⁻⁶⁾.

How does this connect to NGSS?

- ▶ Students' racial biases can potentially be reduced through NGSS-aligned curriculum and instruction ⁽⁵⁾:
 - Materials should be designed to engage students in data analysis, argumentation, and modeling to learn about the core idea of genetic diversity.
 - These scientific practices can help learners make sense of cross-cutting concepts (ex: cause and effect in genetics).
 - NGSS curriculum and instruction can reduce students' biases by changing how they perceive human genetic variation.

Biology education framed by this kind of curriculum and instruction ⁽⁵⁾ ...






May reduce students' beliefs that:

- People of the same racial group are genetically uniform.
- People of disparate racial groups are categorically different.
- Biologically-influenced abilities are unchangeable.





For an overview of our research studies and access to select papers, visit bscs.org/humane-genetics.

For more information on NSF-Core Award #1660985, contact Dr. Brian Donovan at bdonovan@bscs.org.

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