Genetic & Evolutionary Roots of Behavior
Gleitman *et al*. (2011), Chapter 2

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Psych 9A / Psy Beh 11A
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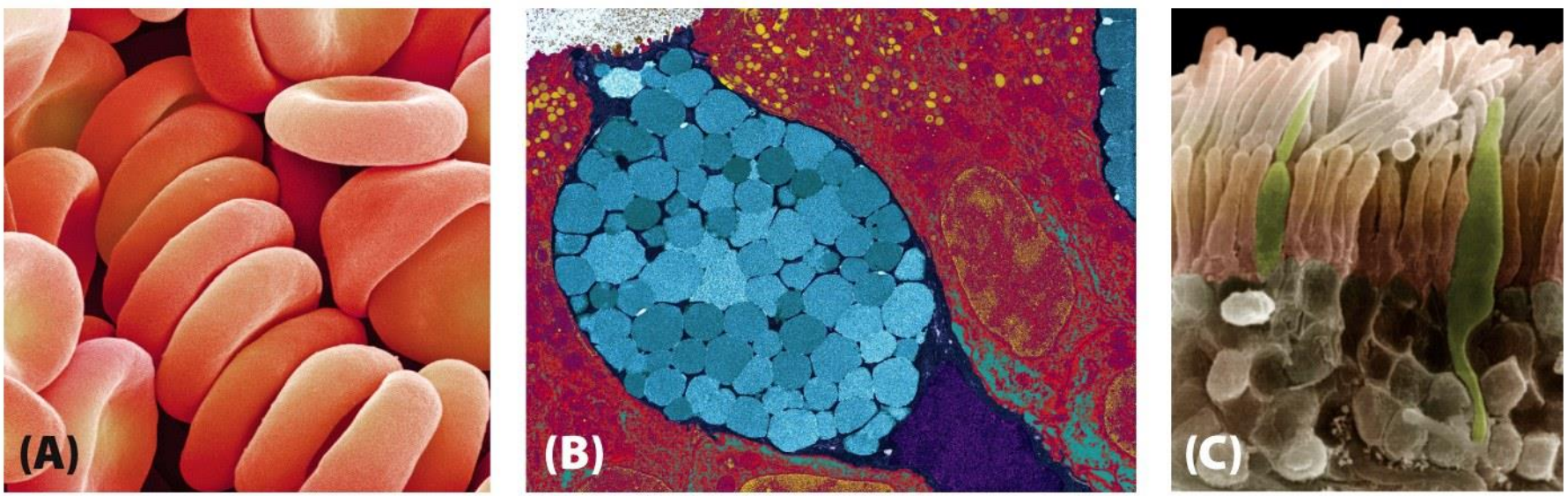
Chapter Topics

- Genetics and DNA
- Evolution by natural selection
- The genetics and evolution of behavior
- Strengths and limits of evolutionary theorizing
- Summary

Many different kinds of cells in our bodies:



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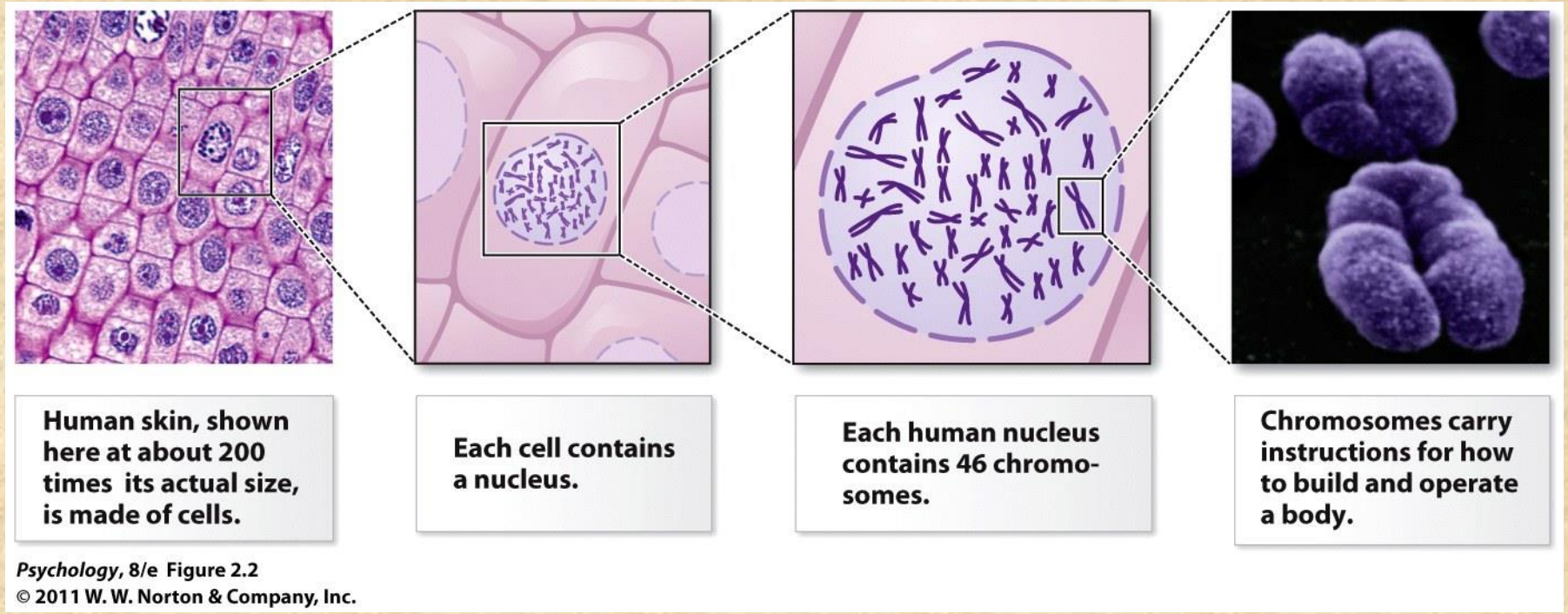
Red blood cells

Intestinal goblet cells

Retinal photoreceptors

Genetics and DNA

- The *nucleus* of each biological cell contains *chromosomes,* which each contain a single molecule of *DNA.*
- Within this molecule, *genes* govern the cell's functioning by providing detailed instructions for making proteins.



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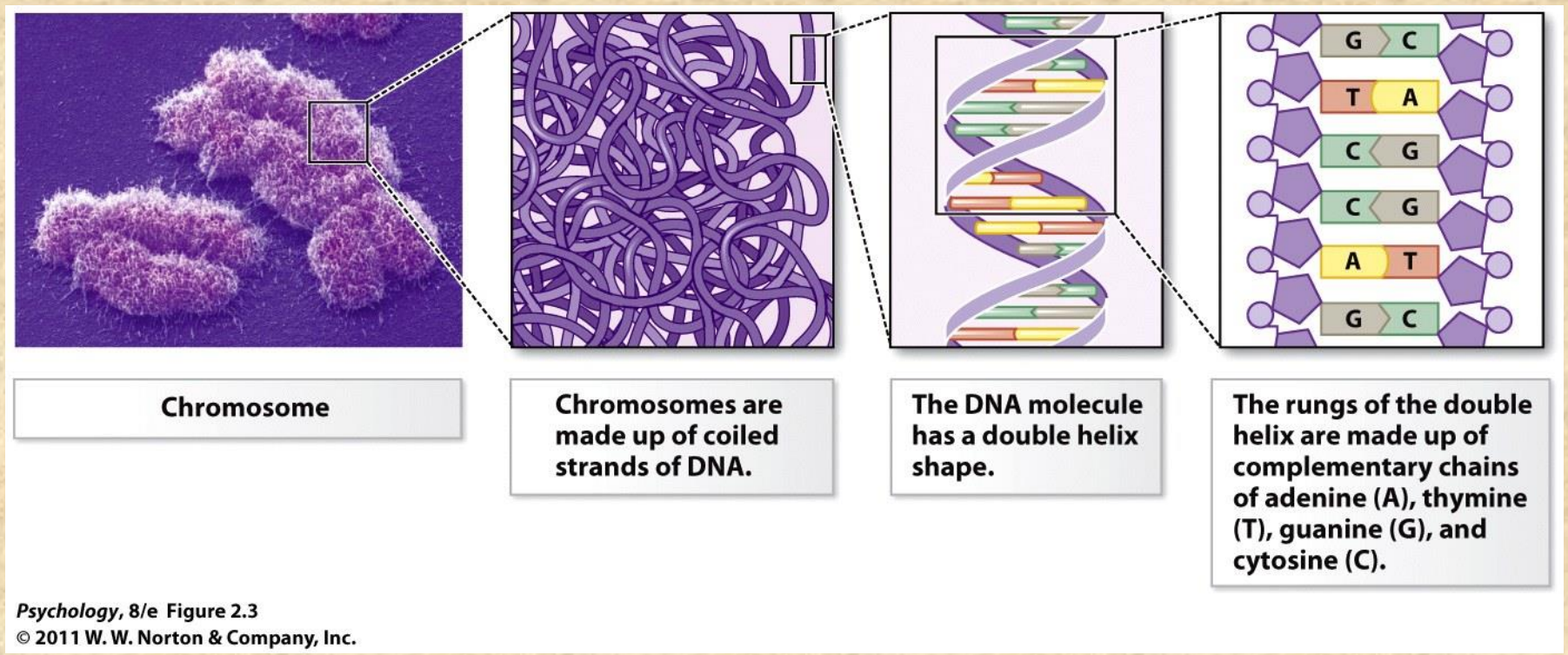

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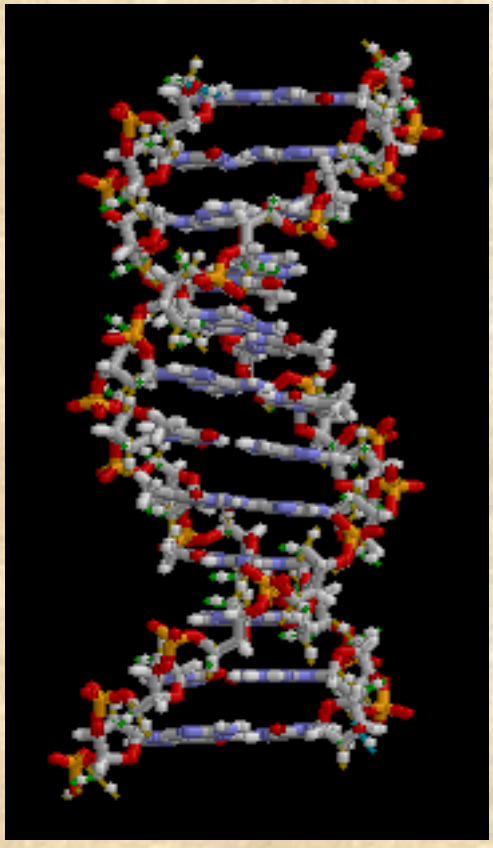
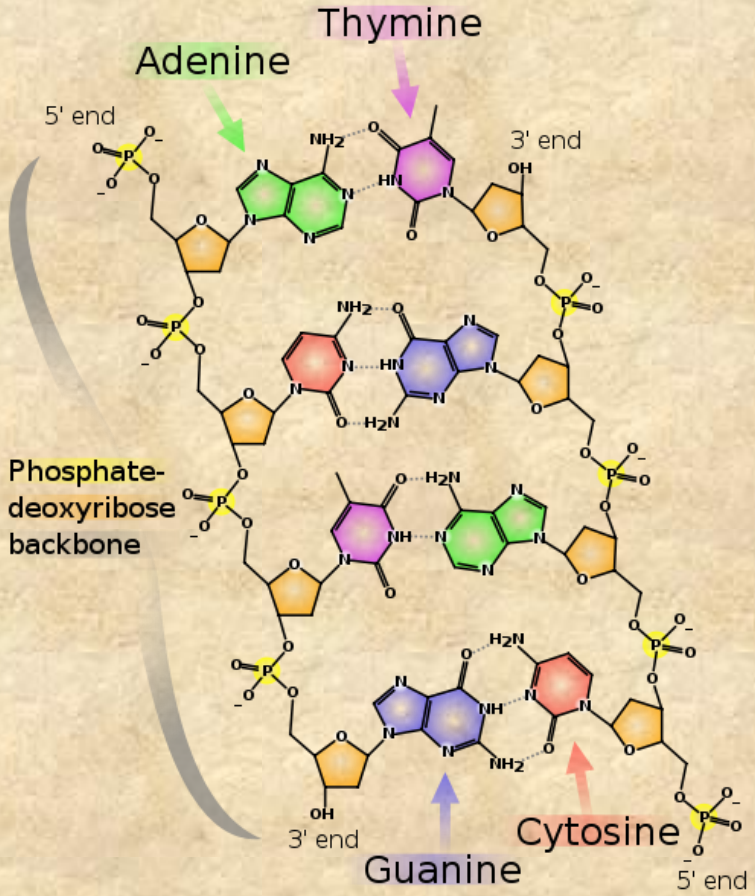
The double strands of a DNA molecule are arranged in helical form: the double helix. This discovery in 1953 won Watson & Crick the Nobel prize. The molecule unzips to allow access to the genetic code provided by the sequence of ATGC bases.





Genome

- Humans have 23 pairs of chromosomes and roughly 25,000 protein-coding genes.
- These are collectively called a person's *genome.*

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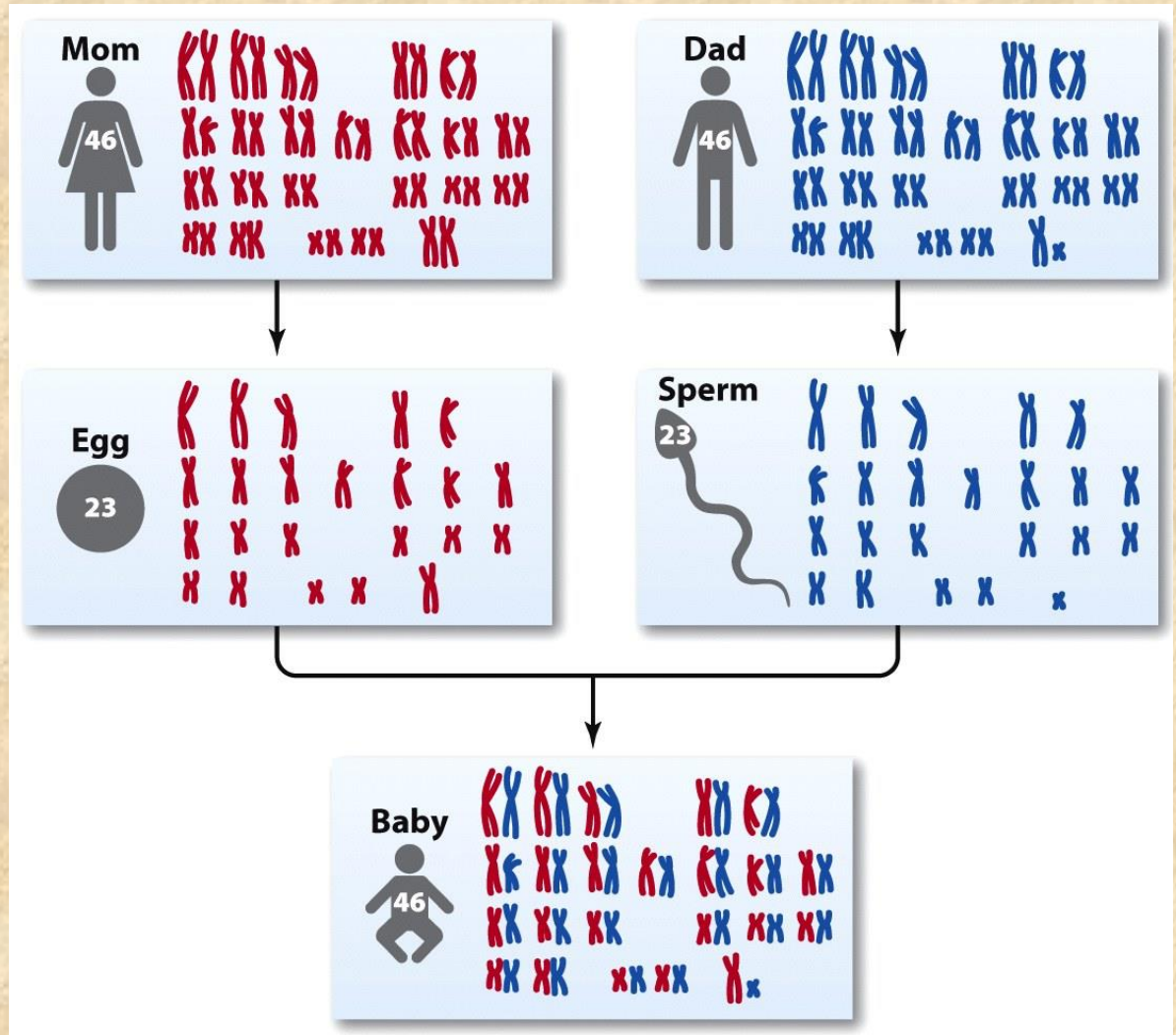
Gene Expression

- In each cell, some genes are *expressed* at any point in time and others are not.
- Gene expression is controlled by the biochemical environment inside the cell, which is influenced by the organism's:
  - overall environment.
  - experience.
  - behavior.

Gene Expression

- An organism's genome therefore specifies only its *genotype.*
- The overt traits and behaviors of the organism define its *phenotype*:
  - the product of the genotype and experience, which are in continual interaction



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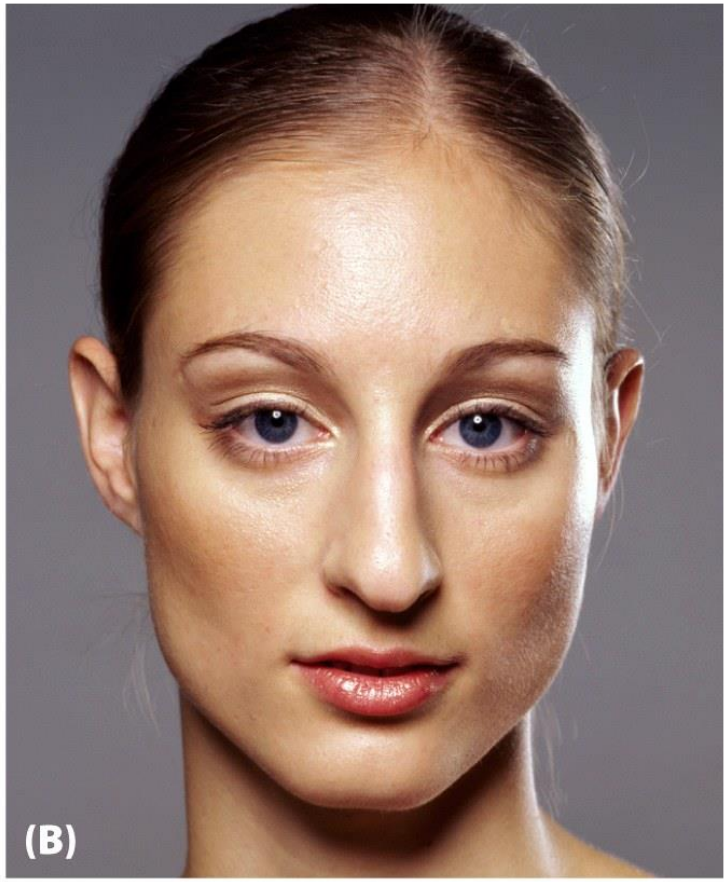
← meiosis

Interactions among Genes

- Most characteristics are influenced by the action of many genes.
- Some depend on a single pair of genes. Common human traits that depend on a single gene pair: red-green color blindness, dangling earlobes, baldness, dimples, susceptibility to poison ivy.

Not all heritable traits have functions...



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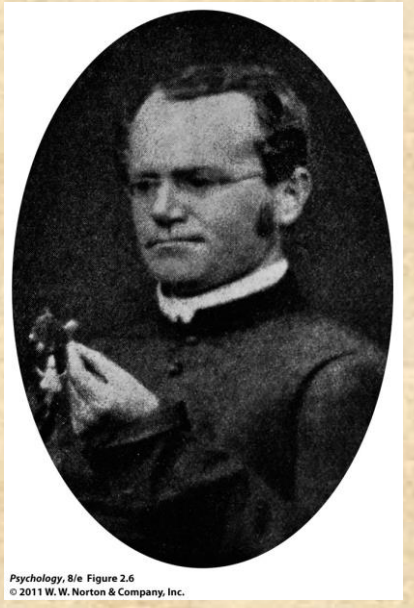
Interactions among Genes

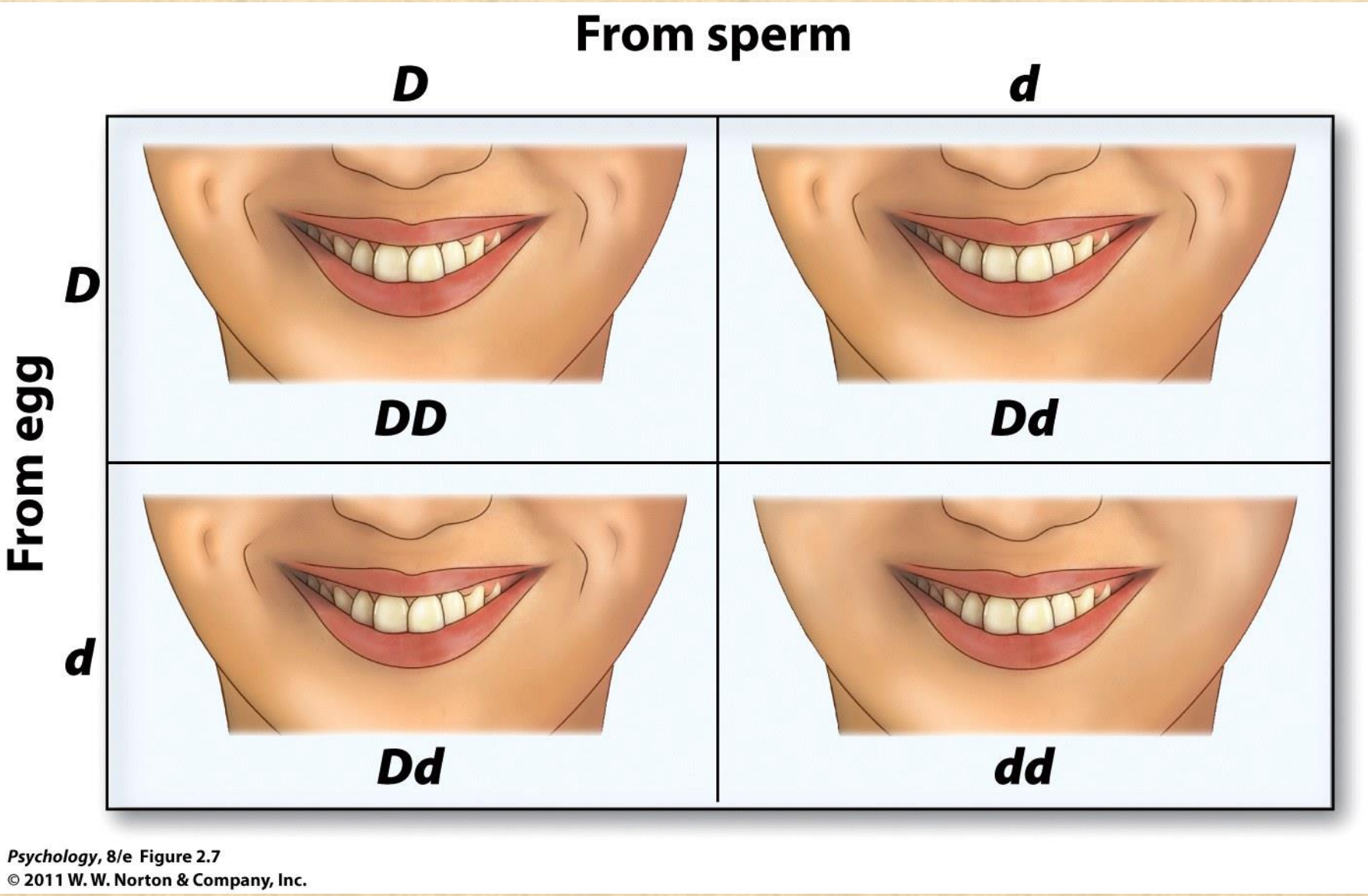
- Most characteristics are influenced by the action of many genes.
- Some depend on a single pair of genes. Common human traits that depend on a single gene pair: red-green color blindness, dangling earlobes, baldness, dimples, susceptibility to poison ivy.
- Each gene is paired with another gene.
  - The pairs are located at corresponding positions on pairs of chromosomes.

Dominant vs. Recessive

- The paired genes may or may not be the same *allele.*
- If they are different:
  - one gene may be *dominant* and the other *recessive,*
  - or the genes may be *codominant* (both are expressed—*e.g.*, blood type),
  - or one may be *incompletely dominant* (phenotype intermediate to the two coded by the genes).



Gregor Mendel



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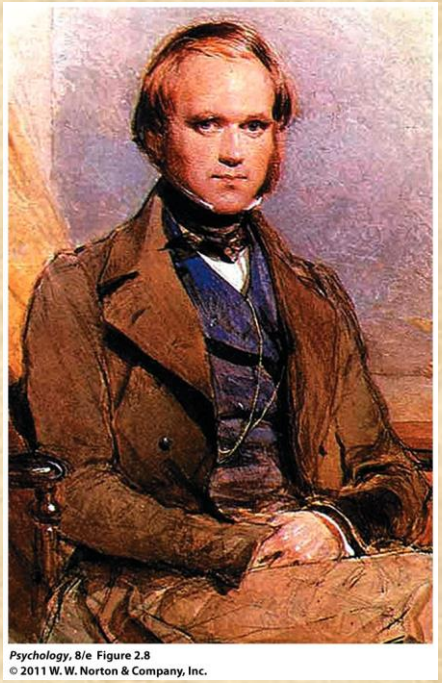
Polygenic Inheritance

- *Many* traits depend on complex interactions among *many* genes, frequently lying on different chromosomes. Examples include bipolar disorder and schizophrenia.

- There is a wealth of information on human genetics. Try the Human Genome Project for starters.

Darwin and Evolution

- Darwin hypothesized that all modern organisms:
  - are descended from a small set of shared ancestors.
  - have emerged over time through the process of evolution.
- An enormous amount of evidence has confirmed these proposals.



Charles Darwin

Darwin and Evolution

- The key mechanism is *natural selection*.
  - If individuals with certain traits are more likely to survive and reproduce,
    - their genes will be better represented in the next generation.
  - And if the genes gave rise to the traits advantageous to survival and reproduction,
    - those traits will be more common in the next generation.
- Do avoid the *naturalistic fallacy*, however—it does not follow that evolution somehow improves organisms or that anything natural is good.

Genes and Evolution

- Darwin's three principles:
  - There must be variation among individuals within a population.
  - Certain of the variants must survive and reproduce at higher rates than others.
  - The traits associated with this advantage must be passed from parents to offspring.

Genes and Evolution

- Both the variation and the transmission of traits depend on the organism's genome.
- The emphasis is on the survival of genes.
  - This evolutionary perspective explains behaviors in which organisms endanger their own survival to protect their offspring or relatives.
  - What matters is the survival of genes, NOT the survival of individuals.

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Plover's broken-wing display. The plover mother draws predators away from the nest by pretending to be injured.

Evidence for Evolution

- The evidence for modern evolutionary theory comes from many sources, including:
  - the fossil record.
  - examination of the resemblance between genomes of various organisms.

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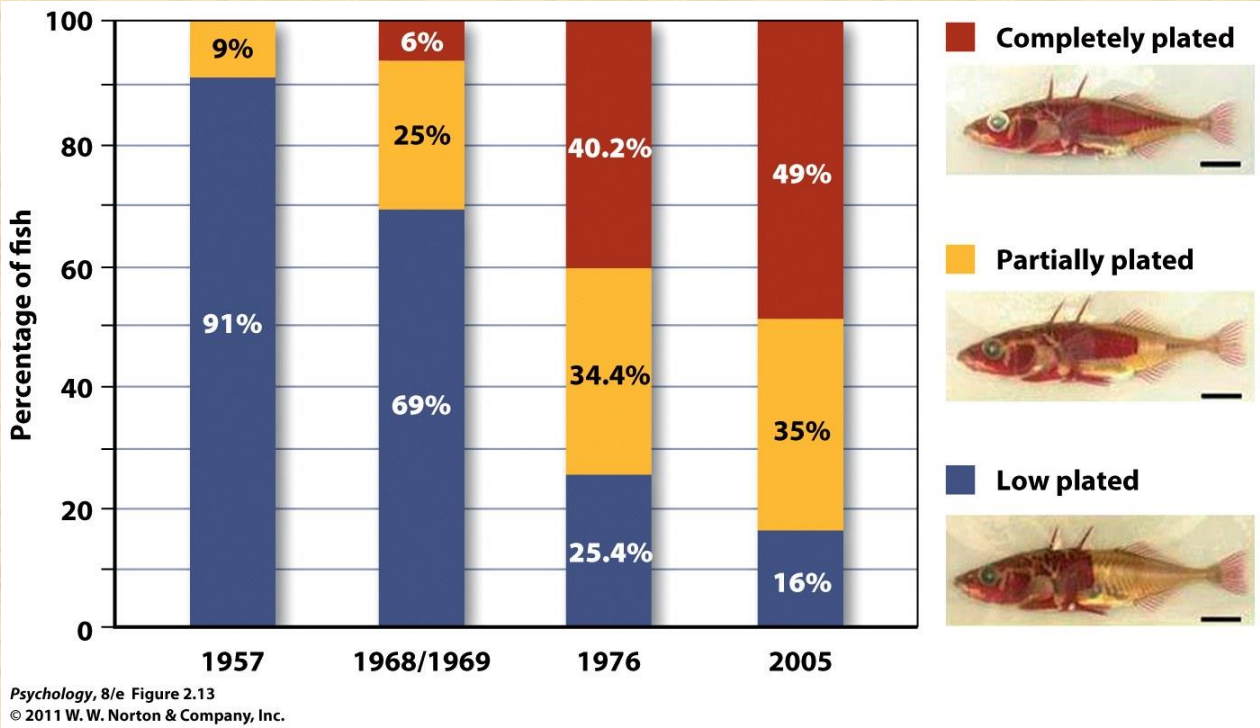
The four-winged dinosaur (*Microraptor gui*) has flight feathers on its arms and its legs. This suggests that this dinosaur is one of the ancient ancestors of modern birds.

Evidence for Evolution

- *One can document the unfolding of evolution in some modern organisms*.



Sticklebacks in Lake Washington developed bony plates as protection against trout; the lake cleared and they became more visible to the trout.

Evidence for Evolution

- *One can document the unfolding of evolution in some modern organisms.*
- The unity of life
  - Shared ancestry for many organisms is evident.
    - For example, approximately 60% of the genes found in fruit flies are also found in humans...
    - For example, the insertion of genes from jellyfish that cause them to make green fluorescent protein into monkeys causes them to glow green also. One infers that the biochemical machinery that allows this gene's expression is shared between jellyfish and monkeys.

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Genetics and *Behavior*

- Evolution by natural selection has shaped behaviors just as much as physical traits.
- Natural selection favors behavioral flexibility.
  - Organisms have evolved mechanisms so they can:
    - alter their responses.
    - learn new skills.

Example: Smiling

- The behavior of smiling seems to be *species general* for humans, but is not *species specific.* Many primates smile in certain social situations.
- Smiling is also evident in individuals blind since birth.
  - It does not depend on a history of learning.

What Kind of Smile Is That?

- There are at least two types of smiles.
  - One type is expressive of an individual's inner state.
    - produced even if no other people are around

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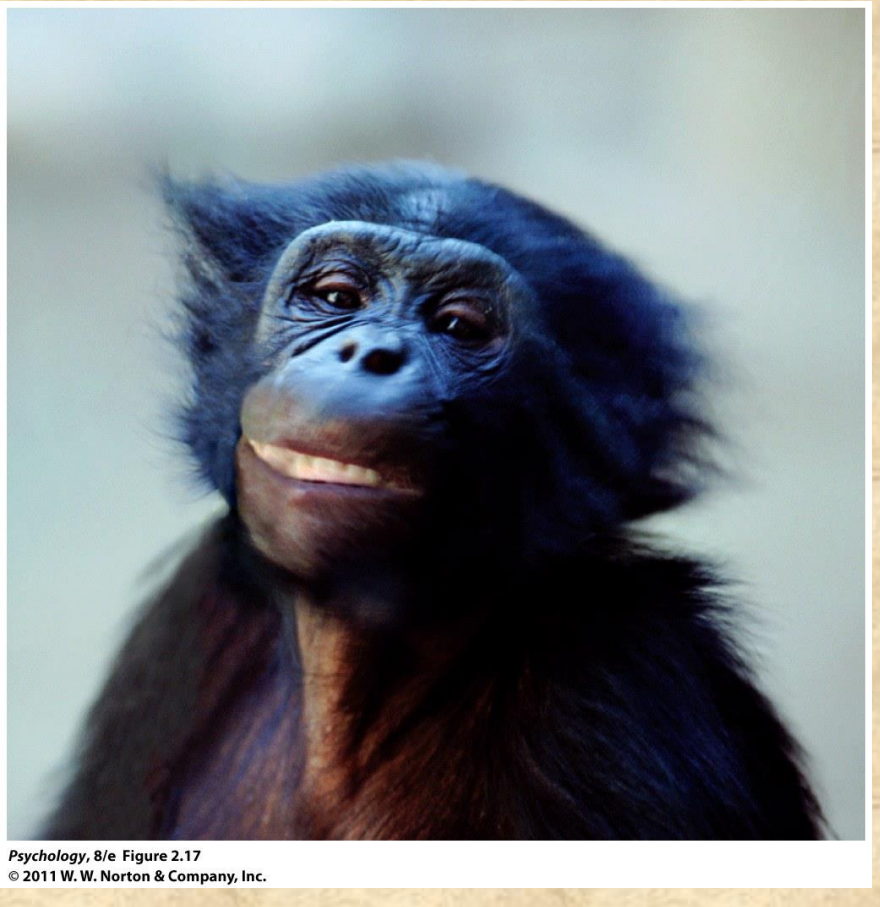
Response to a pleasant stimulus.
Look for crow's feet

What Kind of Smile Is That?

- There are at least two types of smiles.
  - One type is expressive of an individual's inner state.
    - produced even if no other people are around
  - The other type is more social.
    - functions as a greeting or a means of defusing tense situations



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Polite smile: lips drawn back revealing teeth with jaw closed

What Kind of Smile Is That?

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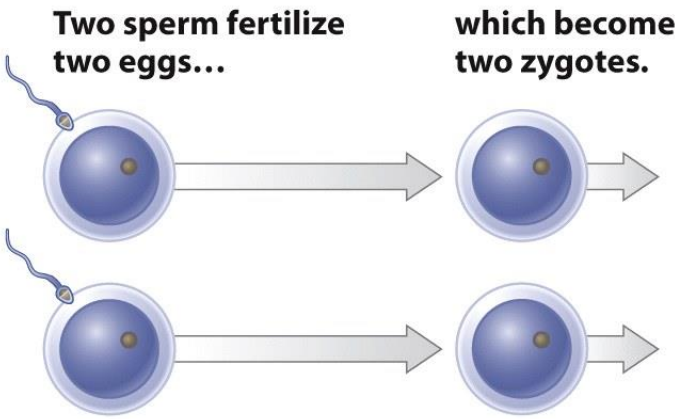
- The evidence suggests that smiles have ancient roots.
  - selected by evolution as a means of communication, allowing others to read our inner states and intentions

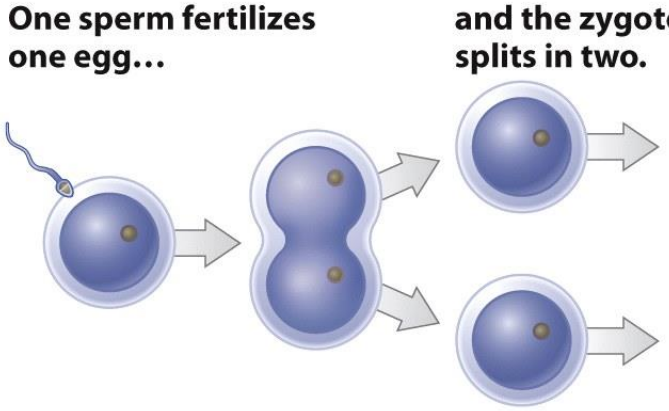
Genetics and Intelligence

- An individual's level of intelligence is influenced by genetic factors as well as by environmental ones.
  - People differ in their abilities to learn, solve problems, and adapt; what psychologists call intelligence is a generalization of this capacity.
  - Identical twins are a good example: their levels of intelligence are similar, even if they grew up separately.



(A) Dizygotic (fraternal) twins

50% overlap in genotype (just like siblings): fraternal twins



(B) Monozygotic (identical) twins

100% overlap in genotype: identical twins

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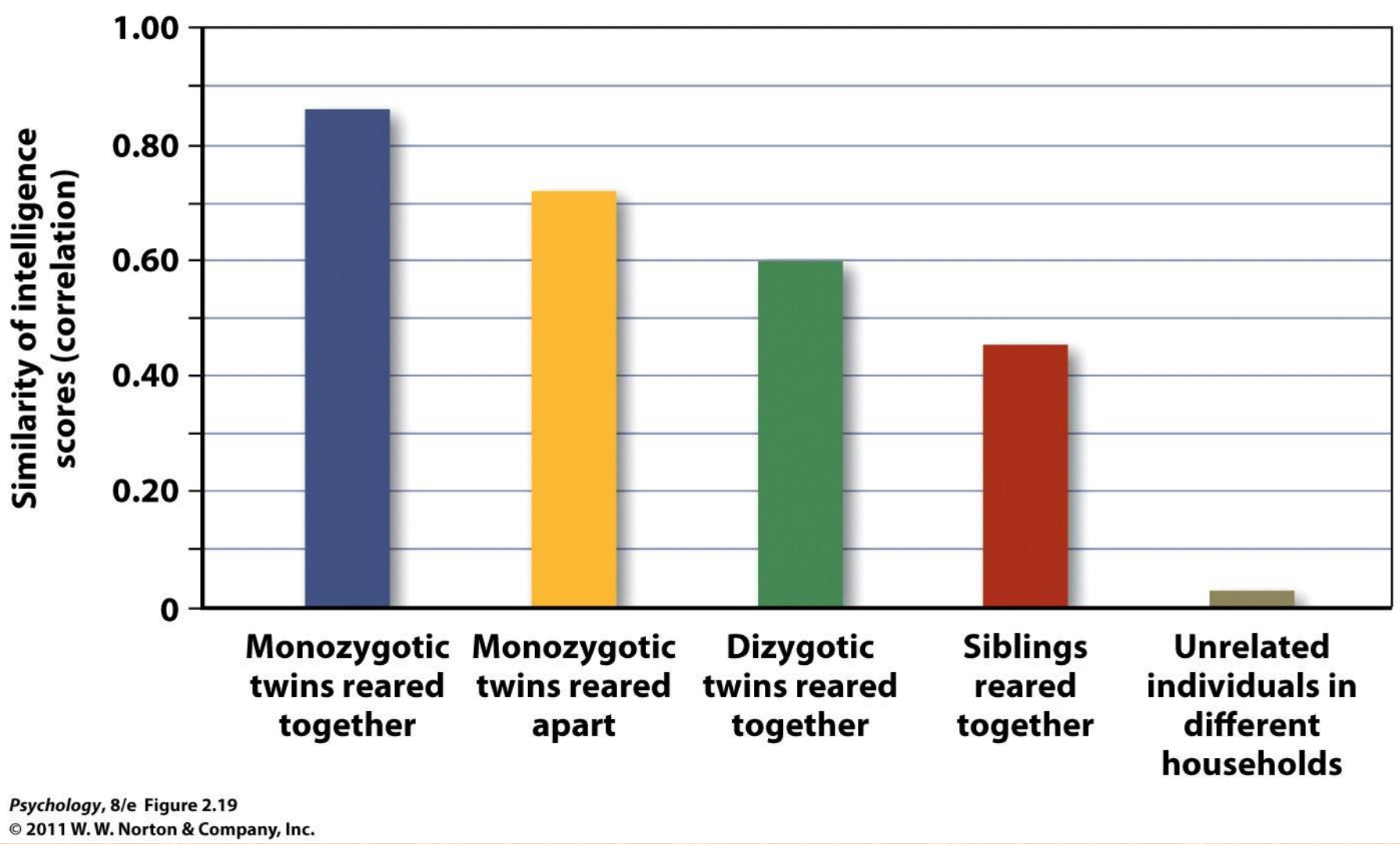

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Heritability Ratio

- Intelligence is also influenced by environmental factors.
- heritability = genetic variance ⁄ total phenotypic variance
  - The *heritability ratio* is a summary statistic that tells us what proportion of variation in a trait within a population is due to genetic differences.
  - How much do phenotypes for a trait vary in the group examined, in their current environment?
  - How much of this variability can be attributed to genetic factors?
  - Intelligence – heritability ratio of perhaps 60%, but this depends strongly on the environment of the group studied

Heritability Ratio

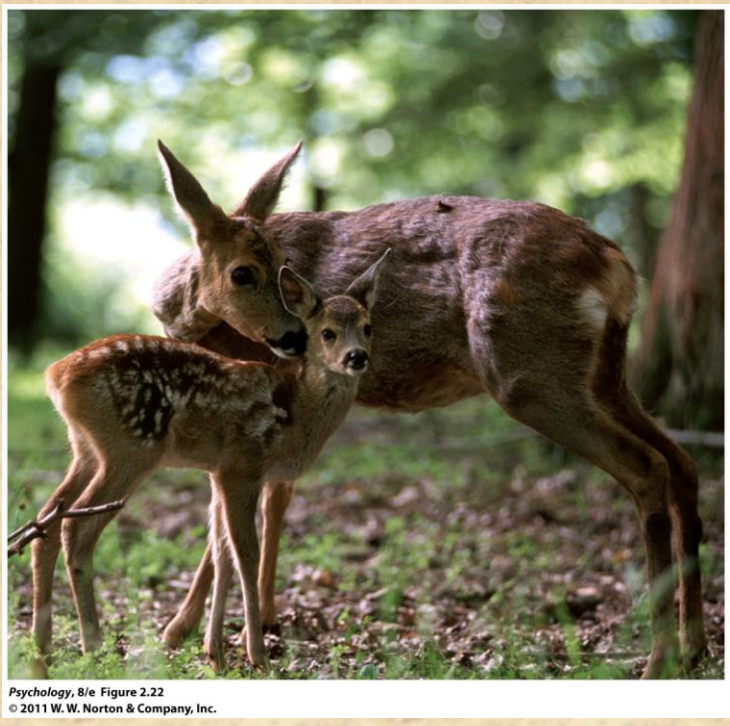
- The value of the heritability ratio depends on the group being examined.
  - In groups with lower socioeconomic status (SES), the heritability of traits like intelligence may be zero. The genetic potential is not reached because of environmental factors.
  - Heritability also increases with a person's age.
    - This may be because people choose environments that amplify their genetic potential.

IQ and Natural Selection

- Human intelligence was favored by natural selection.
  - Our ancestors had a reproductive advantage if they could communicate, solve problems, and draw conclusions
- Why do humans *vary* in their intelligence?
  - It's unclear—not all inherited characteristics are the direct result of natural selection.

Evolution of Mating

- Most mammals are *polygynous* (several females mating with a single male, as opposed to *polyandrous*); this can be understood in evolutionary terms.
- To maximize their reproductive success,
  - males should mate with as many females as possible.
  - females mate just a few times during their lives but try to ensure the well-being of each of their progeny.



Reproduction has high costs for mammalian females

Human Mating Habits

- This argument helps explain
  - why human males express a desire for multiple partners,
  - and why it is the female, in most species, who makes the choice about mating.
- By the same logic
  - Natural selection explains why males take the major role in courtship.

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Human Mating Habits

- Men seem to care more about female youth and health (indicators of fertility)
- Women seem to put greater weight on social status (more generally, the ability to commit resources to raising offspring)
- Natural selection likely favored these tendencies

Evolution and Infidelity

- An evolutionary perspective also leads to the expectation that men will be more distressed by sexual infidelity in their partners than by emotional infidelity, which indeed is reported.
- Women should show the reverse pattern, as is also reported.

Behavior is Complex

- Biology versus environment (nature *vs*. nurture)
  - Either-or arguments are increasingly viewed as irrelevant as the constant interaction between the two has become clearer.
- Does evolution produce "good" traits?
  - Natural selection can favor traits that used to be valuable but no longer are.
    - example: storing body fat or responding to threat