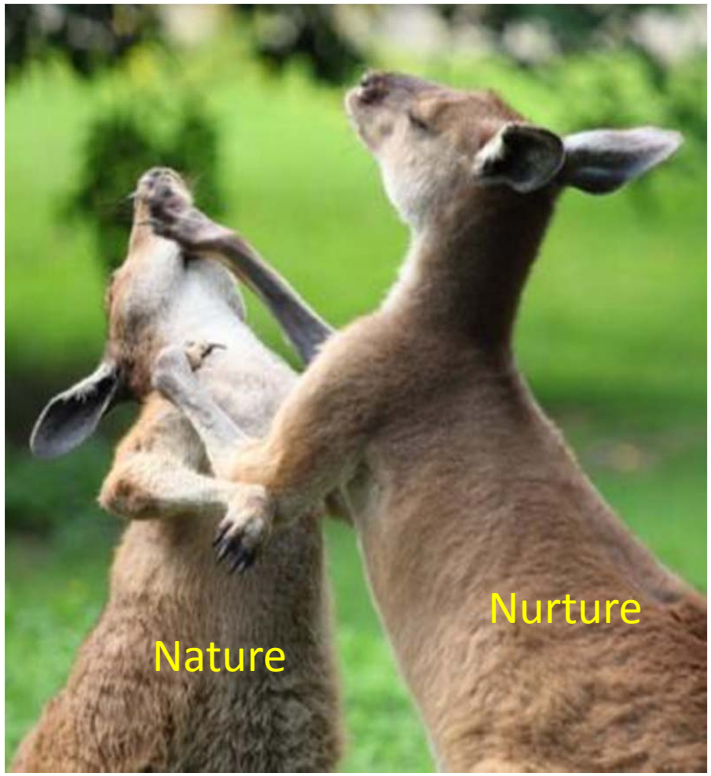
Genes vs. Environment:
How can we tell if each contributes?

Media portrays genetics vs. environment as a “debate”...

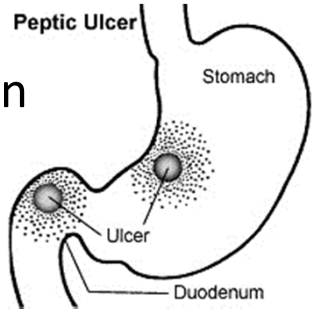


Corn plants from Noor garden...

June 2011

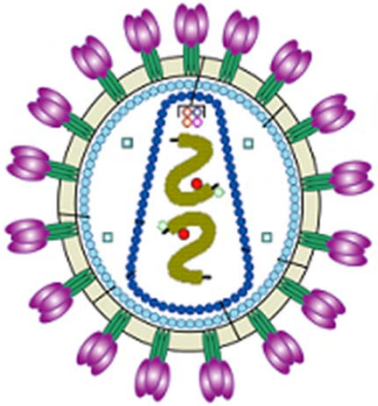
Why do people care?

- Want to **predict** evolutionary change
- Used in **animal and crop breeding**
  - We breed for sweet corn/ lean cows/ playful dogs
    - Does the environment matter?
    - Does it help to pick parents that have those traits?
- Important in **medicine**
  - Is there a genetic predisposition for peptic ulcers?
    - If my mom & dad had them, am I likely to get them?



Genes vs. Environment

- NOT a pure dichotomy
  - It's rarely "either/ or", but usually some of both
  - BUT, one may contribute way more than other
    - Eye color (excluding contacts)
    - HIV status



HIV

Do genetics contribute???

- Parent-offspring resemblance could indicate genetics are important (shared genes)

Do genetics contribute???

- Parent-offspring resemblance could indicate genetics are important (shared genes)
- ... but parents and offspring often share part of their environment, too.

Do genetics contribute???

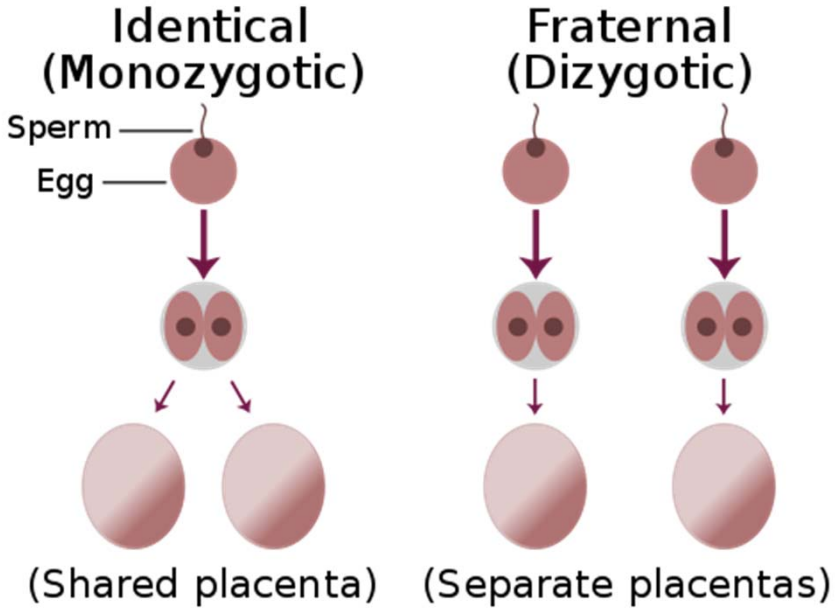
- Parent-offspring resemblance could indicate genetics are important (shared genes)
- ... but parents and offspring often share part of their environment, too.
- How to separate???

Do genetics or environment contribute?

- **Resemblance between relatives**
  - **Constant environment, varying genetic relations**
  - Constant genetic relations, varying environment
- “Common garden” experiments
- “Reciprocal transplant” experiments

Two types of twins

- Monozygotic (“identical”)- genetically exactly the same
- Dizygotic (“fraternal”)- genetically like any brother/ sister

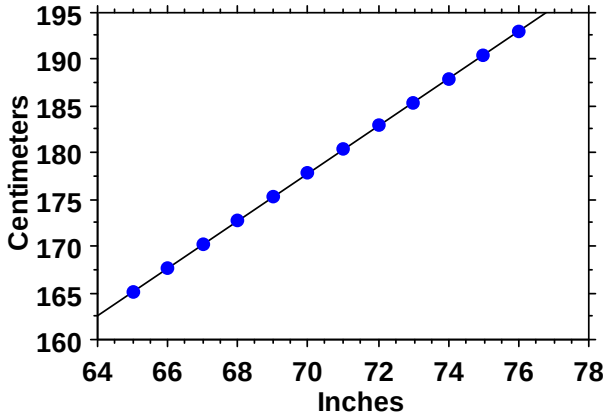


Two types of twins

- Predict that, if there's a genetic component, **monozygotic** twins should be more similar than **dizygotic** twins.
  - Monozygotic: same environment, exactly same genes
  - Dizygotic: same environment, some different genes

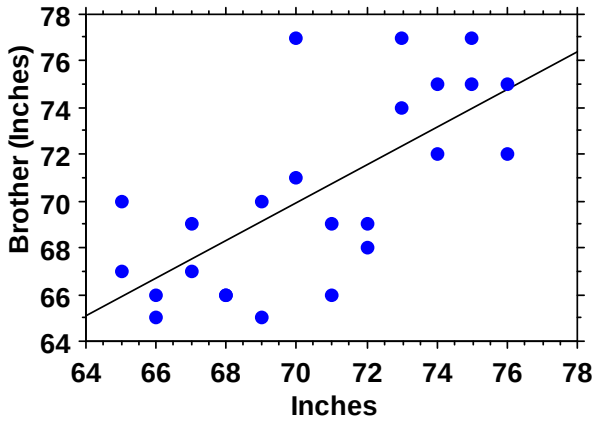
Use **correlations** in traits

- Correlation- how well traits match between groups
  - Given numeric score: r Ranges -1 -> 0 -> 1
- **Perfect positive** match (r=1)
  - Your height in inches to your height in centimeters



Use **correlations** in traits

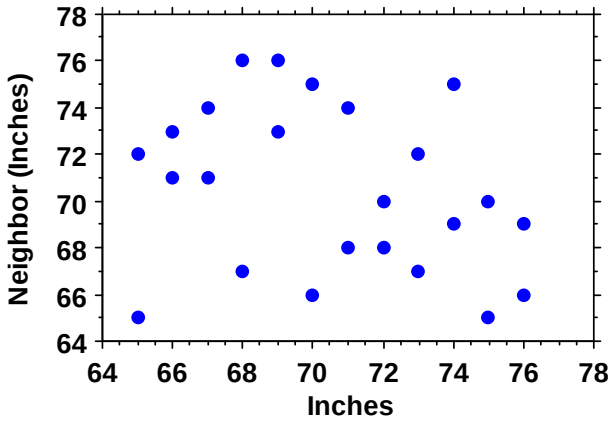
- Correlation- how well traits match between groups
  - Given numeric score: r Ranges -1 -> 0 -> 1
- **Some positive** match (r=0.7)
  - Your height to your brother's height



Remember:
May be from genetics or shared environment

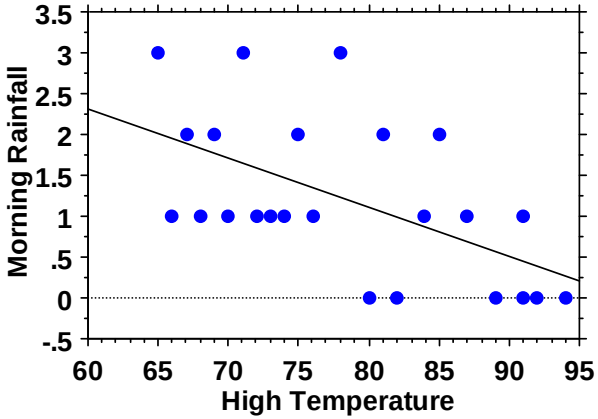
Use **correlations** in traits

- Correlation- how well traits match between groups
  - Given numeric score: r Ranges -1 -> 0 -> 1
- **No** match (r=0)
  - Your height to your neighbor's height



Use **correlations** in traits

- Correlation- how well traits match between groups
  - Given numeric score: r Ranges -1 -> 0 -> 1
- **Negative** match (r= -0.56)
  - Daily high temperature to morning rainfall in April



Prediction

- Predict that, if there's a genetic component to trait, **monozygotic** twins should have stronger correlation in trait than **dizygotic** twins.

  - Monozygotic: same environment, exactly same genes
  - Dizygotic: same environment, some different genes

Some Results!

- Examine "correlations" for twins
  - High correlation means high similarity
- For **IQ**
  - Monozygotic twins: 0.85
  - Dizygotic twins: 0.42
- For **Gastroesophageal reflux disease**
  - Monozygotic twins: 0.29
  - Dizygotic twins: 0.13

Do genetics or environment contribute?

- **Resemblance between relatives**
  - Constant environment, varying genetic relations
  - **Constant genetic relations, varying environment**
- “Common garden” experiments
- “Reciprocal transplant” experiments

Prediction

- Monozygotic twins reared *together* should have higher correlation in traits than monozygotic twins reared *apart* if there's an **environmental** component
  - Together: same environment, exactly same genes
  - Apart: different environment, exactly same genes

Some Results!

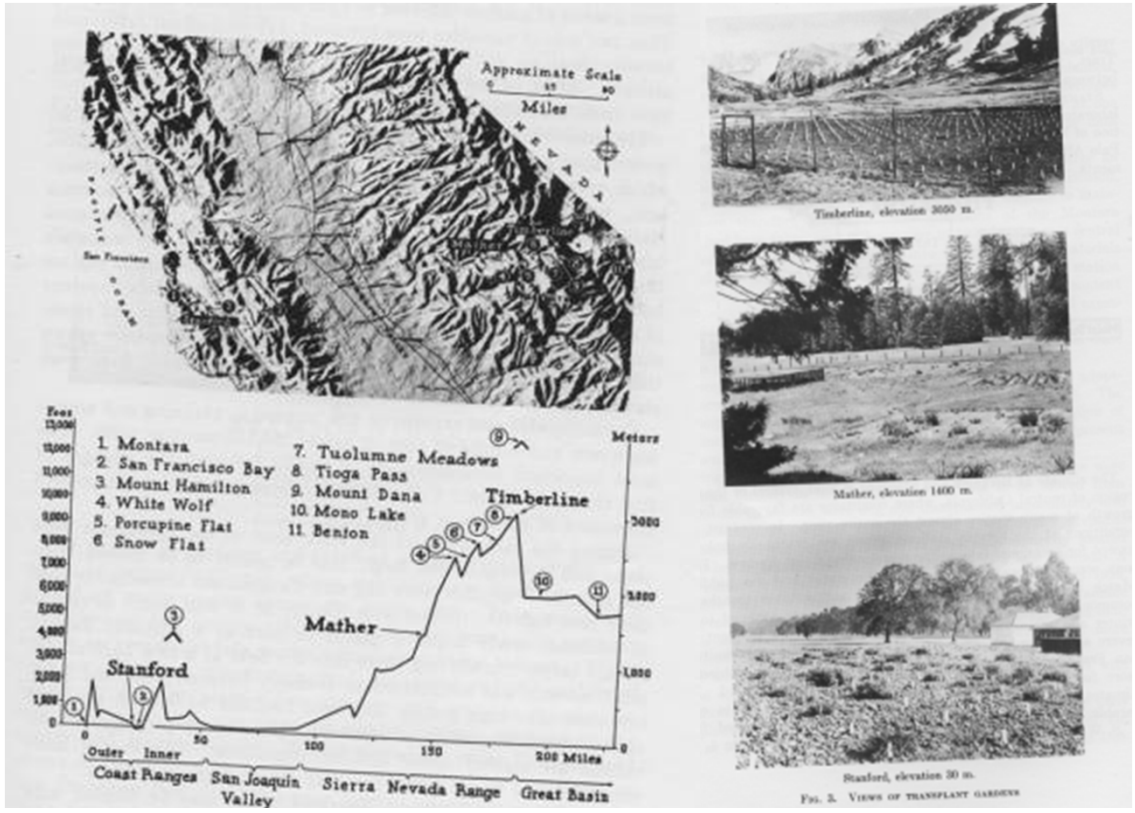
- For **Body Mass Index (BMI)**
  - Monozygotic together: 0.74
  - Monozygotic apart: 0.70

- For **Verbal ability**
  - Monozygotic together: 0.76
  - Monozygotic apart: 0.51
  - Dizygotic together: 0.43

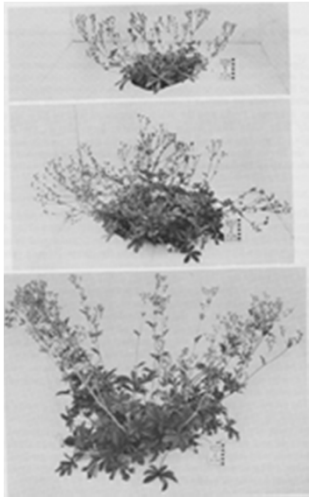
Do genetics or environment contribute?

- Resemblance between relatives
  - Constant environment, varying genetic relations
  - Constant genetic relations, varying environment
- **“Common garden” experiments**
- “Reciprocal transplant” experiments

Studies of *Potentilla* in 1930's by Clausen, Keck, & Hiesey



High elevation form



Common garden

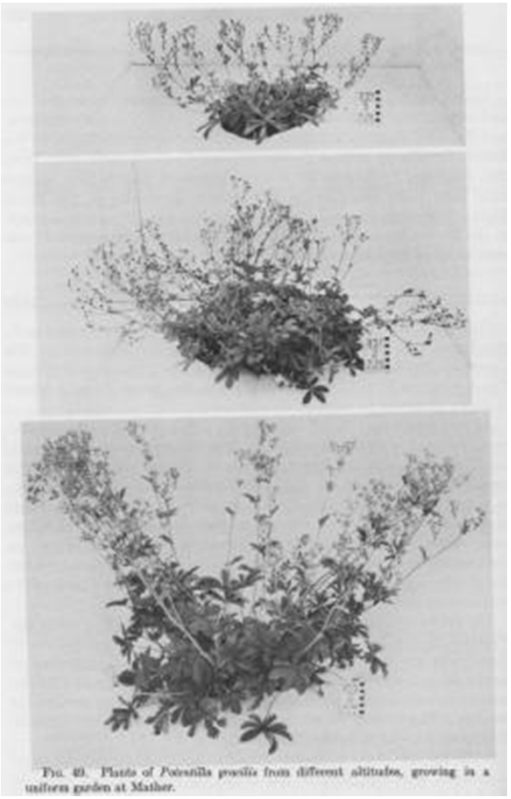
- Grow plant forms obtained *from* different places *in* a single environment

- **PREDICTION:**
  - If form difference is all **environmental**, plants would all look the same
  - If part of the form difference is **genetic**, plants would look different
  - Same concept as Mono- vs Dizygotic twin studies
    - Constant environment, unrelated plants

Some Results!

- Form difference apparent even when grown in the same environment

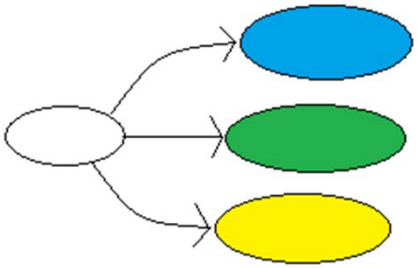
- **Form difference has a genetic component**



Do genetics or environment contribute?

- Resemblance between relatives
  - Constant environment, varying genetic relations
  - Constant genetic relations, varying environment
- “Common garden” experiments
- **“Reciprocal transplant” experiments**

Reciprocal transplant



- Grow plant form obtained *from* a single environment *in* several different environments
- **PREDICTION:**
  - If part of the form difference is **environmental**, plants would all look different
  - If form difference is all **genetic**, plants would still look the same
  - Same concept as twins reared together vs. apart
    - Same genetic makeup, varying environment

Some Results!

- Form difference for same type grown in different environments.

- **Form difference has an environmental component**

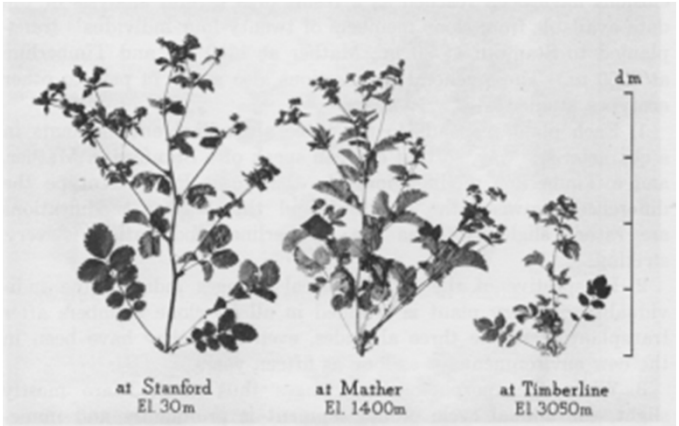


FIG. 18. Effect of transplanting a clone of *Potentilla glandulosa* ssp. *typica* to different altitudes.

Image Credits, Unit 8-1

- Fat hippo, © sarah5, all rights reserved, www.photoxpress.com
- Green DNA w/ red mutation, © appler, all rights reserved, www.photoxpress.com
- Blue iris, © 2010 Adam Cuerden, CC by 3.0, en.wikipedia.org.
- Green iris, © 2009 Pedramiri, CC by-SA 3.0, en.wikipedia.org.
- Hazel iris, © 2007 M. Bloch, CC by-SA 3.0, en.wikipedia.org.
- Brown iris, © 2009 Arctice, CC by-SA 3.0, en.wikipedia.org.
- Family resemblance, © 2006 slightlywinded, CC by 2.0, www.flickr.com
- Family resemblance, © 2009 K. Kendall, CC by 2.5, www.flickr.com
- Genes + environment, © National Institute of Environmental Health Studies, all rights reserved, www.niehs.nih.gov
- Olsen twins, © 2011 David Shankbone, CC by 3.0, en.wikipedia.org.
- Fraternal vs. Identical formation, © 2010 Trlkly, CC by 3.0, en.wikipedia.org

Image Credits, Unit 8-1 (cont.)

- Brain lasers, © ktsdesign, all rights reserved, www.photoxpress.com
- Digestive tract, © ag visuell, all rights reserved, www.photoxpress.com
- 3D white puppets communicating, © ioannis kounadeas, all rights reserved, www.photoxpress.com
- High elevation potentilla, © 2008 Walter Siegmund, CC by-SA 3.0, en.wikipedia.org
- Low elevation potentilla, © 2011 Sue Langley, all rights reserved, http://sierrafoothillgarden.wordpress.com/
- Garden, © 2008 Southern Foodways Alliance, CC by 2.0, www.flickr.com