7-minute science
Questions
Follow up on Mother: Caring for 7 Billion

• Empowering women means
  • Financial control.
  • Access to education.
  • Access to family planning services.
  • Jobs (outside agriculture), with equal pay.
  • Safety. Freedom from fear.

• Good news:
  • Near doubling of women in government in 20 years (to average 20% of legislative bodies)
### Women in power, 2015

<table>
<thead>
<tr>
<th>Country</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWANDA</td>
<td>58</td>
</tr>
<tr>
<td>BOLIVIA</td>
<td>52</td>
</tr>
<tr>
<td>CUBA</td>
<td>49</td>
</tr>
<tr>
<td>SEYCHELLES</td>
<td>44</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>44</td>
</tr>
<tr>
<td>SENEGAL</td>
<td>43</td>
</tr>
<tr>
<td>BELGIUM</td>
<td>42</td>
</tr>
<tr>
<td>ECUADOR</td>
<td>42</td>
</tr>
<tr>
<td>FINLAND</td>
<td>42</td>
</tr>
<tr>
<td>FEDERATED STATES OF MICRONESIA</td>
<td>0</td>
</tr>
<tr>
<td>QATAR</td>
<td>0</td>
</tr>
<tr>
<td>TONGA</td>
<td>0</td>
</tr>
<tr>
<td>VANUATU</td>
<td>0</td>
</tr>
<tr>
<td>YEMEN</td>
<td>0</td>
</tr>
<tr>
<td>KUWAIT</td>
<td>2</td>
</tr>
<tr>
<td>SOLOMON ISLANDS</td>
<td>2</td>
</tr>
</tbody>
</table>
One day, a mutation...

ACGTTGCATA
ACGTTACATA
...caused neoteny
...which was good news and bad news. We are smarter.
...but we are basically helpless for our first years of life.
Babies can't go on hunts

They scare the prey.
...and you can't leave them home alone

...so mom stays home.
Baby and mother need to eat, requiring a provider.
...requiring "rewards" to the provider.
...made more effective by mutual rewards
...leading to more sexual activity, thus more babies...
...leading to starvation
...or contraception!
Early methods

• Taboos, abstinence
• Herbs
• Infanticide
• Rituals
## Modern Methods: Barrier

<table>
<thead>
<tr>
<th>Method</th>
<th>What is it?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male Condom</strong></td>
<td>A thin covering that you unroll over the hard penis. Made of</td>
</tr>
<tr>
<td><strong>Female Condom</strong></td>
<td>A soft, loose pouch that you put inside your vagina. Flexible</td>
</tr>
<tr>
<td><strong>Spermicide</strong></td>
<td>Spermicidal chemical comes in several forms; you can choose</td>
</tr>
<tr>
<td><strong>Diaphragm</strong></td>
<td>A soft silicone dome with a flexible rim that holds spermicide.</td>
</tr>
<tr>
<td><strong>Cervical Cap</strong></td>
<td>A small, soft silicone cup holding spermicide. Designed to fit</td>
</tr>
</tbody>
</table>
Knowledge-based


Knowledge Based Methods

**Withdrawal (Pulling Out)**

*What is it?* The man takes his penis out of his partner’s vagina before

**Fertility Awareness**

*What is it?* When you understand your fertile time (days you can get

**Breastfeeding (Lactation Amenorrhea)**

*What is it?* Breastfeeding stops egg development if the following three

**Sex Without Intercourse**

*What is it?* You can experience intimacy, closeness, pleasure and orgasms
Long-term

Not free.
Fool-proof.
No actions needed.
Hormonal Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>What is it?</th>
<th>read more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Contraception</td>
<td>A pill or combination of pills you take after sex to prevent</td>
<td></td>
</tr>
<tr>
<td>The Pill</td>
<td>A pill containing synthetic hormones you take orally every day</td>
<td></td>
</tr>
<tr>
<td>The Patch</td>
<td>A bandage-like patch that sticks to your skin. Hormones are</td>
<td></td>
</tr>
<tr>
<td>Vaginal Ring</td>
<td>A clear, soft, flexible 2-inch circle worn in vagina. Your</td>
<td></td>
</tr>
<tr>
<td>The Shot</td>
<td>A long-acting injection of synthetic progestin hormone.</td>
<td></td>
</tr>
</tbody>
</table>

Family Planning Needs Increasingly Met by Modern Methods, but More Progress Needed

Percent of Demand for Family Planning Satisfied by Modern Contraceptive Methods

EGYPT 64 71
JORDAN 41 47
KENYA 40 52
PHILIPPINES 36 58
PAKISTAN 21 31
NIGERIA 13 43
SEXEGAL 13

NOTE: Data points are for each corresponding survey year.

SOURCE: ICF International, Demographic and Health Surveys.

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Steady Drop

The U.S. abortion rate has declined significantly in recent years.

Abortions per 1,000 women aged 15–44

<table>
<thead>
<tr>
<th>Year</th>
<th>Rate per 1,000</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>19.4</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>16.9</td>
<td>13% DECLINE</td>
</tr>
<tr>
<td>2014</td>
<td>14.6</td>
<td>14% DECLINE</td>
</tr>
</tbody>
</table>

Source: Guttmacher Institute.

www.guttmacher.org
Pregnancies by Intention Status

Nearly half of U.S. pregnancies are unintended.
"We found no evidence to indicate that existing interventions to reduce repeat teenage pregnancy were effective"

~40 million/year = Estimated number of unintended (unwanted) children.

~80 million/year = Total global population growth.

Eliminating unwanted births would cut population growth in half!
How is having a child like buying a refrigerator?
Some economists write about childbearing as though couples sat at the dining room table and worked out their mutual interest in having babies the way they might plan their investments or select a new refrigerator. Baby making is nothing like buying a refrigerator, however; it’s more like the appliance retailer bringing you a new refrigerator every year or two unless you’ve taken effective and consistent steps on a nearly daily basis to make sure none is delivered. Sexual intercourse is an act of intimate shared pleasure that occurs “many hundreds or even thousands of times more frequently than is needed to achieve the desired number of pregnancies,” as University of California population and health specialist Martha Campbell and colleagues have written. Rather than akin to ordering a refrigerator, more often the act includes steps—if nothing more than a prayer—to keep the delivery truck away from the door.
Can we make family planning more like "buying a refrigerator"?

Eric Pianka, Denton A. Cooley Centennial Professor of Zoology, UT Austin.

The "Johnny Anti-Appleseed Solution" for Overpopulation

"First...bless everyone with infertility.
1. Design a molecule that could bind DNA and make people sterile.
2. Design another molecule that would unmask the first and make the person fertile, just for a short time.
3. Make people work for the second pill*. You'd get responsible parenthood. No more unwanted children, no juvenile delinquents..."

*Married couples only?

Author of The Vanishing Book of Life on Earth
Informed and consentual

<table>
<thead>
<tr>
<th>consentual</th>
<th>informed</th>
<th>not informed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ok</td>
<td>coerced</td>
</tr>
<tr>
<td>not consentual</td>
<td>forced</td>
<td>covert</td>
</tr>
</tbody>
</table>

- What would happen if contraception/sterilization was administered without informed consent?
- Examples:
  - Birth control in the drinking water.
  - Live, engineered, contagious, contraceptive virus.
Imperfect adherence

Annual medical costs of UP in the United States were estimated to be $4.6 billion, and 53% of these were attributed to imperfect contraceptive adherence. If 10% of women aged 20–29 years switched from oral contraception to LARC, total costs would be reduced by $288 million per year.

Imperfect contraceptive adherence leads to substantial UP and high, avoidable costs. Improved uptake of LARC may generate health care cost savings by reducing contraceptive non-adherence.

Can replacement value could be attained by informed consent + perfect adherence?

• 213 million pregnancies occurred in 2012
  • 85 million pregnancies, representing 40 percent of all pregnancies, were unintended (mistimed or unwanted).
    • Of these, 50% ended in abortion,
    • 13% ended in miscarriage, and
    • 38% resulted in an unplanned birth. (=32.3M)
  • 128 million pregnancies were intended.
    • Of these, 84% resulted in planned birth (=108M)
• Total births in 2012 was 140 million.
• Total deaths in 2012 was 56 million.
• Natural Increase = 84 million (= 1.2% growth rate)
• Hypothetical natural increase without unplanned births = 52 million.

Informed consent + perfect adherence could decrease growth rate from 1.2% to 0.7%


Immune-based contraception?

Vaccination Targets

• **Gametogenesis** - testes or ovary proteins. Immune castration/spaying.

• **Fertilization** - Sperm proteins, egg proteins, signaling proteins

• **Implantation** - immuno-abortifactants

How to use the vertebrate immune system

Vaccination

formulation
• B-cell antigens
• T-cell antigens
• Immune stimulants (adjuvants)

identifies the enemy
self? not-self?

administration
• intramuscular
• intranasal

innate immune response

systemic immune system
mucosal immune system
How to use the vertebrate immune system

- **Innoculation, infection**
- **Innate immune response**
  - "call-to-arms"
- **Dendritic cells (DC)**
  - self? not-self?
  - **Treg cells**
    - calm down
- **T cells**
  - remember the enemy
- **B cells**
  - identify the enemy
  - **B memory cells**
  - **B plasma cells**
  - attack
Research opportunities in overpopulation? Not much,...

Total number of grant opportunities listed on Grants.gov which include the word X anywhere in the full announcement.

<table>
<thead>
<tr>
<th>X</th>
<th>116</th>
<th>cancer</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>18</td>
<td>alzheimer</td>
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<tr>
<td></td>
<td>48</td>
<td>poverty</td>
</tr>
<tr>
<td></td>
<td>431</td>
<td>population</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>contraception</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>overpopulation</td>
</tr>
</tbody>
</table>
sperm

CatSper

small piece of CatSper

immunity

vaccine
1. The sperm tail is required for fertility.
2. A calcium channel called CatSper is required for tail motility.
3. To make a vaccine against CatSper, we take a loop from its surface.
4. We attach the loop to the surface of a virus-like particle (VLP).
5. Women are injected and generate antibodies in the vaginal mucosa.
6. Antibodies attack sperm.
7. Sperm can't swim.

*But if an excess of loop is added first, then the antibodies are blocked and fertility returns.*
fixed mouse sperm + anti-CatSper 4 (green), DAPI nuclear stain (blue)
CatSper Project

CatSper Project Team Members

Christopher Bystroff, Ph.D. Rensselaer Polytechnic Institute
Jean-Ju Chung, Ph.D. Yale University School of Medicine
Robert Wyman, Ph.D. Yale University
Chunyu Wang, M.D. Rensselaer Polytechnic Institute
Scott Forth, Ph.D., Rensselaer Polytechnic Institute
Aileen Gariepy, M.D., M.Ph., FACOG. Yale University School of Medicine
Fred Sigworth, Ph.D. Yale University School of Medicine
Scott Michael, Ph.D. Florida Gulf Coast University
Sharon Isern, Ph.D. Florida Gulf Coast University
Rajesh Naz, Ph.D. West Virginia University School of Medicine
Jon Hennebold, Ph.D., Oregon Health and Sciences University
Clair Kaplan, M.S.N., APRN, Planned Parenthood of Southern New England
William Ryerson, Population Media Center
Other contraceptive vaccines that block fertilization

- Whole sperm
- Zona pellucida (ZP3) -- blocks egg/sperm reaction, causes degradation!
- Eppin -- blocks late sperm maturation step.
- YLP12 -- ZP mimic peptide
India's state of emergency between 1975 and 1977 included a family planning initiative that began in April 1976 through which the government hoped to lower India's ever increasing population. This program used propaganda and monetary incentives to, some may construe, inveigle citizens to get sterilized. People who agreed to get sterilized would receive land, housing, and money or loans.

A strong backlash against any initiative associated with family planning followed the highly controversial program, which continues into the 21st century.[27]

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Census Year</th>
<th>Population [23]</th>
<th>% Change [23]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1951</td>
<td>361,088,000</td>
<td>-----</td>
</tr>
<tr>
<td>2</td>
<td>1961</td>
<td>439,235,000</td>
<td>21.6</td>
</tr>
<tr>
<td>3</td>
<td>1971</td>
<td>548,160,000</td>
<td>24.8</td>
</tr>
<tr>
<td>4</td>
<td>1981</td>
<td>683,329,000</td>
<td>24.7</td>
</tr>
<tr>
<td>5</td>
<td>1991</td>
<td>846,387,888</td>
<td>23.9</td>
</tr>
<tr>
<td>6</td>
<td>2001</td>
<td>1,028,737,436</td>
<td>21.5</td>
</tr>
<tr>
<td>7</td>
<td>2011</td>
<td>1,210,726,932</td>
<td>17.7</td>
</tr>
</tbody>
</table>

https://en.wikipedia.org/wiki/Compulsory_sterilization#India
Does increased sex taboo lead to higher or lower population?

Pakistan TFR high compared to Iran, but dropping
Assignment for Tuesday Apr 18

• Read "Coole"

• Listen to the radio news, watch TV news, read newspaper, news blogs.

• Make notes of any mention of population.

• Make notes of failure to mention population when it is clearly relevant to the news story.

• Enter your result in the Ask window (select lecture 24)
Work on projects