

Chapter 8: The Human Population



World Population, Don't Panic Video

World Dot Clip

Hans Rosling

Case study: China's one-child policy

In 1970, China's 790 million people faced starvation

The government instituted a one-child policy

Unintended consequences: killing female infants and a black-market trade in teenage girls



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[Video](#)

Two General Categories of Countries:

Developed Countries:

1. Higher average incomes
2. Industrial economies
3. Slower population growth

Examples:

USA, France, Japan

Developing Countries:

1. Lower average incomes
2. Agriculture-based economies
3. Rapid population growth

Examples:

India & Ethiopia

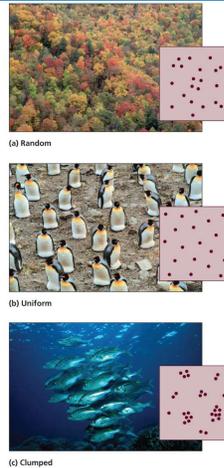
Population characteristics

- **Population size** = the number of individual organisms present at a given time
 - Numbers can increase, decrease, cycle or remain the same
- **Population density** = the number of individuals within a population per unit area
 - High densities make it easier to find mates, but increase competition, and vulnerability to predation
 - Low densities make it harder to find mates, but individuals enjoy plentiful resources and space



Population characteristics

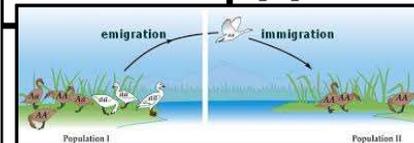
- Population distribution (dispersion) = spatial arrangement of organisms within an area
 - *Random* – haphazardly located individuals, with no pattern
 - *Uniform* – individuals are evenly spaced due to territoriality
 - *Clumped* – arranged according to availability of resources
 - Most common in nature



Population Change

4 Factors determine the size of a population

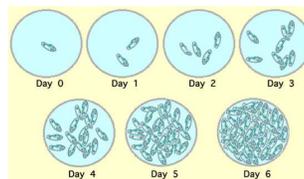
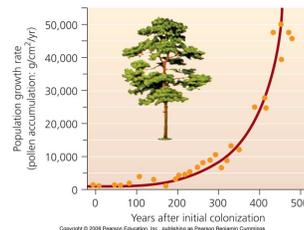
- Immigration:** movement of individuals **into** a population
- Emigration:** leaving (exciting) of individuals of a population
- Natality:** birth in a population (increase)
- Deaths:** deaths within a population (Decrease)



- Growth rate formula =
 $(\text{Crude birth rate} + \text{immigration rate}) - (\text{Crude death rate} + \text{emigration rate}) = \text{Growth rate}$

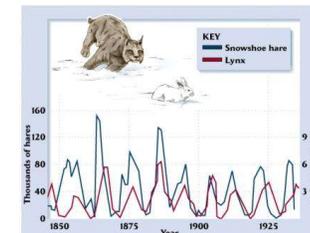
Exponential Population Growth

- Exponential population growth caused by steady rates
 - J-shaped curve graph
- Exponential growth cannot be sustained indefinitely
 - It occurs in nature with a small population and ideal conditions
 - Resources are limited



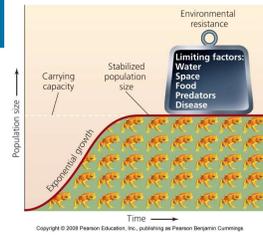
Limiting Factors

- Limiting factors = physical, chemical and biological characteristics that restrain population growth
 - Water, space, food, predators, and disease
- Environmental resistance = All limiting factors taken together



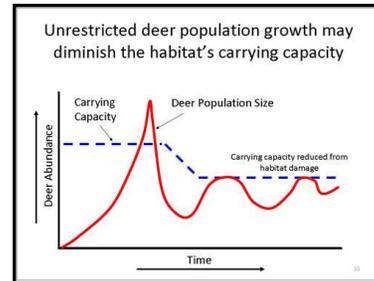
Carrying capacity

- **Carrying capacity** = the maximum population size of a species that its environment can sustain
 - Carrying capacity change



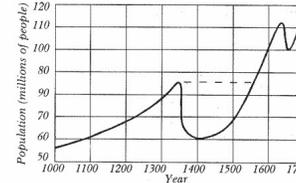
Logistic Population Growth

- An S-shaped curve
- Limiting factors slow and stop exponential growth



Population density affects limiting factors

- **Density-dependent factors** = limiting factors whose influence is affected by population density
 - Predation
 - Competition
 - Diseases
- **Density-independent factors** = limiting factors whose influence is not affected by population density
 - Natural Disasters
 - Unusual weather
 - Human Impact



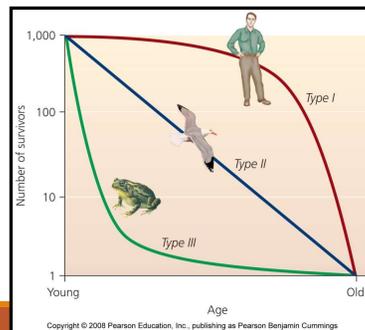
Recovery of European population following the plagues of 1347 was only two hundred years—an insignificant moment in the evolutionary time scale. (After Langer 1965; author)



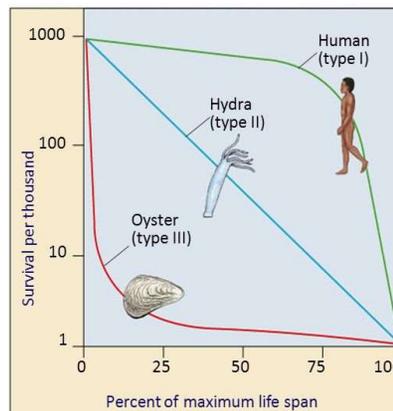
Survivorship Curves

Survivorship curves = the likelihood of death varies with age

- Type I: More deaths at older ages (**Humans**)
- Type II: Equal number of deaths at all ages (**Birds, Reptiles**)
- Type III: More deaths at young ages (**Amphibians, fish**)



Survivorship curves



What do these graphs indicate regarding species survival rate & strategy?

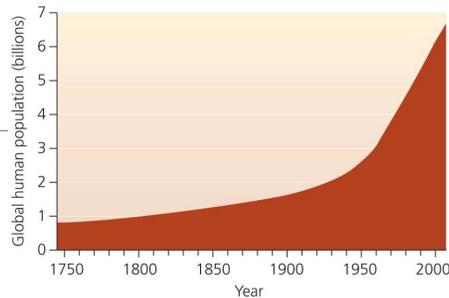
I. High death rate in post-reproductive years

II. Constant mortality rate throughout life span

III. Very high early mortality but the few survivors then live long (stay reproductive)

Population Growth Rate

1800 = 1 billion
 1930 = 2 billion
 1960 = 3 billion
 1975 = 4 billion
 1987 = 5 billion
 1999 = 6 billion
 2013 = 7 billion



Populations continue to rise in most countries, particularly in poverty-stricken developing nations

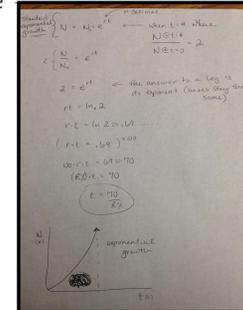
Although the rate of growth is slowing, we are still increasing in absolute numbers due to **exponential growth**

Where you Stand?

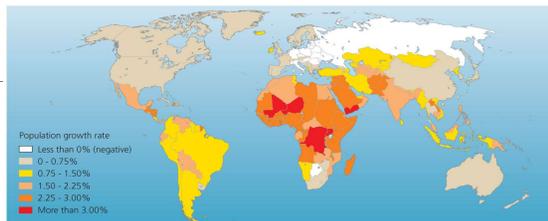
Rule of 70

Doubling Time

- When a population grows exponentially, the time it takes for the population to double.
- symbol "dt", can be approximately calculated using the "Rule of 70,"
- Formula for Rule of 70
 - $dt = 70/r$
 - "r" is sometimes written as "k"
- Doubling time (usually in years)
- r (or "k") = the growth rate expressed as a percentage.
 - NOTE: 5% must be entered as 5 instead of 0.05.
 - Drop the percent symbol



Rates of growth vary from region to region



Rule of 70

About 10 years ago the global growth rate was 1.2%, the population would double in 58 years ($58 \times 1.2 = 70$) $70/1.2 = 58$

If China's rate continued at 2.8%, it would have had 2 billion people in 2004.

2017 Population Growth rate: **1.2% per year**

What is the doubling time? $Dt=70/1.2$ $Dt= 58.3$ years

Rule of 70 Problems

- If the population of rabbits in an ecosystem grows at a rate of approximately 4 percent per year, the number of years required for the rabbits' population to double is

- A. 4 years
- B. 8 years
- C. 12 years
- D. 17 years**
- E. 25 years

First, identify variables.

$Dt = ?$
Rate = 4%
70

What's the formula?

$Dt = 70/r$

Plug values into formula.

$Dt = 70/4$ Drop the percent symbol

Answer

17.5 years

Rule of 70

In how many years would you expect a population to double if the population is growing at a constant rate of 2% per year?

$$Dt = 70/\text{rate} \quad Dt = 70/2 \quad Dt = 35 \text{ years}$$

Suppose it took 5 years for a population to double. Determine the constant rate of growth (i.e. annual percent).

$$Dt = 70/\text{rate} \quad 5 \text{ years} = 70/\text{rate}$$

$$5 = \frac{70}{\text{rate}} \quad \frac{5}{1} = \frac{70}{\text{rate}} \quad \frac{5 \text{rate} = 70(1)}{\text{Divide by 5 on both sides}} \quad \text{Rate} = 70/5$$

Cross multiply

$$\text{Rate} = 14 \%$$

Rule of 70 Practice Problems

1. If country X has a rate of 3%, how many years will this country take to double in size?

$$Dt = 70/3 \quad Dt = 23 \text{ years}$$

2. If country Y has a rate of 6%, how many years will this country take to double in size?

$$Dt = 70/6 \quad Dt = 12 \text{ years}$$

3. If country Y has a rate growth of 1.28%, how many years will this country take to double in size?

$$Dt = 70/1.28 \quad Dt = 54.7 \text{ years}$$

4. If country X's population doubles in 7 years, what is its constant rate of growth?

$$7 \text{ years} = 70/\text{rate} \quad \text{rate} = 70/7 \quad \text{rate} = 10\%$$

Population Growth Rate Formulas

- 3 Formulas used to figure out population growth rate
 - Depends on the information given, which formula to use.

$$\text{Growth Rate} = \frac{(\text{Births} - \text{Deaths})}{\text{Total Population}} \times 100\%$$

$$\text{Growth Rate} = \frac{\text{Crude Births} - \text{Crude Deaths}}{10}$$

$$\text{Growth Rate} = \frac{(\text{Crude Births} + \text{Immigration}) - (\text{Crude Deaths} + \text{Emigration})}{10}$$

Crude birth/death rates = rates per 1000 individuals

Population growth affects the environment

The IPAT model:

$$I = P \times A \times T \times S$$

- I = environmental impact
- Population = individuals need space and resources
- Affluence = greater per capita resource use
- Technology = increased exploitation of resources
- Sensitivity = how sensitive an area is to human pressure
- *Education, laws, ethics are also taken into consideration

Humanity uses 1/3 of all the Earth's net primary production

Population growth affects the environment

$$I = P \times A \times T \times S$$

Impact	Population	Affluence	Technology
I	= P	x A	x T
(Impact)	(Population)	(Consumption / Person)	(Impact / Consumption)

Video

Population Density

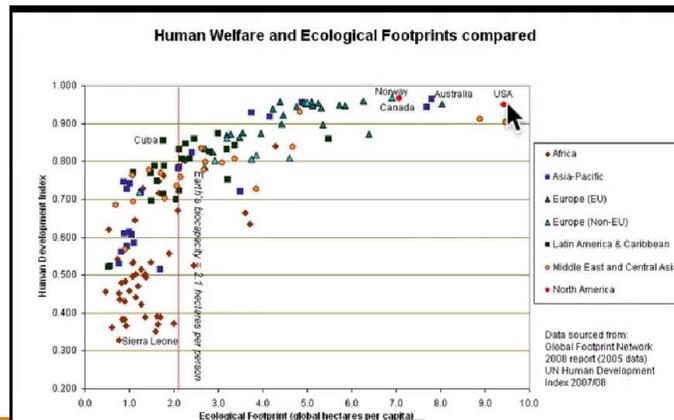
$$\text{Population Density} = \text{Population} / \text{Area}$$

Density is just as important as numbers:

- tends to be higher in temperate, tropical, and subtropical regions and along rivers coastlines

- Certain areas bear far more environmental impact than others and denser areas may experience more issues due to urbanization (ch. 13), pollution, and resource extraction

Population growth affects the environment

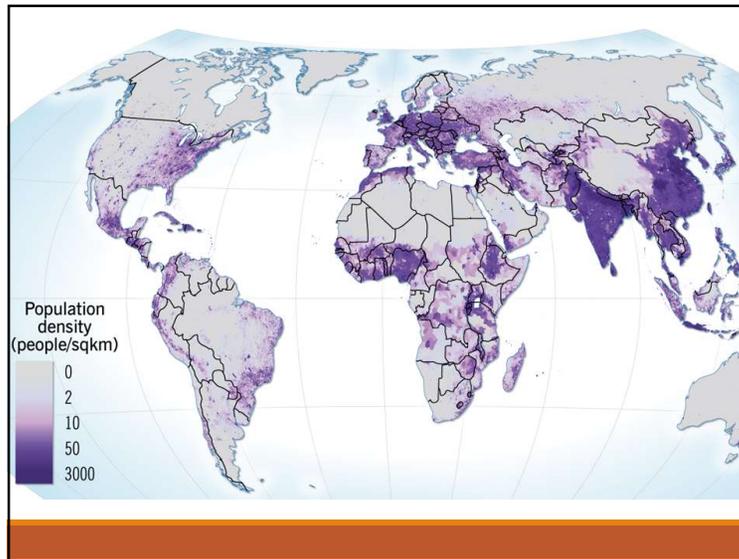


Demography: study of populations, especially human populations.

Demographers study

- historical size and makeup of the populations
- density & distribution
- age structure
- sex ratios
- fertility rates
- migration patterns

*Prediction may be inaccurate, because human behavior changes suddenly and is hard to predict.



Sex ratios



*Greatly distorted ratios can lead to problems

In China, 120 boys were reported for 100 girls

- Cultural gender preferences, combined with the government's one-child policy, led to selective abortion of female fetuses
- Had undesirable social consequences of many single Chinese men
- Teenage girls were kidnapped and sold as brides

Immigration and emigration play large roles

- Refugees flee their home country as a result of
 - war, civil strife, and poor environmental conditions
- U.S. has a TFR of 2.1 and an age structure diagram approaching a column shape but it has a high rate of immigration (may increase by 44% by 2050)
- When people move into developed countries their ecological footprints tend to increase

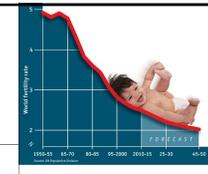
Currently the issue with ISIS and Syrians fleeing to Europe.

[Syrian Crisis Video](#)



Fertility Rate

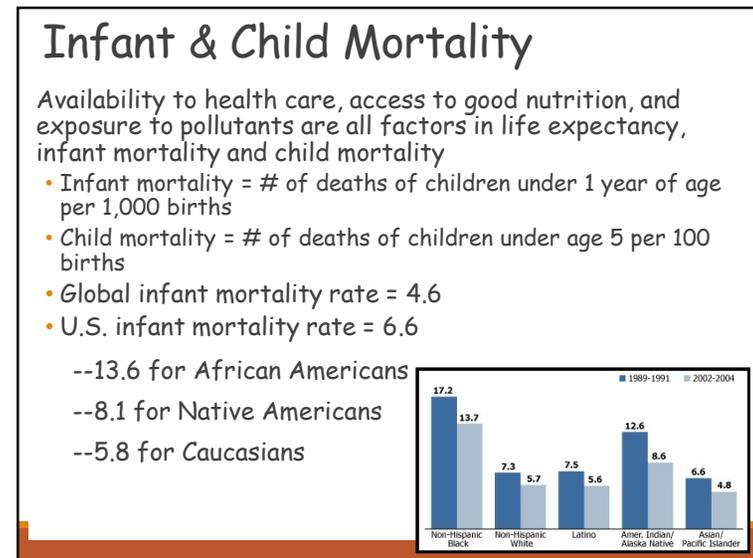
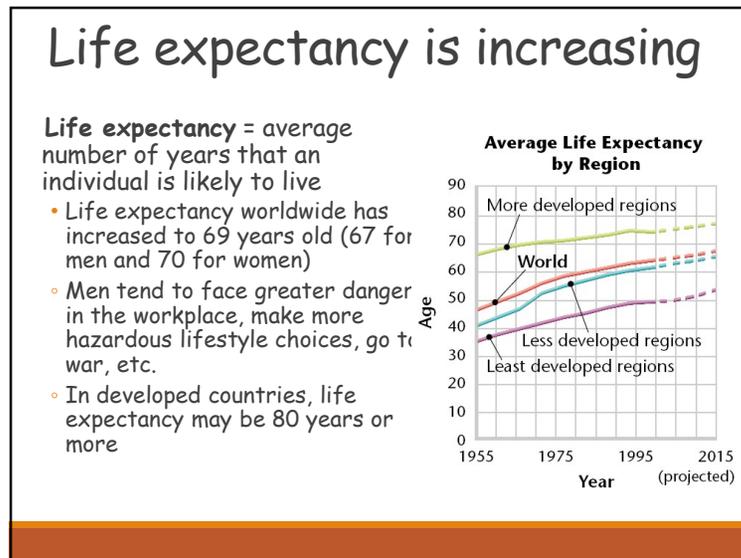
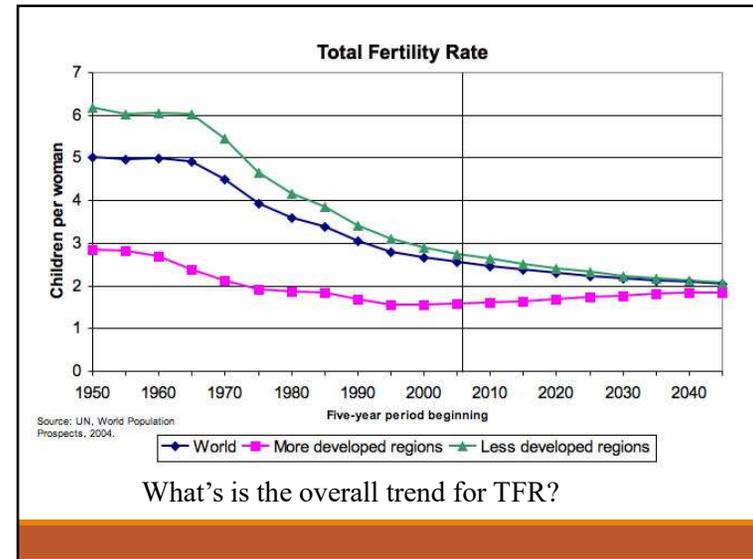
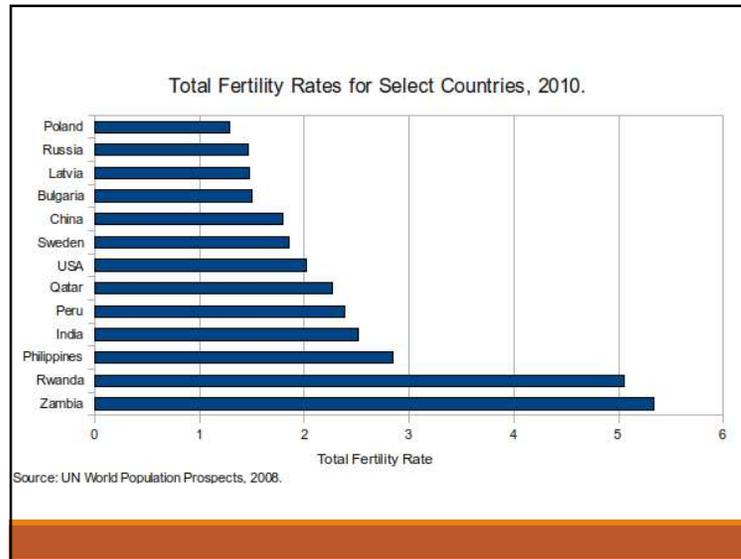
Total fertility rate (TFR) = the average number of children born per female



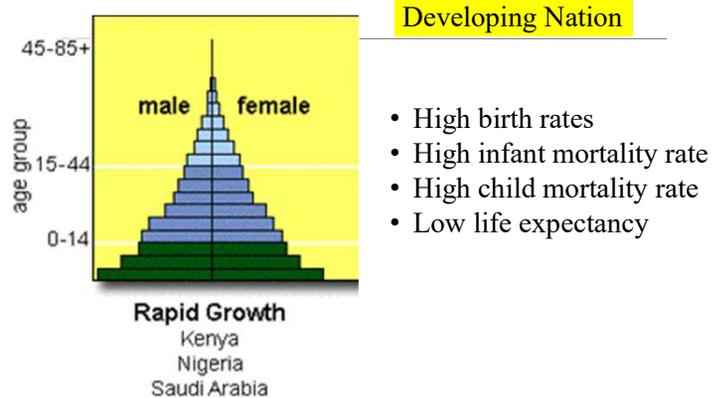
Replacement level fertility = TFR that keeps the size of a population stable (2.0 per women) depends on rates of *prereproductive mortality*, which depends on a economic status

- developed countries = 2.1 or lower
- developing = 2.5 to 3.3
- World TFR = 2.4 children per women
- USA = 1.8

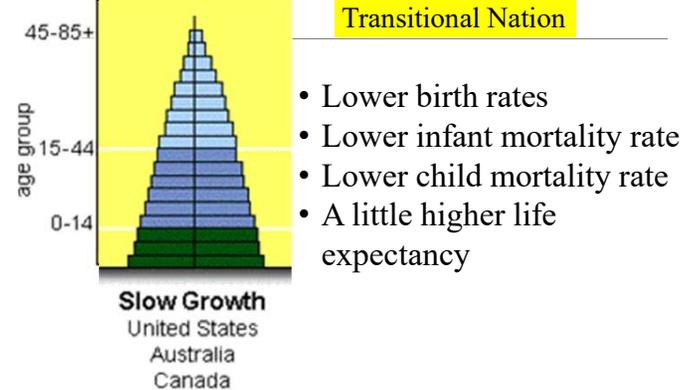
Increasing urbanization decreases TFR



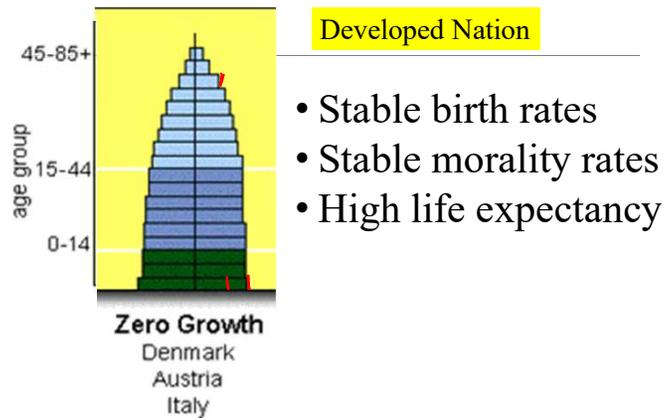
Age Structure



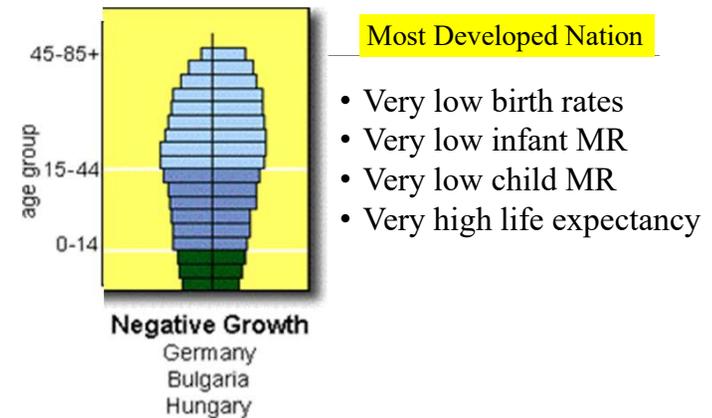
Age Structure

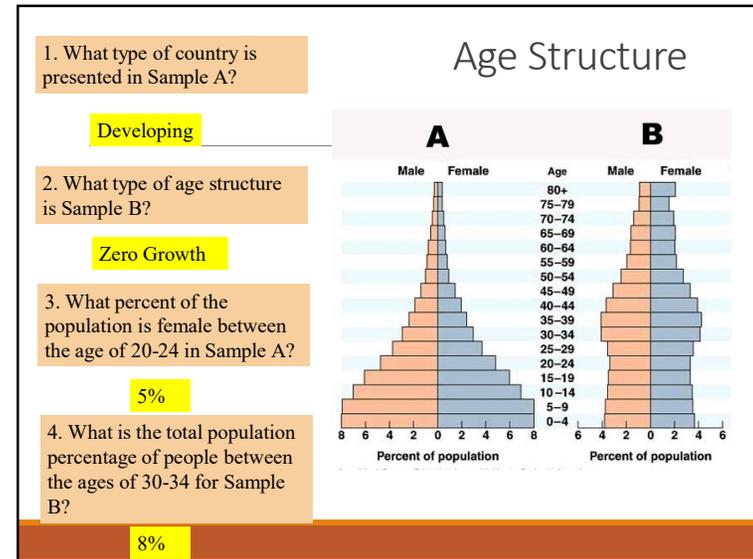
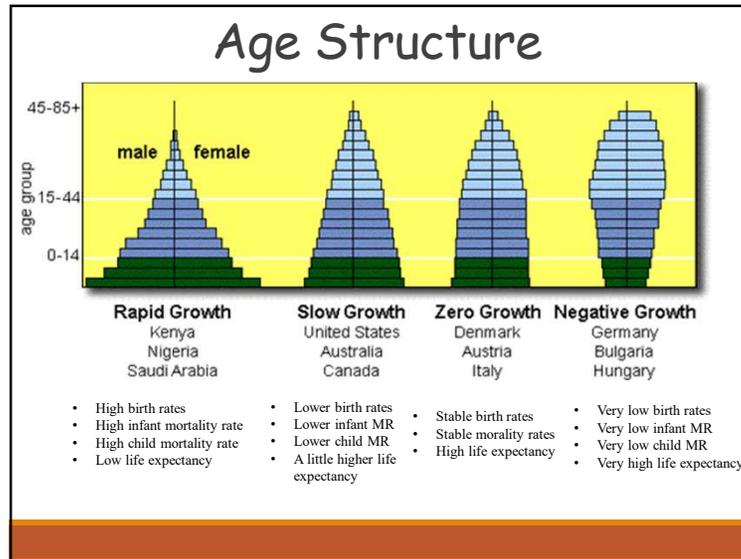


Age Structure



Age Structure





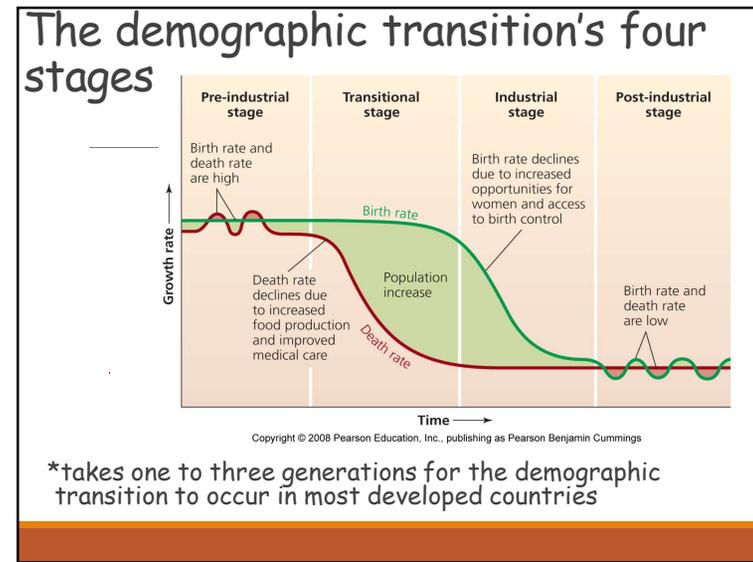
The demographic transition

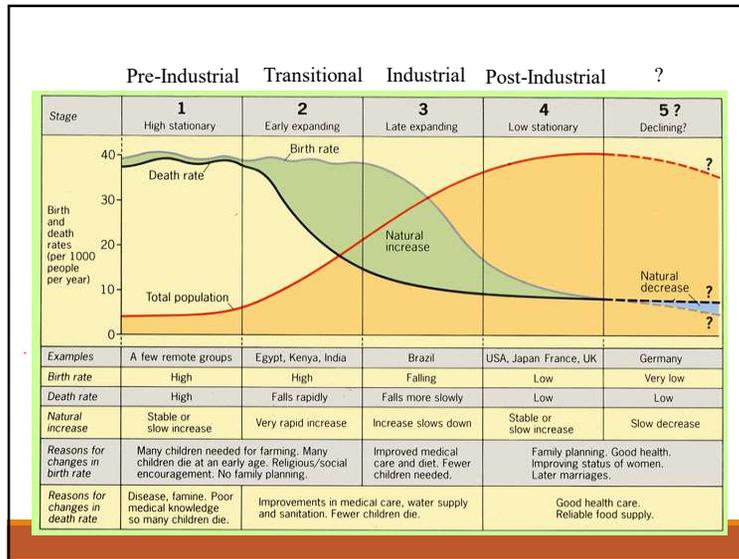
Demographic transition = a model of economic and cultural change to explain the declining death and birth rates in industrializing nations

Stable preindustrial state of high birth and death rates change to a stable post-industrial state of low birth and death rates

As mortality decreases, there is less need for large families

- Parents invest in quality of life





Draw a Demographic Transition Diagram

On Black Table

Include the following:

Birth Rate Line

Death Rate Line

Total Population Line

Stage Name

X-axis

Y-axis

Reason for change in death rate

Reason for change in birth rate

Example of country

Is the demographic transition universal?

Would it really be a good thing if every country experienced the transition?

The transition could fail in cultures

- That place greater value on childbirth or
- Grant women fewer freedoms



Demographic Transition Video

Women and Fertility

The factors most clearly related to a decline in birth rates are

1. increasing education: educated women find that they do not need to bear as many children to ensure that some will survive. They may also learn family planning techniques.

2. economic independence for women: women work to contribute to family's prosperity & spend less energy bearing and caring for children. If parents must pay for child care, children may become a financial burden rather than an asset.

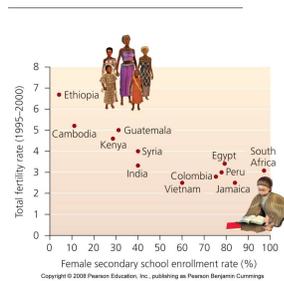
Empowering women reduces growth rates

Fertility rates drop when women gain access to:

- **Contraceptive**
- **Family planning programs**
- **Better educational opportunities**

In 2007, 54% of married women worldwide used contraception;

- China = 86%
- U.S. = 68%
- African nations < 10%



Women with little power have unintended pregnancies

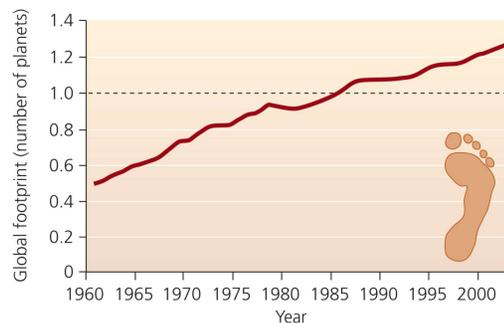
Population policies and family planning work

Many countries provide incentives, education, contraception, and reproductive health care

Funding and policies that encourage family planning lower population growth rates in all nations

- Thailand has an educational based approach to family planning and its growth rate fell from 2.3% to 0.7%
- Brazil, Mexico, Iran, Cuba, and other developing countries have active programs

Humanity's global ecological footprint surpassed Earth's capacity to support us in 1987



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The wealth gap and population growth cause conflict

The richest 20% use 86% of the world's resources

- Leaves 14% of the resources for 80% of the world's people to share



(a) A family living in the United States



(b) A family living in Egypt

Demographic changes have severe effects

6,000 Africans die each day

- Increased infant mortality
- Life expectancy fell from 59 to 40
- Millions of orphans created

Young, productive people die

- Communities break down
- Income and food production decline
- Medical expenses and debt skyrocket.



AIDS undermines the transition of developing countries to modern technologies

Demographic fatigue



Demographic fatigue = governments face overwhelming challenges related to population growth.

- With the added stress of HIV/AIDS; governments are stretched beyond their capabilities
- Problems grow worse

Nations in Africa must take aggressive steps soon

- Or these countries will have rising death rates and increased birth rates
- It would cause a profoundly negative outcome, both for humans and the environment

Conclusion

The human population is larger than at any time in the past

Populations are still rising, even with decreasing growth rates

Most developed nations have passed through the demographic transition

Expanding rights for women slows population growth

Will the population stop rising through the demographic transition, restrictive governmental intervention, or disease and social conflict caused by overcrowding and competition?

Sustainability requires a stabilized population in time to avoid destroying natural systems