

- 
- 1) A population of protozoa develops with a constant relative growth rate of 0.7944 per member per day. On day zero the population consists of two members. Find the population size after six days.
- 2) A bacteria culture starts with 500 bacteria and grows at a rate proportional to its size. After 3 hours there are 8000 bacteria.
- Find an expression for the number of bacteria after  $t$  hours.
  - Find the number of bacteria after 4 hours.
  - Find the rate of growth after 4 hours.
  - When will the population reach 30,000?

- 
- 3) The half-life of cesium-137 is 30 years. Suppose we have a 100-mg sample.
- Find the mass that remains after  $t$  years.
  - How much of the sample remains after 100 years?
  - After how long will only 1 mg remain?
- 4) A roast turkey is taken from an oven when its temperature has reached  $185^{\circ}\text{F}$  and is placed on a table in a room where the temperature is  $75^{\circ}\text{F}$ .
- If the temperature of the turkey is  $150^{\circ}\text{F}$  after half an hour, what is the temperature after 45 minutes?
  - When will the turkey have cooled to  $100^{\circ}\text{F}$ ?

- 5) Consider a population  $P = P(t)$  with constant relative birth and death rates  $\alpha$  and  $\beta$ , respectively, and a constant emigration rate  $m$ , where  $\alpha$ ,  $\beta$ , and  $m$  are positive constants. Assume that  $\alpha > \beta$ . Then the rate of change of the population at time  $t$  is modeled by the differential equation:

$$\frac{dP}{dt} = kP - m \quad \text{where } k = \alpha - \beta$$

- Find the solution of this equation that satisfies the initial condition  $P(0) = P_0$ .
- What condition on  $m$  will lead to an exponential expansion of the population?
- What condition on  $m$  will result in a constant population? A population decline?
- In 1847, the population of Ireland was about 8 million and the difference between the relative birth and death rates was 1.6% of the population. Because of the potato famine in the 1840s and 1850s, about 210,000 inhabitants per year emigrated from Ireland. Was the population expanding or declining at that time?