Lab 1.

Experimental measurement of the intrinsic rate of increase in Fruit Flies.

Objective:
If we know \( r \), the intrinsic rate of increase, and \( N_0 \), the starting population size then we can easily determine the growth curve of an exponentially growing population from the relationship \( \frac{dN}{dt} = rN \) (we will do this in Lab #2).

It follows that if we know \( N_0 \) and can determine the shape of an exponential curve observationally, then we can determine \( r \); probably the most fundamental parameter in ecology.

Practical Uses:
Calculation of \( r \) for an exponentially growing population is likely to be of direct value in applied microbiology (calculation of microbial growth rate in fermenters), and in biological control applications (e.g. large scale production of sterile fruit flies for pest control).

Introduction.

We will use the familiar laboratory fruit fly, *Drosophila melanogaster*, as our experimental organism. Drosophila is easy to sex and count, and has a relatively short life cycle.

The Experiment.

Working in groups of two, anaesthetize a vial of flies (don’t over-do it, or you will kill or sterilize them!), and sex them under a dissecting scope:
Males have shorter bodies, with solid dark coloration of their abdomens; females have brown stripes on their abdomens.

Place **one** female fly on one of each of **two** agar-filled Petri dishes, secure the lids in place with lab tape, and label them with your names and the time.
Retrieve your Petri dish(es) tomorrow (the lab will be unlocked from 8:30 am – 5:00 pm.), release the fly, place the dish under a dissecting microscope, and count the number of eggs laid. Record the number of eggs and the time on the table on the lab white-board. I will recover the class data ~ 5 pm and post it on the course website so it is accessible to everyone.

Calculate the mean number of eggs per female per hour.

The life span of an adult *D. melanogaster* can be taken to be 40 days. The rate of development is temperature dependent, but the generation time can be assumed to be 10 days (egg laying to egg laying) at 22°C. (for simplicity, we will assume females can lay eggs from eclosion (“hatching”; in fact they reach sexual maturity after 8-10 hours).

The following table tracks a **hypothetical** population of flies with a 10 day development cycle and a 10 day adult life span, with a fecundity rate of 100 eggs/female/day. Note that even though on day 12, 100 flies of Generation 2 hatch, only half those are females so the number of eggs laid that day is 50 x 100 = 5000, not 10,000. Note also that the founding female dies at the end of day 10, and that on day 21, the first 100 flies of Generation 2 have died, and so on. Finally, notice that not only is the total fly population increasing every day from day 11 onwards, but the rate of increase is going up. In this example, the rate of increase does not ramp up smoothly because we are not tracking continuous growth, but rather incremental growth (synchronized, 20 day life spans). In Lab #2, we will model continuous growth using the exponential growth equation.

Draw up a similar table using a 40 day adult life span, and a 10 day generation time. Use the class average number of eggs per female per day for the first 10 days of the adult life span, then reduce fecundity steadily to 0 eggs/female/day at 40 days.

You will recall that the intrinsic rate of increase, $r$, is calculated as:

$$ r = \frac{\ln R_0}{T_g} $$

(yearly rate of increase = the natural log of $R_0$ divided by the generation time, where $R_0$ is the number of females produced per female)

For our hypothetical flies, $r = \frac{\ln(5000)}{10} = 0.8517$

Calculate $r$ for your flies, using the class average for $R_0$
Dynamics of a Hypothetical Fly Population
(generation time, 10 days; adult life span, 10 days, fecundity 100 eggs/female, sex ratio 50:50)

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<th>Generation2</th>
<th>G2 eggs laid</th>
<th>Generation3</th>
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Things to Consider

Why would this approach to the measurement of r be inappropriate to finding r for a population of deer living in the Angeles National Forest?

A female Brown Rat, *Rattus norvegicus*, living under optimum conditions can average 5 offspring per litter, and produce 3 litters per year. *R. norvegicus* reaches sexual maturity at 6 months, and the average life span in the wild is 2 years. If a rat-free island is colonized by a single pregnant female rat, approximately how long will it take for the population to reach 1000 animals (assuming carrying capacity is very much greater than 1000, and growth proceeds exponentially).