In Macroeconomics, we will be concerned with people's tradeoffs between labor and leisure. Leisure is defined as all activities that are not labor. By this definition, sleeping, taking a shower, and going to the library are all leisure.

Implicitly, then, we are looking at people's tradeoffs between leisure and consuming goods. If we spend less time on leisure (and thus more time producing goods) we'll get to consume more goods. If we spend more time on leisure, we'll have less time to produce goods, and hence we'll get to consumer fewer goods. These decisions will help determine the size of the economy.

I have clipped an example out of another Macro book and spelled it out below. This is similar to the story that O' Sullivan and Sheffrin tell. Here, Robinson Crusoe is stranded on a desert island and must allocate his time either on leisure or on labor (which produces goods that he can then consume). In the example, RC's labor (picking berries) allows him to consume berries. I like this example because the link between leisure, real GDP, and consuming stuff is very explicit.

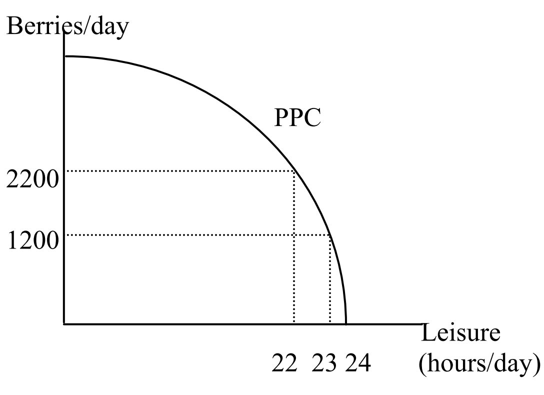
<u>Production functions are the same info as PPCs</u>

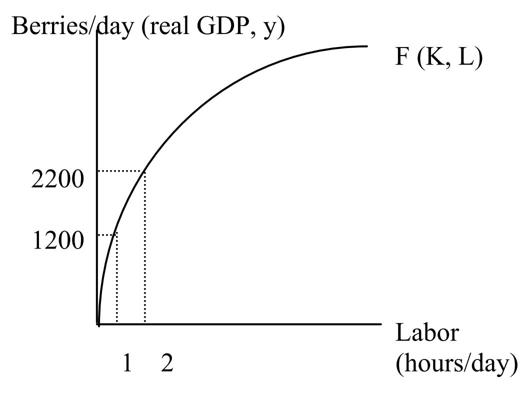
There are 24 hours in each day that can be spent either working (gathering berries) or on leisure. A picture of RC's PPC is below on the left. The point here is that this looks like a standard PPC.

If RC spends all of his time on leisure, he gets 0 berries. This means no labor.
If RC spends 23 hours on leisure, he gets 1200 berries. RC works 1 hour per day.
If RC spends 22 hours on leisure, he gets 2200 berries. RC works 2 hours per day.
If RC spends 12 hours on leisure, he gets 4165 berries. RC works 12 hours per day.

Notice that hours of leisure/day = 24 - hours of work /day

But now, let's flip this picture over. Now, instead of measuring leisure on the horizontal axis, we will measure <u>labor</u> on the horizontal axis (below right). We are expressing the same information, in a slightly different way. We call this graph on the right the **production function**, and denote if F (K, L). On the vertical axis, we are measuring berries / day (real GDP, or real output). We will use the production function throughout class.





A **production function** is a mathematical description of an economy's technology, showing the total production that an economy can obtain from its inputs of labor, capital, and natural resources.

The F (K, L) notation simply means that production is a function of the amount of capital (K) and the amount of labor (L). That is, if we have more capital to use to produce things, we'll get more output. If we use more labor, we will also be able to produce more output.

(We are assuming for simplicity that output is produced using only capital and labor. Thus, we are ignoring all other inputs, such as land and human capital here).

The production function we have drawn above is called the **short run production function**. When I drew this production function, I assumed that there was some amount of capital being used, say 84 units. That, is the **short run production function is drawn with a fixed amount of capital**. The amount of capital being used isn't changing as we move along a production function.

Why? Here's the story. There is some period of time where we stuck with the amount of capital that we've got. It takes time to increase the amount of capital. Think of an automobile factory. If the automobile factory decides it wants to produce a few more cars, it can easily hire some more labor, or perhaps even have its existing labor force work more hours. However, it will be much more difficult to add capital. Can an automobile factory quickly expand its factory? Quickly add an assembly line? Can it do so overnight? I don't think so.

Essentially, it takes time to expand the capital stock. We call the short run the time period in which the capital stock is fixed.

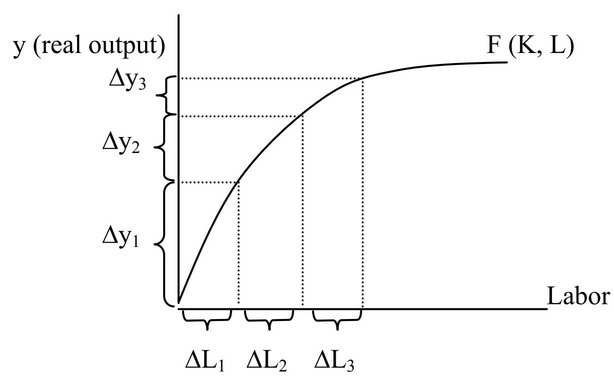
How long is the short run? The answer is I don't know, but I do know that it will be longer in some industries than in other industries. It probably takes a while to build a new automobile factory. What about Delta Air Lines – how soon can they add extra airplanes? In the nuclear energy industry, the short run is pretty long. It takes a long time to build a new power plant. McDonalds is much quicker. It would be even quicker still to add capital to your hot dog cart business.

Marginal Product of Labor

Look at the graph below. Notice, as we add the first unit of labor (ΔL_1), we get a large gain in real output (Δy_1). When we add the second unit of labor (ΔL_2), we get a smaller gain in real output (Δy_2). Finally, the third unit of labor (ΔL_3) adds an even smaller amount of real output (Δy_3).

We will define **Δy / ΔL = the marginal product of labor, abbreviated MP_L**.

The MP_L is the additional output produced from a one unit change in the amount of labor.



Notice, as we add each unit of labor, we get increased output, but real output increases at a diminishing rate. That is, the marginal product of labor decreases as we add more labor. Or symbolically,

$(\Delta y_1 / \Delta L_1) > (\Delta y_2 / \Delta L_2) > (\Delta y_3 / \Delta L_3)$

The mathematically inclined might notice that the marginal product of labor is simply the slope of the production function. Others, need not worry.

Alternatively, this information could be given to us in chart form, as it is done below.

RC's production function

Units of labor (hours)	Real output (berries)	MP_L (berries / hour)
0	0	x
1	1200	1200
2	2200	1000
3	3000	800
4	3500	500

Again, notice that the marginal product of labor is decreasing.

The Principle of Diminishing Marginal Returns – why do we have MP_Ls that diminish?

The Principle of Diminishing Marginal Returns – the principle that raising the quantity of an input eventually reduces its marginal product, if the quantity of other inputs remained fixed. In this case, as we add more labor, the marginal product of labor will eventually fall, if we hold the amount of capital fixed.

Why does the MP_L diminish? – Imagine RC on the island. In the first hour of work, he picks the berries from the lowest part on the trees. The next hour, he picks berries from a higher part where has to get up on his tiptoes, then he needs to climb up the tree entirely. It takes him longer to pick berries, and thus he is producing less real output per hour. Another reason it might diminish is as he works more and more, he gets tired. The big point is that each hour of work results in fewer berries / hour.

Still not convinced? What is the marginal product of each hour of studying, say the night before the final exam? The first hour scores you quite a few points. The second some more points, but not as many? In my experience, the 8th hour of studying has a pretty low marginal product. Is it even bigger than 0? Could you study so much that you would actually hurt your score?

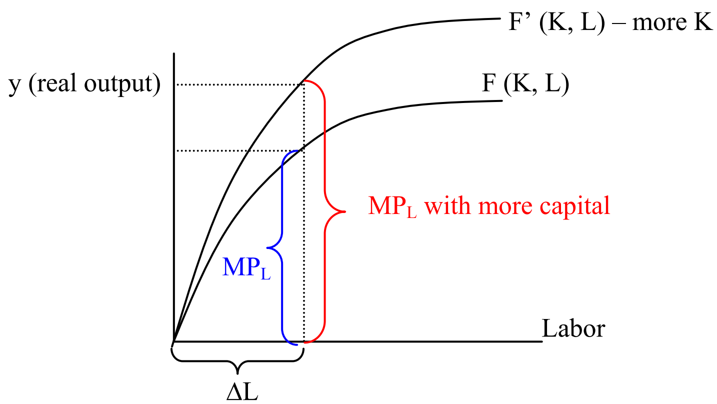
Does the marginal product have anything to do with the amount of capital the worker has at his disposal, you ask? Good question. Consider a McDonalds restaurant, say with only one cash register (one unit of capital). The first worker can take a bunch of orders. The second employee also can take a lot of orders, but finds himself waiting on the other employees some of the time to use the cash register. As we add more and more employees, they each spend a lot of time waiting to get into the cash register, and thus can take fewer orders.

It isn't that the 7th employee is a less-skilled worker; it is that as we add more and more labor, each worker has less capital to work with. When there is one worker, that worker gets a whole cash register to work with. When there are three workers, it's as if each worker has only "1/3 of a cash register" to work with. And so on…

What will happen to the production function as we add more capital?

The production function will shift up. As workers have more capital to work with, each unit of labor will be more productive. Stated more precisely, as we add more capital, the marginal product of each unit of labor will increase. The production function will shift up vertically. See the picture on the next page.

Similarly, but not drawn, if we decreased the amount of capital, the production function would shift down.



Compare the MP_L of some arbitrary unit of labor on the graph (in blue) with the MP_L of the same unit of labor after capital is added (in red).

Look back at the RC example. Suppose we give RC more capital. Perhaps we could give him a ladder (so he doesn't have to climb up the trees). Or better still, suppose we give him a cherry picker. Wouldn't you think the MP_L of the first hour of labor would increase above 1200 berries? Or stated differently, with the cherry picker, wouldn't you expect that he could pick more berries per hour? And the same for the second hour of labor? And the third?

Units of labor (hours)	y	MP_L	y'	MP_L'
0	0	x	0	x
1	1200	1200	1500	1500
2	2200	1000	2800	1300
3	3000	800	3800	1000
4	3500	500	4100	600

<u>So, how does the chalkboard thing translate into the jargon?</u>

In the chalkboard example, you needed labor, chalk, and the chalkboard to produce "Chad Turner is the man" sentences. As we add more and more labor, each laborer has less chalk to work with, and less chalkboard to work with (less capital). Eventually, (2 laborers in both classes), there will be diminishing returns to labor (holding capital constant).

<u>What should I be reading?</u>

Just the notes for a while. See page 247 for a pinch of book info if you are real interested.