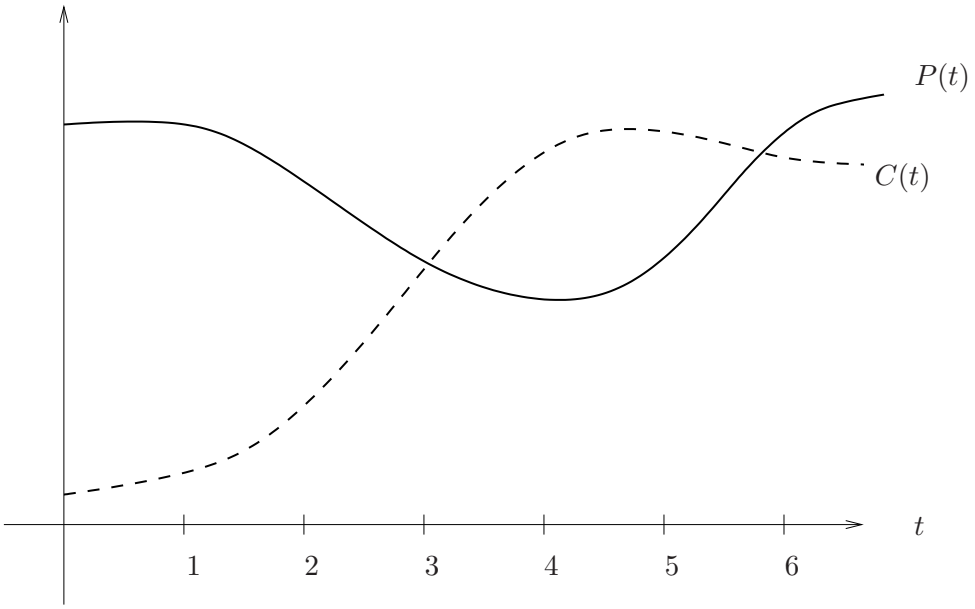
9.(7 points) In order to survive and perform their tasks, cells in your body must simultaneously produce and break down a molecule called ATP. When ATP is broken down, energy is released to the cell, and ATP is destroyed. For a certain cell, the rate of production of ATP, $P(t)$, in millions of molecules per second, and the rate at which ATP is broken down, $C(t)$, also in millions of molecules per second, are given in the following figure, where t is in seconds. The graph of $P(t)$ is shown as a solid line, and $C(t)$ is dashed.



Observe that since $P(t)$ is the rate at which ATP is being produced while $C(t)$ is the rate at which ATP is being broken down, $P(t)-C(t)$ is the rate at which ATP is accumulating in the cell. Therefore, the total change in ATP in the cell is represented graphically by the area between $P(t)$ and $C(t)$. Moreover, if $P(t) > C(t)$, then the area between them represents an increase in ATP while if $C(t) > P(t)$, the area between them represents a decrease in ATP. We will use this observation to answer the following.

(a) At time $t = 1$, is ATP increasing or decreasing?

Since $P(t) > C(t)$ at $t = 1$, we know that the rate that ATP is accumulating in the cell is positive at $t = 1$. Therefore the amount of ATP is *increasing* at $t = 1$.

(b) At approximately what time between $t = 0$ and $t = 6$ does the cell have the greatest amount of ATP? Explain.

Around $t = 3$. Note that $P(t) = C(t)$ around $t = 3$ and just before $t = 6$. Since $P(t) > C(t)$ for $0 \le t \le 3$, the area between them represents an increase in ATP. On the other hand, between $t = 3$ and $t = 6$, $C(t) > P(t)$ so the area between them represents a decrease in ATP. Therefore, the cell has the greatest amount of ATP at $t = 3$.

(c) At approximately what time between $t = 0$ and $t = 6$ is the amount of ATP in the cell decreasing the fastest? Explain.

Around $t = 4.5$ (between $t = 4$ and $t = 5$). We are looking for the time when $P(t) - C(t)$ is the most negative, (or where on the interval between $t = 3$ and $t = 6$ the slopes of tangents to C and P would be equal), and this occurs between $t = 4$ and $t = 5$.