If $h(x) = g(f(x))$, $\lim_{x\to a} f(x) = L$, and $\lim_{x\to L} g(x) = M$, then $\lim_{x\to a} g(f(x)) = M$.
Below is an explanative example.

Let $f(x) = 2x$, $g(x) = x^2$, $h(x) = g(f(x)) = (2x)^2$.

1. We show first that $\lim_{x\to 3} f(x) = 6$.

$$\begin{aligned}
|2x-6| <{}& \epsilon_f. \\
-\epsilon_f < 2x-6 <{}& \epsilon_f. \\
-\epsilon_f + 6 < 2x <{}& \epsilon_f + 6. \\
-\frac{\epsilon_f}{2} + 3 < x <{}& \frac{\epsilon_f}{2} + 3. \\
-\frac{\epsilon_f}{2} + 3 - 3 < x - 3 <{}& \frac{\epsilon_f}{2} + 3 - 3. \\
-\frac{\epsilon_f}{2} < x - 3 <{}& \frac{\epsilon_f}{2}. \\
|x-3| <{}& \frac{\epsilon_f}{2}. \\
\delta_f = \tfrac{\epsilon_f}{2}&.
\end{aligned}$$

2. Next we show that $\lim_{x\to 6} g(x) = 36$.

$$\begin{aligned}
|x^2-36| <{}& \epsilon_g. \\
-\epsilon_g < x^2-36 <{}& \epsilon_g. \\
-\epsilon_g + 36 < x^2 <{}& \epsilon_g + 36. \\
\sqrt{-\epsilon_g + 36} < x <{}& \sqrt{\epsilon_g + 36}. \\
\sqrt{-\epsilon_g + 36} - 6 < x - 6 <{}& \sqrt{\epsilon_g + 36} - 6. \\
|x-6| <{}& \sqrt{\epsilon_g + 36} - 6. \\
\delta_g = \sqrt{\epsilon_g + 36} - 6&.
\end{aligned}$$

3. Finally we want to show that $\lim_{x\to 3} g(f(x)) = 36$.

   For an arbitrary ϵ we need to find a δ such that $|(2x)^2 - 36| < \epsilon$ when $|x-3| < \delta$. From part 2 we know that $|(2x)^2 - 36| < \epsilon$ when $|2x-6| < \sqrt{\epsilon + 36} - 6$. From part 1 we know that $|2x-6| < \sqrt{\epsilon + 36} - 6$ when $|x-3| < \frac{\sqrt{\epsilon+36}-6}{2}$. Thus for an arbitrary ϵ we choose $\delta = \frac{\sqrt{\epsilon+36}-6}{2}$.