1) Suppose $(x,y) \in R \circ R$. Then there exists $(x,a), (a,y) \in R$ such that $(a,y) \circ (x,a) \in R \circ R$ and $(a,y) \circ (x,a) = (x,y)$. Since R is transitive and (x,a) and $(a,y) \in R$ $\Rightarrow (x,y) \in R$. Therefore, $R \circ R \subseteq R$ $\boxtimes$

2) (1) Suppose $f: A \to B$ and $g: B \to C$. Let $A = \{a\}$, $B = \{a,b\}$, and $C = \{b\}$ (Counterexample)

$f = \{(a,a)\}$ is injective, not surjective

$g = \{(a,b),(b,b)\}$ is not injective since $g(a) = g(b)$

Hence, if $g \circ f$ is injective, ~~both~~ $f \,\&\, g$ are not both injective

(2) Suppose $f: A \to B$ and $g: B \to C$. Let $A = \{a\}$, $B = \{a,b\}$ and $C = \{b\}$

$f = \{(a,a)\}$ is not surjective as nothing maps to $b \in B$.

$g = \{(a,b),(b,b)\}$

Hence since f is not surjective, then $f \,\&\, g$ are ~~not~~ both surjective.

(3) Suppose $f: A \to B$ and $g: B \to C$. Let $A = \{a\}$, $B = \{a,b\}$, and $C = \{b\}$

injective $\to f: \{a,a\}$

surjective $\to g: \{(a,b)(b,b\}$

$g \circ f: A \to C$ implies must be bijection

$g \circ f = \{(a,b)\}$ is a bijection

Hence if $g \circ f$ is not bijective, ~~both~~ $f \,\&\, g$ are not both bijective