

**A.** Two fair dice are rolled, one after the other.

- i. Let  $E_6$  be the event that the sum of the dice is 6. Let  $F_4$  be the event that the first die is 4. Are these two events independent?
- ii. Let  $E_7$  be the event that the sum of the dice is 7. Let  $F_4$  be the event that the first die is 4. Are these two events independent?
- iii. Let  $E_i$  be the event that the sum of the dice is  $i$ . Let  $F_j$  be the event that the first die is  $j$ . For what values of  $i$  and  $j$  are these two events independent?

**B.** Suppose a cell signaling network has five components. Each component acts independently with probability  $p_i$ ,  $i = 1, 2, 3, 4, 5$ . These components form a signaling pathway shown in the diagram below. The system is said to work

if a signal originating at the left end of the diagram (the receptor) can reach the right end (the promotor), where it can pass through a component only if that component is working. For instance, if components 1 and 4 both work, then the system works. Component 3 can transduce a signal in either direction (some *scaffold proteins* in cells provide such multivalent functions). What is the probability that the system works?