

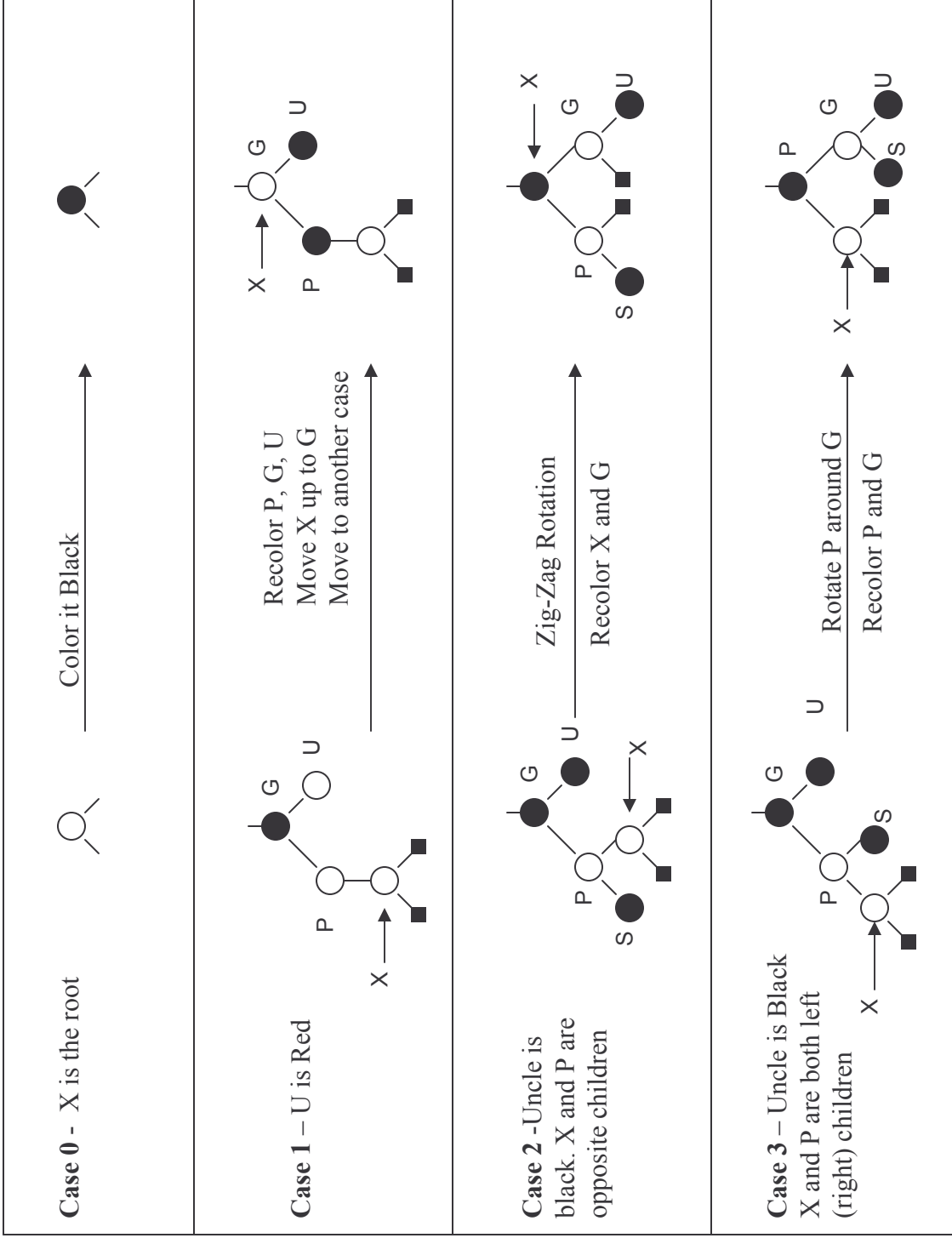
# Red-Black Tree Rotations

# Red-Black Diagrams

The diagrams which follow show the rotations and recoloring for each “case” for Bottom-Up Insertion, Top-Down Insertion and Bottom-Up Deletion.

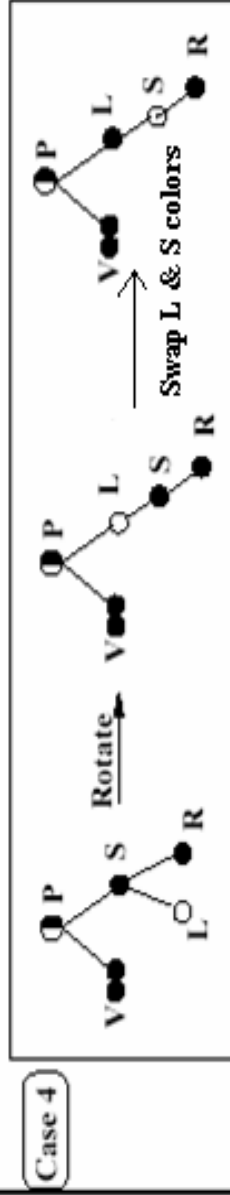
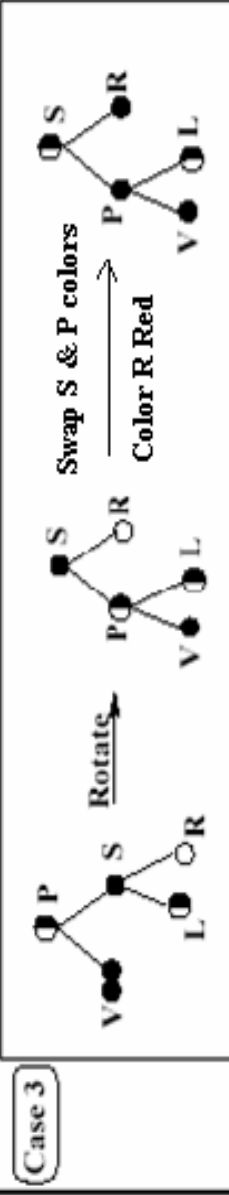
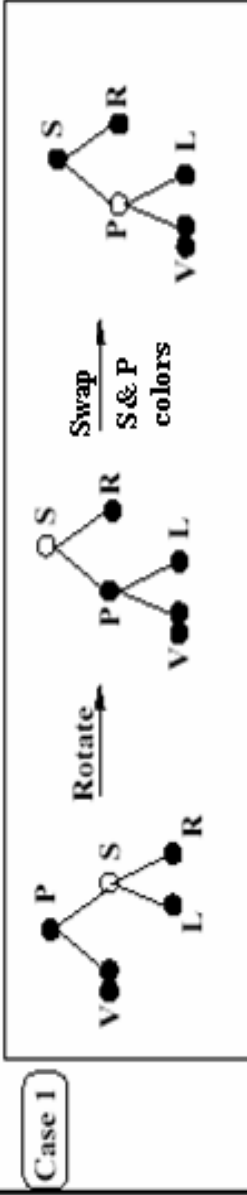
Bear in mind that each case has a left-right symmetrical twin which is not shown here.

# Bottom-Up Insertion



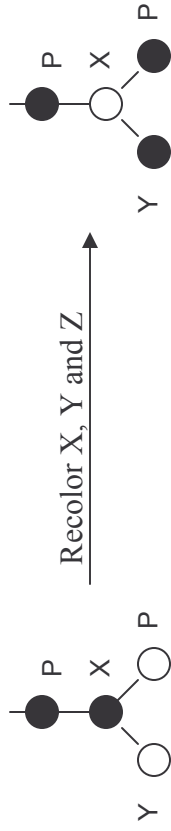
# Bottom-Up Deletion

- Black
- Red
- Don't care
- Extra Black



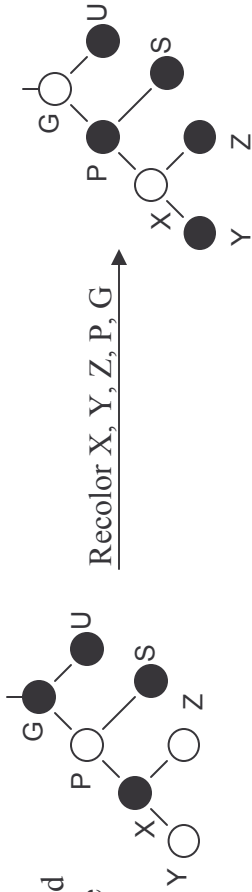
# Top Down Insertion

**Case 1** – P is Black



Recolor X, Y and Z

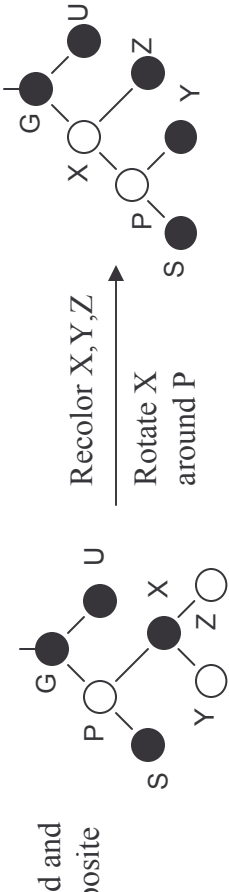
**Case 2** – P is red and P and X are both left (right) children



Recolor X, Y, Z, P, G

Rotate P around G

**Case 3** – P is red and P and X are opposite children



Recolor X, Y, Z

Rotate X around G