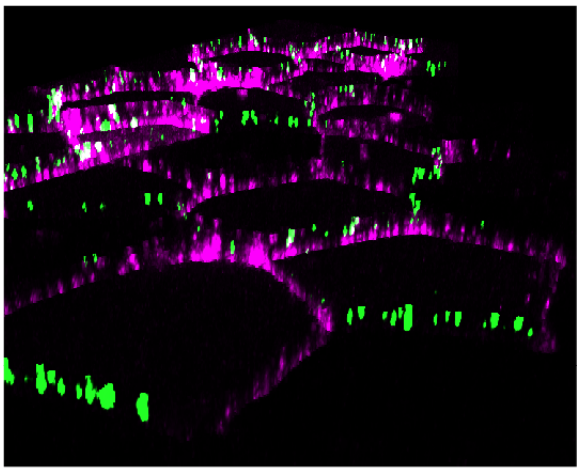
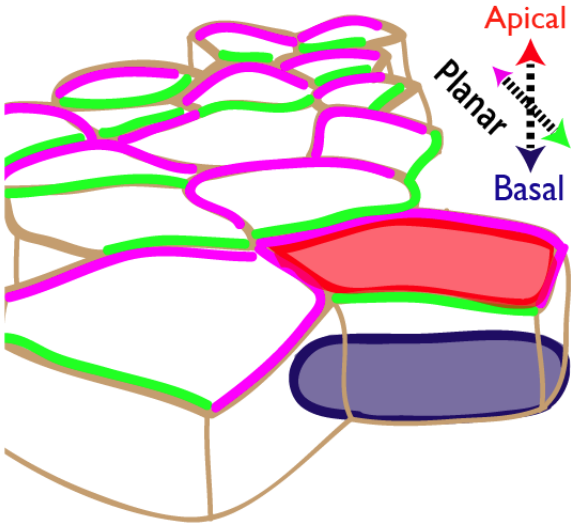
Supplementary information S1 (box) | Apical-Basal versus Planar Cell Polarity





Epithelial cells must be polarized in order to execute specialized functions. Some examples include mature cells of the intestinal epithelium, which have protrusive microvilli that increase the absorptive apical surface area, mucus-secreting goblet cells, which deliver surfactants to the surface of lung and gastrointestinal tissues[1], and multiciliated cells, which provide the forces for fluid flow in the ependymal, respiratory, and reproductive tissues through the beating of apical motile cilia[2]. While these examples have unique properties and structures that facilitate their different physiological functions, the signaling pathways that establish cell polarity necessary for their development remains conserved between them and metazoans[3].

Cell polarization requires the asymmetric localization of different cell polarity determinants in all three axes, which can be differently regulated during developmental processes (see Figure). Protein localization and function along the Z-axis of epithelia, referred to as apical-basal polarity, is relatively well understood and requires well- conserved proteins and lipids to organize into apical and basolateral domains through signaling feedback loops[4]. These proteins tend to specify the "inside" and "outside" of an epithelial sheet or tube (see Figure) and are often required for proper lumen formations. By contrast, planar cell polarity (PCP) signaling establishes domains orthogonally to apical-basal polarity along the X and Y axes and allow for the coordination of cell behaviors across the plane of the tissue (see Figure).

Planar polarity signaling components are most often localized to the apical surface of epithelial cells, and there are some examples of planar-polarized apical-basal determinants and adherens junctions proteins, demonstrating an interesting overlap between these two distinct cell polarity signaling pathways. For example, in dividing sensory organ precursor cells of the *Drosophila* notum, the Par3-Par6-aPKC complex is localized to the posterior regions by PCP protein Fz[5-7], and Dlg1 recruited to the anterior regions by PCP protein Vang[8]. However, such associations are likely tissue-specific, as the asymmetric recruitment of Par3 can occur via Vang rather than Fz in some cells of the *Drosophila* eye ommatidial epithelium[9]. In addition, some studies suggest that apical-basal polarity proteins regulate the apical localization of PCP signaling proteins[10], suggesting apical-basal polarity occurs upstream of planar polarity, while recent findings suggest the opposite can occur, with apical-basal proteins requiring PCP signaling for proper localization[9]. Thus, while there are clearly links between apical-basal and PCP signaling programmes in order to ultimately pattern tissue polarity, it seems distinct regulatory relationships between them can vary depending on the cell developmental context.
Data in image in panel b is from: Butler, M. T. & Wallingford, J. B. Control of vertebrate core planar cell polarity protein localization and dynamics by Prickle 2. *Development* **142**, 3429–3439 (2015).

References

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Supplementary information S2 (box) | Planar cell polarity and the actin cytoskeleton

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