Supplementary Figure and Movie Legends

Supplementary Figure 1. Vangl2 function is critical for axial elongation.

(a-d) Representative embryos from wt (a), or embryos injected with a Control^{MO} (b), Vangl2^{MO} (c) or mRNA encoding Vangl2 (Vangl2^{OE}) (d). **(e)** Quantification of the defects in axial elongation based on scoring 30 embryos under each experimental condition.

Supplementary Figure 2. Morpholino depletion of Vangl2 leads to ciliogenesis defects.

(a,b,e) Stage 28 tadpoles injected with control^{MO} (a) with Vangl2^{MO} (b) or with both Vangl2^{MO} and *Vangl2* RNA (e). Shown are confocal images of the skin surface after staining with an antibody to acetylated tubulin (green) that labels cilia, and a ZO-1 antibody (red) that labels cell borders. **(c,d)** Ciliated cells in a control^{MO} (c) or Vangl2^{MO} (d) injected embryo were stained with an antibody to ZO-1 (green) and an antibody against gamma tubulin (red) that labels basal bodies. Shown is a confocal stack of a representative ciliated cell, rotated 90 degrees. **(f)** Percentage of ciliated cells with less than 30 cilia in tadpoles that were injected at the two-cell stage with the indicated morpholino and/or *Vangl2* RNA.

Supplementary Figure 3: Effects of Vangl2^{MO} on cilia beat frequency

Cilia motility was measured by analyzing movies of cilia beating (Supp movie 3-5). Each graphical bar represents the averaged data from multiple cilia (as labeled) in which the number of frames was measured for a single cilium to complete an entire

beat sequence. The beat frequency was calculated using the frames per second that each movie was captured at (6688 frames per second).

Supplementary Figure 4: Analysis of mutant clones in the Xenopus larval skin

Shown is a low power montage of the stage 28 larval skin, where a small patch of outer layer from a Vangl2^{MO} injected embryo was transplanted onto a wildtype host embryo at stage 10. The graft was also marked with mRFP to distinguish it from host tissue. Insets show higher power views of representative ciliated cells lying at the anterior and posterior border of the grafter tissues, along with higher power images of individual labelled BBs (red) and rootlets (green) within those cells. Note that cells at the anterior border are normally oriented in a posterior direction, while those at the posterior border are reversed.

Supplementary Figure 5: Analysis of ciliated cell orientation at the border of a outer cell clone injected with Vangl2^{MO} or with *Vangl2* RNA (Vangl2^{OE})

Shown are representative ciliated cells located at the anterior (a,c,e) or posterior (b,d,f) border of a outer layer transplant taken from embryos injected with *RFP* alone (a,b), with Vangl2^{MO} and *RFP* RNA (c,d), or with both *Vangl2* and RFP RNA. Insets in each case show higher power images of each cell indicating how basal bodies (red) and rootlet (green) staining can be used to mark cilia orientation (arrows).

Movie Legends

Supplementary Movie 1: Flow produced by an inverted stage 10 transplant

A patch of ectoderm was isolated as Stage 10 from an GFP injected embryo and transplanted to a host after inverting the A-P and D-V axis as shown in Supplementary Figure 1a. At tadpole stages, rhodamine dye was puffed out next to the surface and filmed at 20frames/sec. Note that the direction of fluid flow is the same over both the host and grafted tissue. Anterior is oriented to the left and posterior to the right. The first frame is taken with FITC filter set to show the position of the grafted tissue on the flank of the host while the remaining frames were taken using a Rhodamine filter set.

Supplementary Movie 2: Flow produced by an inverted stage 16 transplant

A patch of ectoderm was isolated at Stage 16 from an GFP injected embryo and transplanted to a host after inverting the A-P and D-V axis as shown in Supplementary Figure 1a. At tadpole stages, rhodamine dye was puffed out next to the surface and filmed at 20frames/sec. Note that the direction of fluid flow is reversed over the grafted tissue compared to the host. Anterior is oriented to the left and posterior to the right. The first frame is taken with FITC filter set to show the position of the grafted tissue on the flank of the host while the remaining frames were taken using a Rhodamine filter set.

Supplementary Movie 3: Cilia motility in a wildtype ciliated cell

Cilia motility in wild type albino embryos in which the skin was explanted onto cover glass visualized using an Olympus BX51 microscope (100X submersible objective) and a Vision Research Phantom 7.2 camera. Movies were captured at 6688 frames per

second and background movement was subtracted to amply the contrast. Movies are played back at 25 frames per second.

Supplementary Movie 4: Cilia motility in a Vangl2^{MO} injected ciliated cell

Cilia motility in Vangl2^{MO} injected albino embryos in which the skin explanted onto cover glass visualized using an Olympus BX51 microscope (100X submersible objective) and a Vision Research Phantom 7.2 camera. Movies were captured at 5000 frames per second and background movement was subtracted to amply the contrast. Movies are played back at 25 frames per second.

Supplementary Movie 5: Cilia motility in a wild type ciliated cell that is surrounded by Vangl2^{MO} injected outer cells.

Cilia motility in a wild type ciliated cell surrounded by Vangl2^{MO} injected outer cells explanted onto cover glass visualized using an Olympus BX51 microscope (100X submersible objective) and a Vision Research Phantom 7.2 camera. Movies were captured at 6688 frames per second and background movement was subtracted to amply the contrast. Movies are played back at 25 frames per second.