Morphology Dashboard

Summary of the metrics you can get

The information obtained from the Morphology Dashboard allows you to gain in depth knowledge on the phenotypic changes of your cells over time at both a population and single cell level. Livecyte's robust single-cell segmentation allows accurate measurement of several structural changes including sphericity, perimeter, area and length: width ratio. In addition to this, it's possible to evaluate the alterations in cellular biomatter through the unique dry mass metric, giving you an indication of the growth of each of your cells.

Applications where it would be useful

These metrics may be beneficial when assessing *in vitro* models of disease or toxicity where there are changes in the morphology and growth of individuals cells. For example, characterisation of several atypical features observed in cardiac hypertrophy or neoplastic changes in cells characteristic of a cancerous phenotype. It also allows further assessment into the mechanism of cell injury by distinguishing between specific features of cell death particularly in cytotoxicity or cell death assays. This can further provide a robust basis to screen and understand the adverse or beneficial effects of drug compounds, as well as efficacy of therapeutics in ameliorating this disease phenotype.

In addition to disease, the Morphology Dashboard allows you to independently evaluate healthy pathways and stem cell differentiation, or with immune cell assays to investigate phenotypic variation in response to immune cell interactions and activation. These metrics allow you to measure accumulation of mass seen in in phagocytosis events, and the morphological changes that accompany this. In cases where a coculture is used, distinguishing morphological characteristics can be used to independently observe subpopulations of cells making *in vitro* models more physiologically relevant.

Thickness – A distribution plot showing the thickness of each cell on each frame. This is a measure of the optical thickness of each cell, which can often be altered when cells undergo structural reorganisation during mitosis. A reduction in cell thickness has also been associated with several types of cell death eluding to applications in cell injury and disease. In addition, by assessing differences in thickness between genetically altered yeast strains it may be possible to understand underlying cell processes critical in maintaining cell morphology.

Median Cell Thickness – A line graph quantifying changes to median cell thickness in the population as a function of time. This is a measure of the optical thickness of each cell which can often be altered when cells undergo structural reorganisation during mitosis. A reduction in cell thickness has also been associated with several types of cell death eluding to applications cell injury and disease. In addition, by assessing differences in thickness between genetically altered yeast strains it may be possible to understand underlying cell processes critical in maintaining cell morphology. In investigating changes in thickness over time, it may be possible to identify stages of cell death or mitosis over the course of the experiment.

Sphericity – A distribution plot of the sphericity of each cell on each frame. A measure of how close to a sphere a cell is and can be indicative of several biological changes including mitosis where cells round

up, as well as in the early stages of apoptosis. A reduction in sphericity can also demonstrate cells undergoing differentiation.

Median Cell Sphericity – A line graph quantifying changes to median sphericity in the population as a function of time. A measure of how close to a sphere a cell is and can be indicative of several biological changes including mitosis where cells round up, as well as in the early stages of apoptosis. A reduction in sphericity can also demonstrate cells undergoing differentiation. Understanding changes to sphericity over time may aid in capturing these biological events.

Length:width ratio – A distribution plot of the length to width ratio of each segmented cell. This is calculated by dividing the length by the width of the smallest rectangular region in which the cell resides. This is a particularly useful metric when studying embryonic development and can be used alongside other metrics such as sphericity to fully understand changes in cell differentiation. Alongside sphericity it has also shown merit in investigating the morphological changes in strains of fission yeast to study underlying cellular processes.

Median Cell Length:width ratio - A line graph quantifying changes to median length:width ratio in the population as a function of time. This is calculated by dividing the length by the width of the smallest rectangular region in which the cell resides. This is a particularly useful metric when studying embryonic development and can be used alongside other metrics such as sphericity to fully understand the changes in cell differentiation. Alongside sphericity it has also shown merit in investigating the morphological changes in strains of fission yeast to study underlying cellular processes. Understanding changes over time may aid in capturing time-sensitive responses over the course of the experiment.

Perimeter – A distribution plot of the perimeter of each of the segmented cells on each frame. This allows you understand if cell boundaries have grown larger or smaller in morphology. It can also be indicative of cell spreading and formation of extension such as filopodia, often seen in the growth and motility of cells, particularly when considered in conjunction with changing cell area.

Median Cell Perimeter - A line graph quantifying changes to median perimeter in the population as a function of time. This allows you understand if cell boundaries have grown larger or smaller. It can also be indicative of cell spreading and formation of extension such as filopodia often seen in growth and motility of cells, particularly when considered in conjunction with changing cell area. Investigating perimeter over time may aid in capturing time-sensitive responses over the course of the experiment.

Area – A distribution plot of the area of each of the segmented cells on each frame. Cell area may be altered during several biological processes including mitosis, phagocytosis and motility and along with other features may aid in characterising cellular phenotype and behaviour.

Median Cell Area - A line graph quantifying changes to median area in the population as a function of time. Cell area may be altered during several biological processes including mitosis, phagocytosis and motility and along with other features may aid in characterising cellular phenotype and behaviour.

Dry Mass - The dry mass is a quantitative measure of the biomass within a cell, minus the water. This distribution plot shows the dry mass of each of the segmented cells in each frame in picograms. The rate of cellular dry mass accumulation is characteristic of cellular growth but can also be indicative of the expulsion or addition of cellular material, the latter observed during macrophage engulfment of apoptotic cells.

Median Dry Mass- A line graph quantifying changes to median dry mass in the population as a function of time. The dry mass is a quantitative measure of the biomass within cells, minus the water. The rate of cellular dry mass accumulation is characteristic of cellular growth but can also be indicative of the

expulsion or addition of cellular material, the latter observed during macrophage engulfment of apoptotic cells. Changes to dry mass over time can be indicative of cell death or hypertrophy of cells in response to treatment.

Publication Example

Frame, F.M., Noble, A.R., O'Toole, P., Marrison, J., Godden, T., O'Brien, A. and Maitland, N.J., 2019. Assessing the Advantages, Limitations and Potential of Human Primary Prostate Epithelial Cells as a Pre-clinical Model for Prostate Cancer Research. In *Human Cell Transformation* (pp. 109-118). Springer, Cham.

Frame F.M *et al* utilised morphology metrics to characterise primary prostate cancer cells from cell lines to investigate the best cell type to base an *in vitro* model on. In addition, it was possible to get in depth information on differences in morphology between different types of primary cells. Through measuring several morphology parameters it was possible to identify a mixture of progenitor and differentiated primary cells within coculture, as well as investigate phenotypic changes that occurred during anti-cancer treatment to these subpopulations.