**S1. Supplemental Text**

***Exploratory Linear Regressions***

The strongest relationships according to linear regressions performed on each pair of variables exist between porosity and elliptical estimate volume (r2=0.401), porosity and elliptical estimate surface area (r2=0.400), porosity and top-half surface area (r2=0.400), and porosity and major axis length (r2=0.427, Supplemental Figure 2a). Pore density and average pore size did not strongly correlate with any of the test-size variables in the linear models (See supplemental Figure 2 for pairwise regression plots of pore measurements and other variables). When the pore characteristics and morphological variables are regressed with environmental conditions, the environmental parameter most strongly correlated is sea surface temperature. SST correlates most strongly with porosity (r2=0.64), pore density (r2=0.59), pore size (r2=0.56), major axis length (r2=0.43), elliptical surface area (r2=0.43) and elliptical volume (r2=0.44).

***Slide Scan Height Corrections***

The height of spherical reference specimens on each slide (such as *Orbulina universa* or the final chambers of *Globigerinoides ruber),* were estimated by counting the number of slides from the top of the object to the last visible plane (an approximate mid-point) and adding that number of slices to the bottom. Extraneous planes were identified, counted, and subtracted from the total height by multiplying the number of additional planes by the step size of the z-stacks (11.1μm).

***Orientation and Surface Area/Volume Proxy Selection***

Specimens were imaged from two views, spiral-side-up and umbilical-side-up. For many species the disparities in the measurements were expected to be negligible, but they could be more significant in species with more highly trochospiral or pyramidal shapes. Spiral and umbilical side measurements were compared (Supplemental Figure 5) and used to understand which two-and-three dimensional measurements were the most affected by spiral/umbilical side orientation. We found that elliptical estimate surface area was the parameter least affected by orientation. The equation of the linear regression for the elliptical surface area measurement had the smallest deviation from a direct correlation (y= 6.9 + 0.97x). Top-half volume and surface area was the most sensitive to orientation, the regression of the measurements from the two views has the most scatter (r2=0.609) and the highest deviation from a 1-to-1 relationship (y=86.9 +0.699x). The two dimensional measurements of cross-sectional area and major axis length were similarly affected by orientation (y= 20.6 + 0.96x and y= 36 + 0.93x). To reduce orientation based error, umbilical side views were preferentially used in the statistical analyses below.