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Why do Dolphins Have Cutaneous Ridges?

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The existence of small-scale static waves on dolphin skin has been known for some time. These cutaneous ridges are aligned with crests approximately perpendicular to the local flow direction. No function, hydrodynamic or otherwise, has hitherto been suggested for the cutaneous ridges. Here we report a DNS study of 3D Tollmien-Schlichting waves propagating over wavy compliant surfaces. The boundary-layer disturbances are generated by a line body force, located at the boundary-layer edge, that varies harmonically with time and sinusoidally in the spanwise direction. For rigid surfaces, quasi-2D TS waves grow most rapidly and wall waviness increases their growth rate. But for compliant walls, 3D TS waves grow most rapidly and their growth rates are substantially reduced over wavy walls with wavelengths closely matching those of the cutaneous ridges. This reveals a novel effect of “wall roughness” on transition, suggesting that cutaneous ridges help to achieve the dolphin’s laminar-flow capability.

View the extended summary