charge stays constant and the upward renormalization of α_G is due to a decreasing Fermi velocity at increasing energies. In both QED and graphene, the renormalization of the coupling between two different energies E_1 and E_2 is given by the relation

$$\alpha(E_2) = \frac{\alpha(E_1)}{1 - A\alpha(E_1)\ln(E_2/E_1)}$$

where A is a constant that depends on the number of fermion species that contribute to the renormalization at energy E_2.

The idea that such a renormalization would occur in graphene was suggested almost a decade before it had actually been successfully isolated[3]. The reason it has taken so long since graphene's initial isolation to confirm it experimentally is that it only becomes evident within 1 eV of the Dirac point and a clear demonstration of the validity of any logarithmic relation naturally requires a dataset that spans several orders of magnitude. In this sense, the experiments performed by Elias *et al.* represent a real tour-de-force, probing graphene's electronic structure down to fractions of meV of the Dirac point, and confirming the logarithmic behaviour all the way down to this point. Beyond establishing the QED-like behaviour of graphene further than any physicist might have reasonably expected, the result improves our understanding of the often controversial nature of electron–electron interactions in neutral graphene.

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References
1. Novoselov, K. S. *et al. Nature* **438**, 197–200 (2005).
2. Elias, D. C. *et al. Nature Phys.* **7**, 701–704 (2011).
3. González, J., Guinea, F. & Vozmediano, M. A. H. *Nucl. Phys. B* **424**, 595–618 (1994).

On mechanics and morphology

When D'Arcy Thompson penned his 1917 book *On Growth and Form* he boldly declared that the morphologist — devoted to understanding the structure of organisms — is *ipso facto* a student of physical science. His meaning was clear: the growth of complex structures mediating specific biological function is underpinned by an intrinsic mechanics, an appreciation of which is crucial to a broader understanding of both form and function.

Thierry Savin and colleagues refer to Thompson's tome in their investigation, published in *Nature*, of the elaborate looped morphology that arises in the vertebrate gut (*Nature* **476,** 57–62; 2011). Using experiment, simulation, and an innovative physical mock-up comprising rubber tubing stitched to latex, they have examined the forces arising from relative growth between the gut tube and a neighbouring sheet of tissue known as the dorsal mesentery. The study reveals a mechanism for the formation of loops based on differential strain between the two tissues.

This is a timely nod to Thompson's century-old ideas, given the recent surge of physicists and mathematicians into the biological sciences, problem-solving artillery engaged. In another paper, published in *Physical Review Letters*, Edouard Hannezo, Jacques Prost and Jean-François Joanny adopt a similarly mechanical approach to understanding the complex structures seen lining the small intestine (pictured), invoking an analogy with the buckling of metallic plates under compression (*Phys. Rev. Lett.* **107**, 078104; 2011). They have

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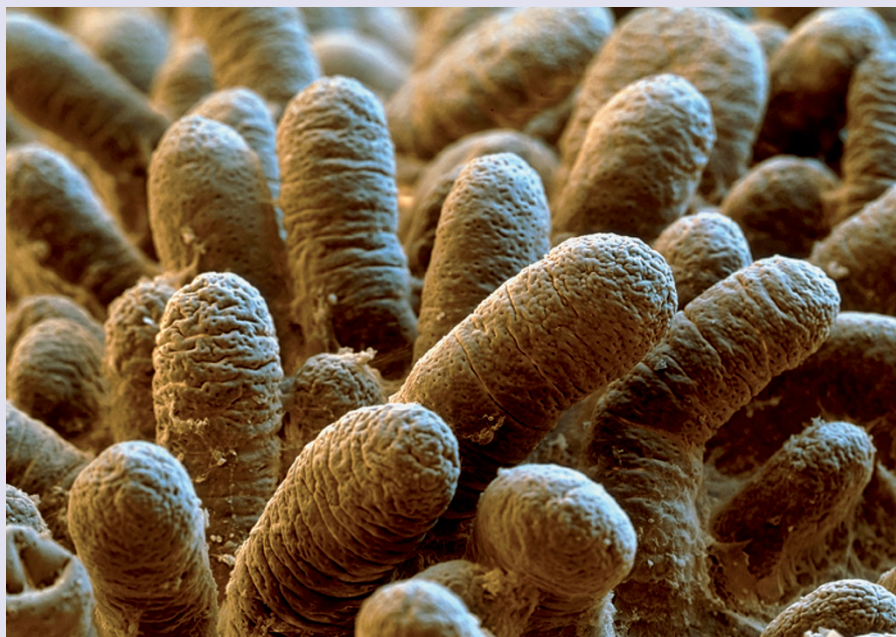
developed a model that implicates cellular division and death as sources of internal stress, which in turn influences morphology and induces mechanical feedback on organ and tissue development.

One of the most interesting aspects of Thompson's treatise is an emphasis on the degree to which structures in different tissues and organisms can be related to one another by means of mathematical transformation. Both of the new papers offer striking evidence to this effect. For Savin *et al.*, scaling arguments for the size, number and radius of loops account for qualitative and quantitative variation across different species, including chick, quail, finch and mouse. In a similar spirit, Hannezo and colleagues report that by tuning their model for the morphology of the small intestine, the markedly different structures populating the colon can also be reproduced.

The upshot of this and related work is that macroscopic mechanics drives morphology during the formation of tissues and organisms — bringing the formalism of physics to bear on long-standing problems in developmental biology.

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