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Domestic cats eat whatever they can catch

Domestic cats (*Felis catus*) are beloved companions for many people, but they are also invasive predators that have been linked to numerous birds, mammals and reptiles going extinct. Their eating habits are of interest to ecologists, to determine the risk these cats pose to endangered species. Writing in *Nature Communications*, Lepczyk *et al*. report a global assessment of the diet of free-ranging domestic cats — and find that they are not picky eaters (C. A. Lepczyk *et al*. *Nature Commun.* **14**, 7809; 2023).

The authors constructed the largest database of cat's diets so far by exhaustively combing through hundreds of previous studies. Their meta-analysis identified 2,084 species eaten by cats, of which 981 (about 47%) were birds, 463 (22%) were reptiles and 431 (21%) were mammals. Surprisingly high numbers of insects (119 species; 6%) and amphibians (57 species; 3%) were also identified.

The emerging picture is that cats are extremely indiscriminate predators that eat whatever animals they can capture or scavenge. Worryingly, about 17% of the identified species are of conservational concern. The authors say that the findings will aid scientists' understanding of the impact of cats on ecological systems. **Andrew Mitchinson**

Medical research

MYC protein helps cancer to take its vitamins

Martina Wallace

Identifying nutrient dependencies of cancer cells is crucial for developing new therapies. The discovery that an aggressive type of cancer cell has a high uptake of vitamin B5 sheds light on the link between vitamin availability and tumour growth.

A rise in the levels of the protein MYC in tumours is associated with poor clinical outcomes in people who have cancer, including increased rates of cancer spread (metastasis) and decreased survival times[1]. Because MYC is a transcription factor that controls the expression of a wide range of genes, increases in its abundance can result in the rewiring of cellular metabolism to support tumour growth[2]. However, the complexity of the metabolic pathways involved, and the intricate interactions between the tumour and its micro-environment, make it challenging to identify nodes that could be targeted therapeutically. Writing in *Nature Metabolism*, Kreuzaler *et al*.[3] show that cells with high levels of MYC increase their uptake of vitamin B5 (also known as pantothenic acid), a nutrient that supports key metabolic processes. This finding might provide a way to target cancer cells through their metabolism.

The authors used advanced imaging methods to analyse mice bearing breast-cancer tumours. Tumours usually consist of a mixture of cancer cells with different gene-expression profiles or features. This gives them the flexibility to adapt to changing micro-environments that often have poor nutrient supplies and low levels of oxygen[4].

However, it is unclear how having high levels of MYC enables a cancer cell to alter its metabolism and thereby give it a growth advantage over neighbouring cancer cells in which the protein is less abundant.

To understand this phenomenon, Kreuzaler and colleagues engineered cancer cells using a method[5] that allowed them to produce high or low levels of MYC. They used fluorescent proteins as tracers, so that the cells with low MYC expression appeared red under the microscope, whereas those with high MYC expression were green. By transplanting a mixture of these cells into mice, the authors generated tumours made up of cells with differing levels of MYC expression. The researchers then used imaging and the technique of mass spectrometry to create a map of the compounds present in various parts of the tumour. They compared this map with the pattern of high-MYC and low-MYC cells to identify how these cells differed from one another.

It emerged that an increase in the level of vitamin B5 was one of the most notable features of cells with high expression of MYC (Fig. 1). The authors also found that MYC caused upregulation in expression of the gene encoding the protein SLC5A6, which transports vitamin B5 into the cell. To investigate whether this correlation between vitamin B5 and MYC was also present in human cells, the authors analysed breast-cancer biopsies, and found that the levels of vitamin B5 varied according to MYC expression in these samples, too. Kreuzaler *et al.* also examined mice that had received transplants of human breast cancer cells with a range of MYC levels. The authors again found that the levels of vitamin B5 correlated with MYC expression.

These experiments demonstrated that there is a relationship between vitamin B5 and MYC. Kreuzaler and colleagues next investigated whether directly altering the levels of vitamin B5 in cancer cells affected tumour growth, to determine whether this node might be a targetable nutrient dependency. Mice with tumours expressing high levels of MYC that were fed a vitamin-B5-free diet showed a decrease in tumour growth, as compared with mice that received a normal diet. Conversely, increasing the transport of vitamin B5 into the cell by overexpressing the multivitamin transporter protein SLC5A6 enhanced tumour growth. These findings provide evidence that manipulating the levels of vitamin B5 in cells with high levels of MYC affects tumour growth, and show that this can be achieved either through dietary intervention or by altering the transport of the vitamin into the cell.

To understand how vitamin B5 supports cell growth, the authors focused on the activity of metabolic pathways. Vitamin B5 has a central role in metabolism because it is needed to make coenzyme A (CoA), a molecule that is essential for many metabolic reactions. CoA acts as a cofactor that activates key intermediate metabolites (products of metabolism) to enable them to be used for energy generation or as building blocks for the synthesis of large molecules such as lipids. Cells are unable to use nutrients effectively without CoA. Kreuzaler *et al.* found that cells with high levels of MYC and vitamin B5 also had high levels of CoA.

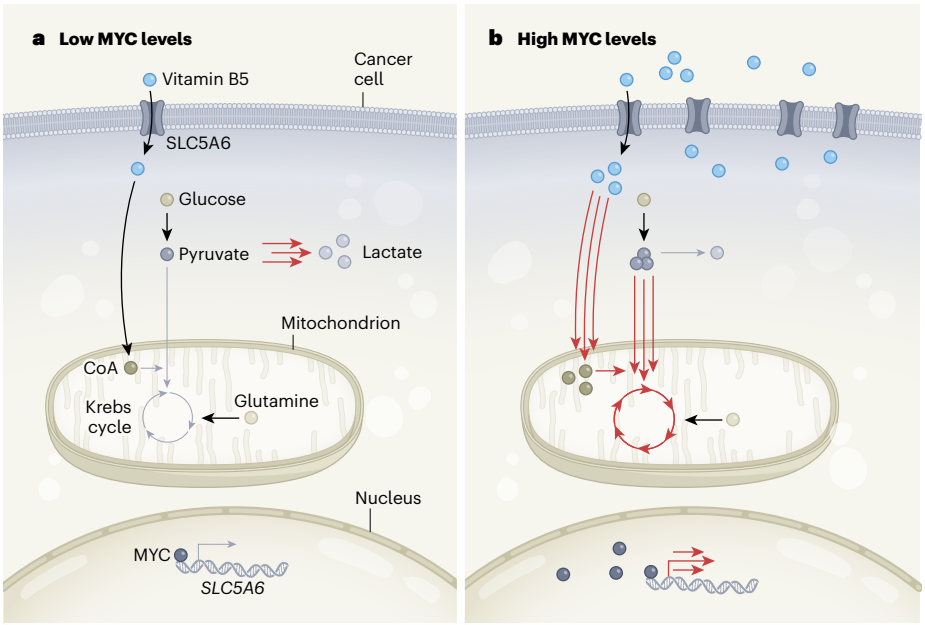

Figure 1 | A connection between high levels of MYC protein and high levels of vitamin B5. High expression of MYC often indicates poor outcomes for people who have cancer[1]. Kreuzaler *et al.*[3] investigated the metabolic changes associated with MYC expression by comparing cells with low and high levels of the protein. MYC drives the expression of the protein SLC5A6, which can transport vitamin B5 into cells. Vitamin B5 has a role in the synthesis of coenzyme A (CoA), which is used to produce various key molecules in the cell, including glucose, pyruvate and glutamine, that can feed into the Krebs cycle – an energy-generating metabolic pathway in mitochondrial organelles. **a**, In cells with low MYC levels, more molecules of glucose and pyruvate generate lactate than feed into the Krebs cycle. **b**, In cells with high levels of MYC, there is high expression of SLC5A6 and high uptake of vitamin B5. More molecules enter the Krebs cycle than give rise to lactate. Red arrows denote pathways with high activity.

To understand how metabolism is altered by vitamin B5 availability in cancer cells with high MYC expression, the authors tracked (using an isotope-monitoring method) how carbon from labelled versions of two key metabolic substrate molecules – glucose and glutamine – was used by tumours. Compared with low-MYC cells, high-MYC cells showed increased levels of glucose- and glutamine-derived carbon in molecules that are intermediates in the Krebs cycle, a central metabolic pathway. Conversely, lower levels of labelled carbon were incorporated into the molecule lactate in high-MYC cells than in low-MYC cells.

These findings suggest that, relative to low-MYC cells, high-MYC cells funnel more glucose into the Krebs cycle, thus increasing its activity to boost energy generation and meet biosynthetic needs. The lower levels of lactate being made from glucose in these high-MYC cells is notable because lactate secretion is normally a common feature of cancer cells cultured *in vitro*[6]. However, this finding by Kreuzaler and colleagues adds to the growing number of observations indicating that lactate production is not always a characteristic feature of cancer growth when metabolism is tracked directly in tumours.

Although the authors' experiments reveal clear differences in metabolism associated with changes in the uptake of vitamin B5, many questions remain about the extent to which vitamin B5 drives other metabolic pathways. CoA is estimated to be involved in at least 100 metabolic reactions[7].

The main challenge arising from Kreuzaler and colleagues' work is how to translate these findings so that this nutrient dependency can be targeted in people with cancer. Precision-nutrition approaches for the treatment of cancer have progressed considerably. However, it is unclear whether decreasing dietary vitamin B5 would be a useful intervention in humans, because it could also have a detrimental effect on immune-cell functions that are needed to repress tumour growth[8].

This work also raises questions about the potential interactions between vitamin supplementation and cancer therapy. Although the authors did not directly investigate how vitamin B5 might affect the survival of tumour cells treated with chemotherapeutics, it is notable that some studies have reported that up to 44% of people undergoing chemotherapy take multivitamins[9] (which usually contain vitamin B5). Kreuzaler and colleagues' work provides a key example of how the use

of advanced mass spectrometry imaging to spatially resolve metabolite signatures in tumours can uncover previously unknown nutrient dependencies in cancer.

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The author declares no competing interests.

Photonics

Twisted system makes nanolasers shine together

Liqin Tang & Zhigang Chen

Ultrathin semiconductor materials that mimic twisted layers of atoms have been used to build synchronized arrays of nanometre-scale lasers. The systems can be configured — and easily reconfigured — to form intricate patterns. **See p.282**

It might seem straightforward to make a bright light source by combining multiple lasers but, in reality, it is tremendously complex. This is because ordinary lasers emit light with several modes — the standing waves that form inside a laser and determine the beam's frequency. These modes can interfere with each other, causing the light to lose the 'coherence' associated with laser emission and making the light's intensity fluctuate. Forcing one laser to operate in a single mode is not easy, and it is even harder for a whole array of lasers. On page 282, Luan *et al.*[1] demonstrate a way of overcoming this challenge by using the remarkable properties of systems known as moiré lattices. The authors' innovative approach enables laser nanoarrays to be synchronized in any pattern, which can be reconfigured on demand.

Moiré lattices are typically formed by stacking two or more layers of materials of single-atom thickness, and then twisting the layers relative to each other. The way in which electrons interact between the layers in this twisted configuration can fundamentally alter the materials' properties and give rise to intriguing new phenomena[2]. Consequently, these materials have opened an arena for exploring quantum phenomena, and for engineering the interactions between light and matter for applications in optoelectronics and photonics[3].

Central to the strong interactions between electrons in moiré materials are their 'flat bands', a name that conveys the fact that the energy of the electrons is constant — or flat — with respect to their momentum[4]. This in turn means that the electrons can be well localized at specific positions in the lattice, which allows them to interact more strongly than they would otherwise. Condensed-matter physicists have long been intrigued by moiré flat bands, because the strong interactions can be used to investigate exotic states of matter. However, these concepts have also had an impact on photonics[5].

The photonic analogue of a moiré material is made up of optical nanostructures that are designed to manipulate light in a way that is reminiscent of an atomic lattice's effect on its electrons. Photonic moiré flat bands give rise to localized states that can help the laser to maintain coherence, a synchronization of the electromagnetic waves' phase (the fraction of the waveform completed at a given point in time).

Luan *et al.* built a photonic moiré system consisting of one thin layer of the semiconductor material indium gallium arsenide phosphide (InGaAsP), which the authors engineered to mimic the pattern of a widely used moiré material called twisted bilayer graphene (Fig. 1). Members of the same research group had previously shown that such a structure could function as a nanolaser when pumped (excited) optically with an external laser[6,7]. Luan *et al.* have now shown that it is possible to build synchronized arrays of such nanolasers to shine together, and that these high-performance arrays can be easily reconfigured and scaled up in size.

The nature of the flat bands in Luan and colleagues' photonic moiré system is such that any combination of flat-band modes is also a localized mode of the superlattice that

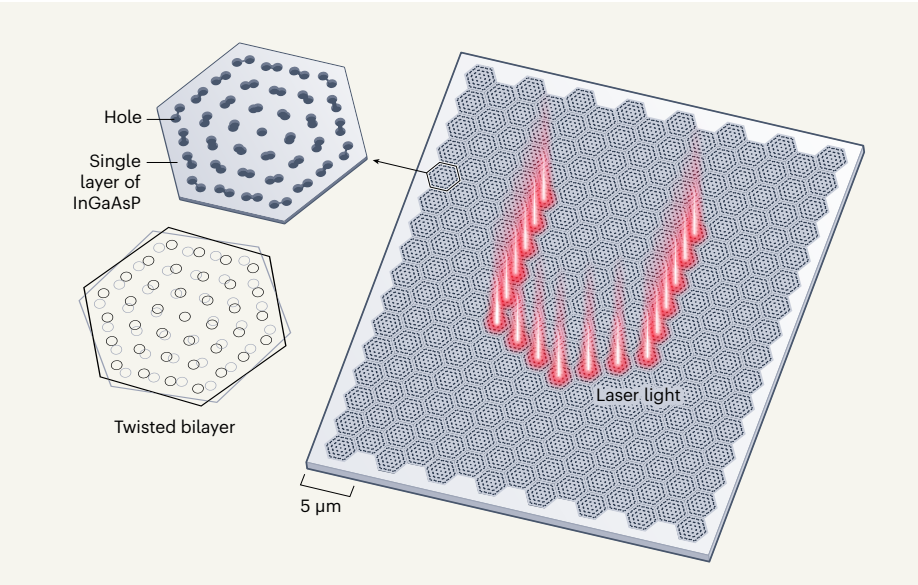

Figure 1 | A reconfigurable nanolaser array. Photonic moiré systems are optical nanostructures that are designed to control light. Luan *et al.*[1] built such a system, which they intended to mimic the structure of an atomic moiré material known as twisted bilayer graphene (shown schematically here as twisted hexagonal lattices). The authors' system comprises a single layer of indium gallium arsenide phosphide (InGaAsP), patterned with holes, and can function as a nanolaser. The authors showed that they could fabricate synchronized arrays of such nanolasers, and that the nanolasers could be configured to form intricate patterns, such as letters of the Roman and Chinese (not shown) alphabets. (Adapted from Fig. S10 of ref. 1.)

Correction

The figure in the News & Views article entitled 'MYC protein helps cancer to take its vitamins' erroneously showed CoA directly downstream from pyruvate in the cytosol, rather than facilitating entry of pyruvate into the Krebs cycle in the mitochondria. In the case of high MYC levels, pathways after vitamin B5 should have been indicated as being high activity by using red rather than black arrows.

Corrected 20 December 2023