Regarding the evolving ties between academia and industry, a reader comments, "By taking the 'technology transfer' business away from the faculty, universities are...sending out the wrong signal to their faculties—that the marketing of their research is an academic mission." The haemodynamics of the crocodilian heart as it pertains to the analysis of the recently found fossilized dinosaur heart and to what dinosaur metabolic rates might have been is discussed. And in response to the Pathways of Discovery "Infectious history" essay by Joshua Lederberg, the contributions of plant scientists to the germ theory of disease are outlined, and clarification is offered of the current leading causes of hepatitis C infection.

Academia and Industry Need A New Marriage Contract

In his Editorial "Science and secrecy" (*Science*'s Compass, 4 Aug., p. 724), Donald Kennedy convincingly discusses the importance of scientific disclosure and some reasons why academic science is on a collision course over secrecy with national security values and the industrial sectors. There is, however, a dimension to the cross-links between academia and the industrial sectors that Kennedy does not discuss that deserves mention.

Traditionally, connections between industry and academia have been through individual faculty members who had mutual scientific interests with their industry counterparts. Collaborations would be arranged, and it was proper for faculty and the university administration to define what arrangements were consistent with the values of the university (*1*).

In recent years, however, research universities themselves have been developing direct relationships with industry. Positions with impressive titles such as "counsel for industry relations" or "associate dean for industry relations" have appeared on many campuses. These new functionaries are expected to foster ties with industry for many different academic fields, and to a large extent they are succeeding, except for a worrisome aspect. If faculty are placed under the umbrella of university-industry agreements, the interests of the faculty become displaced. By taking the "technology transfer" business away from the faculty, universities are not only becoming overly commercial, but they are sending out the wrong signal to their faculties—that the marketing of their research is an academic mission.

It was fine when universities were content to use patent, conflict-of-interest, and antisecrecy rules to maintain their balance on the slippery slope of faculty-industry collaborations. But not any more. As Kennedy implies, the wedding between industry and academia isn't new, but it is time that the marriage contract be updated.

Spyros Andreopoulos
Stanford University Medical Center, 300 Pasteur Drive, Stanford, CA 94305-5119, USA. E-mail: masga@stanford.edu

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At the Crocodilian Heart of the Matter

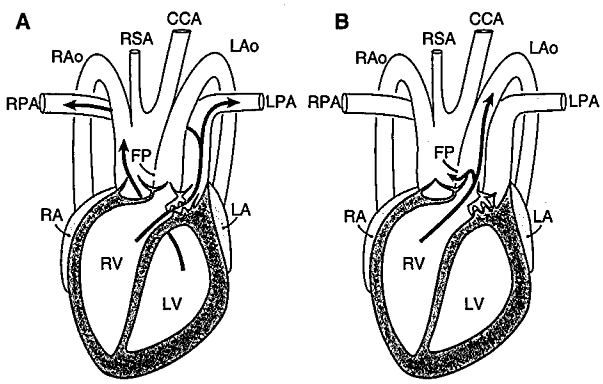
The interpretation of the haemodynamics of the crocodilian heart by Fisher *et al.* in their report "Cardiovascular evidence for an intermediate or higher metabolic rate in an ornithischian dinosaur" (21 Apr., p. 503) is flawed and hence casts doubt on their conclusion that dinosaurs had "intermediate-to-high" metabolic rates.

Crocodilians have a four-chambered heart (two atria and two ventricles with a complete intraventricular septum) that completely separates oxygenated from deoxygenated blood, except during right-to-left shunts when blood in the right ventricle exits via the left aorta instead of the pulmonary outflow tract. Fisher *et al.* say that the foramen of Panizza, an aperture between the left and right aortic arches (FP in the figure), is responsible for the mixing of oxygenated and deoxygenated blood (that is, mixing of blood from the left and right ventricles), and that it is the opening through which blood flows during shunting in crocodilians. However, this is incorrect.

During nonshunting situations (panel A in the figure), blood is ejected from the right ventricle (RV) into the pulmonary arteries (RPA and LPA), and blood in the left ventricle (LV) is pumped into the right aorta (RAo), right subclavian artery (RSA), and common carotid artery (CCA), providing no possibility for the mixing of deoxygenated and oxygenated blood (*1*). During these conditions, blood flow in the left aorta (LAo) is due to blood flowing through the foramen of Panizza from the right to left aorta during diastole and blood reaching the left aorta via the aortic anastomosis (*2*).

A right-to-left shunt (pulmonary to systemic) (panel B of the figure) can occur when the right ventricular pressure exceeds left aortic pressure and blood is diverted away from the pulmonary outflow tract and into the left aorta (*2*). This situation occurs, for example, when the cogteeth valves close (*3*), which appears to happen when adrenaline levels are low (that is, when the animal is resting). The converse, however, a left-to-right shunt (systemic to pulmonary), is not possible in crocodilians, contrary to what Fisher *et al.* imply. Hence, because crocodilians can achieve complete separation of oxygenated and deoxygenated blood and are bradymetabolic (metabolically sluggish), the suggestion by Fisher *et al.* that improved systemic oxygenation might be an adaptation for higher metabolic rates needs further consideration.

There is no doubt that the fossil that Fisher *et al.* describe is an exciting find, but the four-chambered heart seems to point to an ancestral archosaurian condition shared by crocodilians and dinosaurs, and, hence, birds (*4*).



The crocodilian heart and blood flow patterns during (A) nonshunting and (B) shunting conditions. Atria: RA and LA.

Craig Franklin
Frank Seebacher
Gordon C. Grigg
Department of Zoology and Entomology, The University of Queensland, Brisbane, Queensland 4072, Australia. E-mail: cfranklin@zen.uq.edu.au

Michael Axelsson
Department of Zoology, Goteborg University, SE 405 30 Goteborg, Sweden

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