Supervisor-Student Relations: Examining the Spectrum of Conflicts of Interest in Bioscience Laboratories

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Abstract (98 words)
Much attention has been given to *financial* conflicts of interest (COI) in bioscience research. Yet to date, surprisingly little attention has focused on other COIs that arise in supervisor-student relations. We examine a spectrum of related situations, ranging from standard graduate supervision through to dual relationships sometimes found in research with commercial potential. We illustrate some of the less-obvious factors that can bias supervisory judgment, and situate financial COI along a spectrum of forces that are deserving of recognition. We conclude by providing two sets of recommendations: one for individual supervisors, and the other for institutions and policy-makers.

Keywords: conflict of interest, university, bioscience, laboratory, professors, students

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Introduction

In the biomedical sciences, close interactions between academic and commercial entities are commonplace. Funds from pharmaceutical and biotechnology companies

have helped finance major bioscience projects and research centres, graduate students are receiving training in commercial laboratories, and university scientists are translating their intellectual property by patenting and licensing their research or launching start-up companies. Such interactions have received the blessing of universities and local and national governments (Bok 2003; Benner and Sandstrom 2000). But concerns have also been raised about the ethical challenges posed by university-industry relations, especially with regards to academic liberty and conflict of interest (COI) in the context of dual loyalties (e.g., researcher's duties towards their departments and industry partners) (Lewis et al. 2001; Triggle 2004).

In university contexts, COIs are often seen as being primarily an issue for biomedical researchers. Particular attention has been given to the influence that receiving consultation or patient-recruitment fees, or having shares in biotechnology or pharmaceutical companies supporting clinical trials, can have on medical judgment, patient safety in biomedical research, and the function of medical schools (Cohen 2002; Schafer 2004). Concern extends more generally to the publication of scientific research in peer-reviewed journals, and the need for transparency and declaration of competing interests on the part of researchers and institutions (Krimsky et al. 1999; Stein 2004; ICMJE 2007). Much less well studied, however, is the relationship between university professors or faculty-level researchers – specifically laboratory directors working in the biosciences – and their students, or the particular case wherein the researcher is also a director or head of a start-up company and the student is also their employee. In both situations, there is arguably a "dual relationship" that can lead to important conflicts (Sugarman 2005); unfortunately, university regulations (including COI policies) are rarely equipped to deal with this particular issue (Cho et al. 2000; Doutriaux, Padmore, and Schuetze 2003).

In this paper we examine a spectrum of related situations, ranging from standard, relatively uncomplicated graduate supervision, through to the dual relationships sometimes found in research with clear commercial potential. We argue that ethical challenges across this spectrum include not just conflicts of interest, but also conflicts of obligation. Further, we argue that the particularly challenging conflicts that occur with regard to commercial ventures – and about which so much concern has been expressed in the literature (Campbell et al. 2007; Bouchard and Lemmens 2008; Parks and Disis 2004) – are best understood as part of the larger spectrum of challenges that inevitably arise when complex organizational structures are devised to meet complex human interests and needs.

In order to give readers unfamiliar with laboratory environments a better sense of the context we are discussing, we will first sketch the characteristics typical of a university-based research laboratory.

The Laboratory Environment

Academic bioscience laboratories are team-based research and teaching environments, based in fundamental or applied science departments such as biology, biochemistry or medical genetics. A small lab may have 5-10 members, while a big lab could have 12 or

more (some as big as 70 members). Labs are hierarchical in organization and are directed by a faculty member (the lab director) who funds the research activities out of research grants. The director supervises research associates (in the bigger labs), post-doctoral fellows ("post-docs"), technicians and graduate students. Post-docs manage their own projects and may occasionally (more commonly in the United States) have an undergraduate student or a technician working with them. Research assistants and/or technicians will work directly under the director or under a research associate. Graduate students will often have undergraduate students to supervise.

In North America, funding for university bioscience research is obtained primarily through peer-reviewed grants from government science councils (e.g., the US National Institutes of Health and National Science Foundation, or the Canadian Institutes of Health Research). Operating funds can also be derived from charitable foundations and industry sources. These resources are used primarily to purchase research equipment and pay salaries. The employees in a lab include technicians, research assistants (graduate students or individuals with graduate degrees), post-docs and research associates. Unless otherwise supported by external scholarships, students and post-doctoral fellows are paid salaries from their lab director's operating funds to conduct research while working to obtain their degrees, i.e., they are quasi-employees but usually without contracts or employment benefits. Graduate students may also be involved in a diversity of more formal employment relations. They may do other work within the university, perhaps as a Teaching Assistant or Exam Invigilator, Alternatively, they may work as contractors or consultants for industry-sponsored research projects, or even as part/full-time employees in spin-off companies. Students sometimes also conduct the research component of their graduate studies within industry laboratories with which their supervisors have ties, whether or not they are also employees of the company.

The members of a lab work to further the director's particular research agenda; the work they do will also contribute to their individual graduate theses (which may constitute focused sub-projects, part of the larger research program), academic presentations and publications. Students work closely with their senior colleagues to learn the practical and theoretical skills necessary to conduct experimental research. In bigger labs, students often will interact more frequently with a senior student or post-doctoral fellow than they will with their lab director, who is their official departmental supervisor and responsible for their academic progression; in smaller labs, the students are more often directly supervised by the lab director.

Laboratories rely on close working relationships: parts of or the whole team will be actively involved in developing and testing ideas, running experiments, and contributing to the production of research results in the form of posters or presentations at national or international meetings, and peer-reviewed publications. In many fields of bioscience, research and publication are highly competitive; a number of labs may be working on the same research question and racing to be the first to present or publish a scientific discovery. Thus the training and retention of capable graduate students and research

staff, as well as the protection of research confidentiality (until publication), will be important issues for a lab director.

Academic bioscience laboratories sometimes make discoveries or develop technologies that have potential commercial value. Patents may be sought in order to license the product to biotechnology or pharmaceutical companies for further development and commercialization, or to be licensed to other laboratories in the case of scientific research tools. On occasion, a discovery or technology may be sufficiently promising that the director considers starting a spin-off company to commercialize the discovery. This decision is not taken lightly or alone; it necessarily involves extensive discussions between the lab director and the university technology transfer office (including lawyers and patent officers), to evaluate the patentability of the discovery, the value of the intellectual property, and the availability of venture capital, among other factors.

Of course, not all academics will have the requisite management skills or entrepreneurial ability to develop and grow a successful spin-off company and become 'merchant scientists.' Most will continue to pursue their basic or applied research in the university environment (Atkinson-Grosjean 2006). In other words, despite the political rhetoric about universities becoming entrepreneurial institutions, many bioscientists still have little interest in commercialization or the development of spin-off companies. That being said, they (and their graduate students) may be supported by and work with industry partners, conduct contract research or consult for companies.

The subset of researchers interested in setting up a spin-off company may be attracted by the opportunity for personal gain in terms of academic prestige and financial rewards, as well as by closer ties with other private companies that may eventually help fund other aspects of the lab director's research program. A spin-off company may also be seen as a means of making practical contributions to the advancement of science and the development of new and useful products (especially diagnostic tests and medicines) that will benefit patients and society at large (Shane 2004). Spin-offs from academic laboratories will often be located at private research labs, which may share space and facilities with the academic lab; alternatively they may be physically separated and housed nearby or at an off-campus university science park.

Life in a spin-off company imposes demands on the time and freedom of university-based researchers. A university researcher entering that world will have to consider managerial issues, such as which employees to hire (including not just research staff but also clerical and administrative staff) and how to separate their university research activities from those of the company. (Some universities have explicit policies to guide such activities (Cho et al. 2000)). In addition, such researchers will often have to become accustomed to spending long hours seeking out venture capital to support their commercial research, and planning the production and protection of the company's intellectual property. The researcher/director of a new spin-off will have to closely evaluate their capacity and willingness to take on the full responsibilities of leading the company. As companies, grow, some researchers will choose – often under pressure from investors or the company's board of directors – to hire a manager experienced with

biotech spin-offs to take over as the Chief Executive Officer (CEO); the researcher then in turn may become the Chief Scientific Officer (CSO) and focus on charting the scientific direction or priorities for the company, a role more closely fitting their academic training and expertise (Jousma and Scholten 2007). This can be a difficult decision for the researcher to make, because it involves handing over a significant degree of control of the scientific project to non-scientific experts. At this point, the researcher may shift their focus back to the university environment (while maintaining links with the company and, for example, conducting contract research), or leave the company altogether (although they may retain stocks or stock options in the company).

Having sketched the environment of university and commercial labs, we can now begin our exploration of some of the central ethical challenges raised in graduate student supervision in the biosciences.

Three Kinds of Supervisory Relationships

Supervisory relationships come in many shapes, and vary significantly in their form and complexity. We next sketch three very rough categories of supervisory relationships, pointing out the kinds of conflicting obligations and potential COIs that may be found in each. Our aim is to illustrate the range of conflicts that can occur along this spectrum of supervisory relationships.

1. Graduate supervision

The simplest relevant relationship, namely the straightforward supervision of a graduate student by a university professor, is uncomplicated by any commercial interests or relationships. Yet it is important to note that even such straightforward supervisory relationships involve inherent COIs. Supervision requires the exercise of judgment on the part of the supervisor. University and Departmental regulations notwithstanding, supervisors must normally exercise judgment in deciding the type and quantity of work to assign to students, in devising grading schemes, in evaluating student work, and in writing letters of recommendation. Supervisors must also exercise judgment regarding the type and quantity of supervisory activity: the number of hours of contact time granted to a supervisee is a crucial variable. Since students are typically unable (partly because they are unqualified) to judge in a precise way the quality of supervision, supervisory judgment is typically exercised with considerable leeway. This suggests that the supervisory relationship is, at heart, a fiduciary – that is, trust-based – relationship (Sugarman 2005).

Further, supervisors always have other obligations and interests that stand in tension with the demands of supervision. To begin with, university professors typically have a range of professional obligations other than graduate supervision. These obligations include teaching courses, engaging in scholarly research, and serving on university committees. Professors may also have obligations rooted in roles they play beyond the walls of the university: obligations to family, and to their religious or cultural communities, and obligations of citizenship. In addition to competing *obligations*, they also naturally have a range of *interests* that may conflict with supervisory obligations. For example, professors typically have a natural (and reasonable) interest in leisure and

hobbies, in career advancement, in making a substantive contribution to their fields, and in having their students succeed in ways that reflect well on them as supervisors.

We see already, then, in simple supervisory relationships, the ingredients of a classic COI. A COI is any situation in which an individual is in a role requiring them to exercise judgment in the service of some other individual or institution, and in which they have some interest that stands to make it harder for them to exercise that judgment objectively. Professors, in their role as graduate supervisors, are expected to exercise judgment in the educating and mentoring of graduate students; *any* interest they may have in anything other than the student's education and training puts the supervisor in a conflict of interest. Of course, many such conflicts are unavoidable, since every professor has multiple interests. All we can expect of professors in supervisory roles is that they do their best to recognize factors that may bias their judgment, and do what they can to minimize their effect.

It is worth noting just how hard it is to distinguish cleanly – within the class of things that might bias a graduate supervisor's judgment – between a professor's obligations on the one hand, and their interests on the other. For example, a professor's *interest* in career advancement may inspire him or her to do more than the minimum expected, in terms of the obligation (often written into academic contracts) to engage in scholarly research. And the question of whether to call the act of attending to the needs of one's family a matter of 'obligation' or a matter of 'interest' is a complicated one: some at least will define one's 'interests' broadly enough to include the interests of those one cares about, and to whom one also doubtless has obligations. Thus even the simplest of supervisory relationships raise questions of conflict, though hopefully not insurmountable ones.

2. Supervision plus employment of graduate students

We move now to a second, somewhat more complicated scenario, namely one in which a professor supervises a graduate student, while at the same time employing that student as a research assistant in their lab or as a teaching assistant for their courses. Supervisory relationships of this kind retain the complexity manifested by the 'simpler' relationships described in the previous paragraphs. But they also bring additional worries, because such relationships are in fact subject to two different normative regimes, namely one set designed to govern supervisory relationships, and a separate set designed to govern employment relationships.

Following Davis (Davis 1999) we take the norms governing supervisory relationships to be, like the norms governing relations with students more generally, a combination of two sets of norms governing university professors. One is the set of institutional norms governing 'the academy,' which is in essence the name given to the shared enterprise engaged in by professors, students and university administrators. The other is the set of norms constituting the professional ethics of the professoriate. (A full explanation of the overlap and differences between those two sets of norms is beyond the scope of this paper.)

The relationship between supervisors and graduate students is best characterized as a fiduciary relationship: imbalances of knowledge and power mean that the student must trust that the supervisor will conscientiously provide reasonably high-quality education and mentoring. Though the professor's student (unlike, perhaps, the physician's patient) is not best thought of as helpless, the inability of the student to assess anything more than the most superficial aspects of the professor's performance of their supervisory duties means that professors must be trusted. In particular, we need to be able to trust that students won't be exploited for their supervisor's gain. Hence, professors must (and generally do) understand themselves to be obligated to be more diligent in tending to the interests of their supervisees than would be the case if their relationship with supervisees were a simple contractual relationship between consenting individuals.

The *objectives* of graduate supervision – the ends towards which the norms governing such relationships provide guidance – are relatively clear. The most obvious goal is to help the student acquire the knowledge and independent research skills suitable to their academic discipline. In the biosciences, supervision also typically involves mentoring aimed at helping prepare the student for the transition into the workplace: depending on the student's goals, this may involve learning a combination of hands-on laboratory procedures and conceptual research skills, as well as professional skills related to disseminating research results through conference presentations and scholarly publications.

All of this, of course, is constrained by the norms of both science and academia. Academic norms require that students be evaluated fairly and objectively. Both scientific and academic norms support the idea that what the supervisor is helping the student to learn is how best to pursue knowledge as an independent scholar. Supervisory ethics, therefore, requires that the supervisor seek what is in the student's best (academic) interests, subject to the limits posed by standards of academic quality and scientific integrity. It is also worth noting that the norms governing supervision of graduate students are largely unwritten and effectively unenforced. University and departmental guidelines may provide a certain amount of guidance, and some students might indeed look up to them for some indication of what their supervisors' obligations are. But the guidance provided by such documents is likely to be very loose, and a supervisor could easily follow their letter without adhering to their spirit.

In this second category of supervisory relationships (i.e., dual supervisory-employment relationships), another set of norms is relevant, namely the set of norms governing employment. The norms governing relations between employers (or managers) and employees are quite different, even within university settings, from those governing the supervision of students. Employment relations are fundamentally contractual: the employee exchanges labour (i.e., the application of physical and/or mental effort to the employer's projects) in return for some form of remuneration (primarily consisting of a wage or salary). Thus the primary obligation of an employer is to live up to both the letter and the spirit of the employment contract, in pursuit of the production of some external good (some product, service, or in this case scientific discovery). The norms governing employment can easily conflict with the norms governing supervision. The

conditions under which a relationship may be terminated provide a good example. A supervisor should, other things being equal, retain a student as supervisee until that student's degree or project is finished[1]; an employer is obligated only to retain an employee until the employment contract runs out, or in the absence of a contract, until the employee's services no longer serve the employer's needs.

We thus see potential for both conflict of interest and conflict of obligations, with the additional complexity of two competing sets of regulatory norms. In a complex relationship, a single individual, acting as both employer and supervisor, can have two or more divergent obligations at the same moment.

3. Supervisory-employment relationships and commercial research

We move now to discuss the third type of relationship within our proposed spectrum, namely dual supervisory-employment relationships that take place specifically within university research labs doing work with clear commercial potential.

Such settings are subject to all of the worries associated with the previous two categories, but are in addition subject to a further set of worries, including worries closely linked to those that have spurred criticisms of university-industry relationships. Such worries spring, of course, from concerns about the influence of the profit motive. The key worry is that the possibility that research might turn profitable puts professors, who are in supervisory roles over students working in their research labs, in a serious COI. For example, it is possible that the profit motive could affect a professor's supervisory advice. Although we know of no solid empirical evidence, the 'folk hypothesis' is that money is a particularly potent source of bias.[2] In particular, the worry is that a professor with commercial interests might give biased advice on choice of thesis topic: a student might be pushed towards a topic that will contribute to valuable, patentable discoveries (for which the professor is more likely than the student to get credit) rather than a topic that will result in publishable findings that will advance the student's career. Similarly, advice on the timing of graduation might be influenced by their interest in having the student contribute to potentially-profitable research.

It is worth noting that this category – "university labs doing work with commercial potential" – is somewhat amorphous: it may be hard to recognize, from the outside, labs that are doing work with commercial potential. But most if not all biomedical laboratories conduct work that has, at least, commercial potential of some sort, even if their work is not likely to result in the development of a blockbuster pharmaceutical. And to a certain extent, what matters in terms of the issues discussed here is not whether the research being done *has* commercial potential, but whether the professor supervising the lab *believes* that the research has commercial potential. This difficulty in identifying, from the outside, labs that fit this category need not stop us from analysing the relevant

[1] In some institutions, the supervisor may even have an obligation to see a student through to completion, or abandonment of the degree; in contrast, a student is usually free to change supervisors at their discretion.

[2] In fact, there is some empirical evidence to the contrary. See, for example (Moore et al. 2003)

problems. It may pose a serious challenge, however, in implementing institutional remedies.

Table 1: Sources of conflict across the spectrum of supervisory relationships

		Type of Relationship		
		Supervision	Supervision plus Employment	Supervision plus Employment in Commercial Context
Type of Conflict	Conflict of Interest	✓	✓	✓
	Conflict of Obligations	✓	✓	✓
	Conflict of Normative Frameworks		✓	✓
	Significant Financial Conflict			✓

3.1 CEO (supervisor?) and employee (student?) relations in the spin-off

A particularly challenging case in our third category of relationships is the dual relationships that obtain when a professor becomes head or CSO of a fully commercial research lab at a spin-off company, and one or more graduate students takes on a second role as an employee at that company. It is difficult to locate reliable statistics on how common such dual relationships are, but they do occur. Such situations involve all of the tensions and risks of the three categories outlined above: conflicts of interest (will the professor in such a situation give unbiased advice to her supervisees?), conflicts of obligation (will the professor/entrepreneur prioritize obligations to students, or obligations to family?), conflicting normative regimes (will student-employees be treated as students, or as employees?), and the potentially COI-exacerbating effect of the profit motive. But there is at least one additional set of worries, namely those that spring from the fact that managers in private industry are generally regarded as having fiduciary obligations to owners, investors, and shareholders – fiduciary obligations that stand in tension with the fiduciary obligations that professors owe to their students.

In the private sector, the organization (i.e., a firm) that results from various employment contracts is typically one that is fundamentally hierarchical, and best characterized by the ethico-legal concept of *agency*. In an agency relationship, the agent (here, the employee) is engaged to perform a task that the principal (here, the employer) lacks either the time or the skill to perform. In an agency relationship, the primary obligation of the agent (i.e., employee) is to diligently pursue the legitimate interests of the principal.

Of course, in all but the smallest firms (e.g., start-up biotech companies that may initially consist of only a handful of employees), the agency relationship is actually multi-layered (Buchanan 1996): rather than being an agent of the employer, the employee is best seen as an agent of his or her immediate superior, or manager, and the manager is typically an agent in turn for someone at the next step up the organizational hierarchy. With the exception of very small companies (where the manager may also be the owner), managers typically manage on behalf of someone else, whether it be an owner, a small group of investors, or a diverse set of shareholders.

Thus while the employee is in an agency relationship with the manager and hence owes certain obligations of loyalty, the manager is also typically – and importantly – in an agency relationship with the owners of the company, and so is obligated to pursue the owners' legitimate interests. This obligation to the company's owners does imply something about how employees are treated: the owners have obligations to treat employees fairly, and that obligation must be carried out by managers as the owners agents. But the fact that managers act as agents for owners also implies a *limit* on the obligations owed by managers to employees. So, for example, a manager's obligation to train and mentor an employee are strictly limited to the forms of training and mentoring that are conducive to (and cost-effective in pursuing) the interests of the company. And in carrying out wage negotiations on behalf of owners, managers – while bound by basic rules of honesty and the injunction to bargain in good faith – are generally obligated to pursue the interests of the company's owners, rather than the interests of employees.

It is clear, then, that employment relationships in business firms are governed by norms quite different from those that govern university supervisor-student relationships. The fact that people in managerial positions may be subject to a range of different role-related norms (including potentially conflicting fiduciary obligations) is a central problem of management ethics (Buchanan 1996), and many organizations devote considerable energies to establishing policies and informal norms to guide managers through such conflicts. But the conflict becomes perhaps even more critical when a single individual (e.g., the academic entrepreneur) is subject to two different sets of normative constraints with regard to their relationship with a single stakeholder. To summarise, the academic entrepreneur is subject to two different normative regimes: one that requires faithful attention to the educational needs of the student, and one that requires faithful attention to the needs of the owners of the business and that may put significant limits on their ability to do things that benefit employees. When the student and the employee are one person, the conflict is obvious.

Discussion

The distinction between supervisory relationships and employment relationships is not crisp: after all, many students (across the range of academic disciplines) are paid to work as evaluators in the grading of student assignments (i.e., as teaching assistants), or as lab assistants, research assistants, and so on. But the situation of such student-employees differs in a number of significant ways from the situation of employees in the private sector. Indeed, the differences are more instructive than the similarities. To begin with, in standard employment relationships, the level of remuneration is driven by the market: rare and useful skills are handsomely rewarded, while common and less-useful skills are often paid at a rate at or near the legislated minimum. In academic settings, on the other hand, many student jobs are seen as (among other things) forms of student funding, and the rate of remuneration may in some instances be set implausibly high relative to the value of the work performed; this is particularly the case

in the humanities and social sciences (especially when there are also collective agreements for teaching and research assistants).[3]

It is worth looking at the complex situation we are describing from the student-employee's point of view. As we mentioned above, in academic bioscience laboratories, when students do not have their own funding from scholarships, they are invariably paid a salary from the lab director's operating funds. Laboratory research cultures vary significantly, but in general students are expected to spend a minimum of 40 hours per week physically in the lab at their bench conducting experiments; many lab directors will require 70 hours per week or more. Since the director controls the salaries (although granting agencies or departments often set minimum levels of support), they can provide or at least promise bonuses or raises to students. Even a very small hourly raise or a top-up to a scholarship can be used to entice students to finish a project faster, work longer hours (including nights and weekends), and so on. But as students, they lack the benefits that usually come with employment in a company (e.g., vacation time, medical benefits). On the other hand, unlike most regular employees, students may benefit from the prestige of being first (or co-) author on articles, may get funded to travel to and present at national and international conferences, and are often paid to conduct research for which they will receive academic degrees.

The essence of the problem is that the researcher's interests, as manifested in an employment relation with the student (whether this is as lab director or as the head of a spin-off company), may impinge upon their ability to supervise and serve as a mentor for the student in a way that is in the student's best interest. The notion of COI looks quite different in light of these two sets of norms (i.e., the norms surrounding supervision, on one hand, and employment, on the other). In a context that brings these two sets of norms together, COI is a significant threat. In a straight employment relationship with its contractual obligations, the (partial) conflict between the interests of employers and employees is so blatant that it often is not even *called* COI.

It is worth enumerating some of ways in which the range of influences on supervisors' judgment can manifest themselves. Biasing influences on the supervisor-student relationship might show up as:

- Reduced quality and quantity of student advising;
- Biased thesis advice (e.g., regarding whether to continue the project or stop and join the company);
- Biased advice regarding timing of student-led publication (e.g., delaying submission for publication in order to protect commercially valuable discoveries[4]);

[3] Levels of remuneration for student work vary enormously across universities and disciplines. But for at least some work – such as grading multiple-choice tests, or photocopying – students are almost always paid significantly more than the wage (probably near the legal minimum wage) that such work would demand outside of a university.

[4] Students are often involved in the patenting process, including making patentable discoveries. Some universities in Canada have provisions in their thesis submission guidelines that allow for a student to delay (e.g., by one year) the publication of their thesis in the national library system, in order to protect potential IP or important, publishable information that might be stolen by a competitor.

- Moves to delay graduation to keep talent around (rumoured to be common in academic labs);
- Biased advice on choice of research topics (commercial vs. interest-driven);
- Biased career advice (e.g., whether to pursue a post-doctoral position and an academic career path, or to join the company).

With regard to each of these issues, supervisors face a conflict of interest: their interests as academic lab directors, and as researchers with commercial partners, threaten to influence the advice they give to their supervisees. This is not to say, however, that all supervisors, or those who become company directors and who employ their students in biotech start-ups, necessarily create or encounter unmanageable COIs. Our point is that the supervisor-student relationship in bioscience labs is inherently complex, a mix of often conflicting responsibilities and loyalties which is further exacerbated when the supervisor becomes a 'merchant scientist' and the student an employee of the company.

It is worth emphasizing that the simple fact of being in a COI does not imply that one has done something unethical – the issue is how to handle the situation. (MacDonald, McDonald, and Norman 2002; Davis and Stark 2001). The standard advice is roughly to 1) avoid COIs when possible; 2) disclose the interest to all concerned; and 3) remove oneself from sensitive decisions where feasible. Sometimes 1 and 3 are impossible so 2 (transparency) becomes crucial. But this standard advice may be insufficient. Some guidance can come from ethics (including COI) policies and guidelines, but these vary enormously between universities, are sometimes poorly written and poorly disseminated (Smith and Williams-Jones in press; Williams-Jones and MacDonald 2008) and often do not specifically address supervisor-student relations (Cho et al. 2000).

Recommendations

In this paper, we have attempted to illustrate the wide range of influences that can impinge upon the appropriate exercise of supervisory judgment in graduate educational settings, and in particular in bioscience laboratories. Our goals here have been twofold. On one hand, we have sought to shine a light on some of the less-obvious (or less-frequently-acknowledged) factors that stand to bias supervisory judgment. On the other hand, in so doing, we have sought to situate *financial* conflicts of interest along a spectrum of forces – some relatively benign, some malignant; some avoidable, some unavoidable – all of which are deserving of recognition and analysis. Though our main goal here has been descriptive and analytic, we see our analysis as pointing to two rough sets of recommendations: one aimed at individual supervisors, and the other aimed at institutions and institutional policy-makers.

Advice for Individual Supervisors

There are limits to how much can be accomplished by focusing on individual behaviour, motives, and integrity. As argued at length by Norman and MacDonald (2009), it is becoming increasingly clear that conflict of interest (and the related problems discussed above) is best thought of as a specifically institutional problem: we generally worry about COI not (merely) because it affects individuals (e.g., students) but because it

jeopardizes the mission of entire institutions – be they professions, corporations, charities or universities – and jeopardizes the public's faith in them. Thinking even more broadly, COI in bioscience labs can undermine science itself by jeopardizing the mentoring relationships upon which science depends (Shamoo and Resnik 2009). Such being the case, situations in which individual supervisory judgment seems liable to be biased by inappropriate forces are not best dealt with through appeals to individuals to behave appropriately. The reputations of institutions can be damaged by COI, or the appearance of COI, "even when the individual at the centre of the perceived conflict is in fact of unflinching integrity" and has acted entirely appropriately (MacDonald, McDonald, and Norman 2002, 73). Nonetheless, the behaviour of individual supervisors does have a very direct effect on the lives of supervisees, so a few words of advice are appropriate. We offer the following four suggestions:

1. Supervisors should recognize and guard against the full range of factors that might bias the teaching, advising, and mentoring of their students. The fact that institutional policies may focus on financial conflicts of interest does not excuse turning a blind eye to other, perhaps equally biasing, factors.
2. Supervisors should go beyond a vague commitment to "guard against" COI. As educators, they know that "trying harder" is a poor plan. That is true whether it be a student's aspiration to "try harder next term" or a supervisor's intention to keep her professional judgment free of bias. We recommend instead an explicit, written self-audit.
3. Supervisors should educate themselves about what the "standard" biasing factors are (many of which are discussed above) and give careful consideration to whether, and how, their own behaviour falls prey to, or avoids, those sources of bias.
4. Supervisors should talk openly about COI with their supervisees – both in the abstract, and with regard to particular, concrete COIs. This is an important part of the mentoring process, part of helping advisees learn to recognize and deal appropriately with COI as it arises in their own careers.[5] Talking openly about COI is also a good way of reflecting the fact (noted above) that to find oneself in a COI is not in itself blameworthy: it is an ethical challenge to be understood and mitigated, and from which lessons can be learned.

Advice for Institutions

We offer the following four recommendations for institutions, *in addition to* policies already in place for the disclosing and limiting of financial COI. For some of these recommendations, whether it is best implemented by individual labs, departments, or entire universities will depend on various organizational factors, including size, interdisciplinarity, and so on.

1. Institutions should develop clear guidelines (where these are not already present) regarding such things as appropriate workload and remuneration for graduate

[5] On the importance of ethics training more generally for bioscience students and faculty, see Eisen and Berry, 2002.

students and post-docs working in bioscience labs and appropriate time-to-completion for graduate degrees.

2. Institutions should foster open discussion both of the requirements of good mentoring, and the dangers and varieties of COI. The National Academy of Sciences suggests, for example, that institutions "[s]ponsor more discussions of topics relevant to mentoring, such as professional standards [and] ethical values…." (National Academy of Sciences 1997, 67)
3. Institutions should foster a process of self-evaluation or self-audit on the part of professors involved in graduate supervision, regarding the full range of factors known to be liable to corrupt supervisory judgment. What ever their particular format, the goal of such exercises should be explicitly and emphatically to assist supervisors in self-monitoring, rather than to facilitate greater external scrutiny.
4. Technology transfer offices should implement policies regarding the treatment of students whose graduate research is being done in whole or in part in commercial labs, and regarding limitations on spin-off companies recruiting students prior to the completion of their degrees. We do not have a clear vision of what such policies should look like, but we are certain that such policies, and the multi-stakeholder discussions that ought to inform them, would be useful.

It is critical to acknowledge the different and sometimes conflicting values and objectives of academia and industry, and the concomitant professional roles and responsibilities of supervisors and start-up owner-managers. It is our contention that such relations, and the associated conflicts of interest, are in need of explicit attention from researchers, students, university administrators and industry partners.

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