SECONDARY DISCOURSE IN FIRST-YEAR UNIVERSITY TEXTS:

THE ROLE AND FUNCTION OF SCIENTIFIC DEFINITIONS AND THEIR IMPLICATIONS FOR TEACHING ENGLISH FOR ACADEMIC PURPOSES

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CHAPTER 1
A MODEL OF THE LITERATURE AND SOME THEORETICAL PRELIMINARIES

1.1 Introduction

IN RECENT YEARS a number of studies devoted to introductory textbooks used in universities have appeared. Swales (1995: 2-3) provides a convenient list of these:

Studies of textbook discourse have so far been largely restricted to introductory texts in standard undergraduate fields such as physics (Kuhn 1970), genetics (Myers 1992), geology (Love 1991, 1992), and economics (Henderson & Hewings 1990; McCloskey 1985; Tadros 1985).

The present study seeks to add introductory biology textbooks (hereafter IBTs) used in Australian universities to this list. It does so for a number of reasons. Firstly, as Swales' list suggests, no major study of first year biology textbooks has yet been undertaken. Secondly, such a study would be particularly relevant to Australia where the number of students studying biology - particularly non-native speakers of English - has increased steadily in the past decade causing a corresponding need for English for Specific Purposes (ESP) assistance based on studies of textbooks. And thirdly, recent trends in genre analysis make a study of textbooks a prime site for theory building and development. The first two of these justifications are perhaps self-explanatory. To better understand the last, however, it is necessary to locate the studies mentioned by Swales above within the existing literature.

1.2 The primary literature: EAP

Studies of textbooks tend to fall under the rubric of English for Academic Purposes (EAP). Their main raison d'être is to enhance our understanding of how textbooks operate so that such understanding can be applied to pedagogy involving either native or non-native speakers of English (hereafter NS and NNS). This is reflected in the list of studies cited by Swales above.
Three of them first appeared in the journal *English for Specific Purposes* - perhaps the central contemporary forum of EAP.

We might also note Swales' comment that '[s]tudies of textbook discourse have so far been largely restricted to introductory texts in standard undergraduate fields...' (1995: 3). This is another clear indicator of their purpose: most studies have involved introductory textbooks because such textbooks are by far the most widely used in universities and, hence, the most pedagogically important. Above all, studying textbooks has to do with EAP.

1.2.1 *The central dichotomy in EAP relating to textbooks: approaches in linguistics and the sociology of knowledge*

Despite the unifying pedagogical orientation of textbook studies, there are nonetheless two competing approaches. These are discussed in detail in the following sections, but broadly speaking we might say that one approach seeks to install linguistics as its central paradigm, with sociology as a useful minor tool. The other, in contrast, does just the opposite, viewing linguistics as a tool to be used in the sociological investigation of knowledge systems. In the following sections these have been labelled the linguistic approach and the sociology of knowledge approach respectively.

1.2.2 *Distinguishing the two approaches*

The dichotomy mentioned above is in large part marked by the different publication forums of the studies cited by Swales in 1.1. On the one hand, studies having a firm foundation in analysis of what Bhatia calls 'surface linguistic features' (1993: 26) tend to be identified closely with task based NNS pedagogy and have usually appeared in *English For Specific Purposes*. Examples of this approach are Love (1991, 1993), who examines *inter alia* nominalisation and grammatical metaphor, and Myers (1992), who, although ostensibly researching the sociology of scientific knowledge, nonetheless provides lists of textbook characteristics such as pronoun
use, tense occurrence and cohesive characteristics. Other studies following this surface feature approach - such as Swales (1974), Davies (1986), McCloskey (1985) and Henderson & Hewings (1990) - have tended to appear in collections of articles whose charter is to improve understanding of rhetorical and pedagogical practices in a discipline as a whole - economics and business communication being prominent examples (cf. McCloskey 1985; Dudley-Evans & Henderson 1990; Samuels 1990; Henderson et al. 1993). These, one might argue, represent simply the NS complement to the more NNS focussed studies appearing in *English For Specific Purposes*.

No less related to EAP and a pedagogical perspective, but with a more diverse publication history, have been textbook-related studies utilising what is most often identified as a sociology of knowledge approach (e.g., Kuhn 1970, Tadros 1985, Klamer 1990). These studies tend to be more radical in their criticism of the discourse practices they discover in textbooks, and seldom provide the lists of textbook features that the linguistic approach demands in order to meet its pedagogical agenda. The insights and criticisms of the sociology of knowledge approach tend instead to target the entire epistemology of a discipline (cf. Klamer 1990: 151-152), if not the epistemology of something so large as science itself (cf. Kuhn 1970; Harré 1985). Its claims are backed much more by intuition and appeals to systemic cultural models than by reference to textual features. These textual features, in fact, are often treated with suspicion due to the perception that they are derived through application of exactly those 'scientific' processes many researchers are seeking to deconstruct (cf. Woolgar 1988).
1.2.3 The larger origins of the two approaches

From a perspective larger than studies of textbooks, it is not difficult to recognise the larger affiliations of the two approaches described above. The linguistic approach grounds itself firmly in linguistic theory and is in many ways a 'bottom up' method of analysis in which instances of discipline-specific textualisation follow from lexico-grammatical identification. Love (1991, 1993), for example, makes extensive use of systemic functional linguistics in her study of grammatical metaphor and nominalisation, as well as in her exposition of a process-product model of geology textbook organisation. As an approach, this orientation belongs to the larger field of discourse analysis and text linguistics, and usually involves frequent reference to seminal works in those fields such as Widdowson (1979), Van Dijk (1980), Halliday (1985), and Hoey (1979, 1983, 1991); as well as to highly focussed empirical studies of formal textual features (e.g., Barber 1962; Gopnik 1972; Gustafsson 1975).

In contrast, the sociology of knowledge approach tends to view linguistic analysis of text as a tool to be used only once larger issues of power and social organisation have been addressed. This view, we might say, is more 'top down'. It belongs to sociolinguistics and, more broadly, to structuralist sociology and anthropology (e.g., Levi-Strauss 1958; Greimas 1970; Geertz 1973, 1983; cf. also Nöth 1990: 374-376). In terms of the present study focussing on biology textbooks, the most important recent forebear of this approach has been the sociology of scientific knowledge (SSK) movement. The major works from this field have included studies of the genesis and evolution of scientific discourse as carried out by Kuhn (1970), Latour & Woolgar (1979), Mulkay (1979), Knorr-Cetina (1981), Gilbert & Mulkay (1984), and Woolgar (1988), which in turn have drawn heavily on obliquely related works of a structuralist bent such as Barthes (1957), Foucault (1970), Eco (1976), and Lemke (1985).

1.3 Genre analysis and Swales: the approach underpinning this study

Between the two poles of analytical orientation outlined above, a powerful pragmatic approach
to EAP has arisen in the light of John Swales' writings, particularly *Genre Analysis: English in Academic and Research Settings* (1990), which has become one of the central canons of EAP in the nineties. Bhatia, for example, acknowledges the eclectic nature of Swales' approach, as well as its influence, by saying that 'Swales offers a good fusion of linguistic and sociological factors' (1993: 16). In *English for Specific Purposes*, references to Swales' works are rife, and his monographs constitute essential reading for anyone publishing in the field. In fact, it would be difficult to deny that genre analysis is *the* central approach to textual analysis in EAP at present. Since it is this approach that I wish to adopt and extend for the purposes of this study, it is perhaps worthwhile to spend some time on an overview of its central features.

1.3.1 *An overview of Swales' genre approach to textual analysis*

Swales' approach to textual analysis and problem solving in EAP is perhaps best illustrated in the first instance through reference to one of his own examples. In a section of *Genre Analysis* devoted to three case studies, Swales (1990: 204-208; also cited with commentary in Bhatia 1993:14) relates the story of a simple modification the author suggested to an Egyptian student's journal article submission. The original opening ran:

> In aquaculture, the relation among nutrients, stocking rate, water quality and weather are complex. (Swales 1990: 206)

Swales comments that this opening:

> has an explanatory textbook quality about it unlikely to go down well with the expert readers of a specialized journal. It is the kind of opening prone to engender among such readers comments like, 'Wow, no kidding'. The remedy, we decided, was to switch the proposition from *new* information to *old* information, from *foreground* to *background*...(Swales 1990: 205 emphasis in original)

After revision the opening therefore became:

> In aquaculture, the relations among nutrients, stocking rate, water quality and weather are known to be complex. (Swales 1990: 205)
Obviously, no mechanical linguistic problem was involved in remedying the sentence, which was completely grammatical; rather it was a matter of modifying the sentence to mesh with discourse community etiquette and expectations. The modification in question was, in other words, prompted by reference to a probable reaction by intended readers rather than to the rules of an abstract grammar, which the student had already largely mastered.

Swales approach, therefore, places academic writing within the sociological context of what we might, at this stage, loosely call its readership. At the same time, however, it preserves more linguistic concepts - such as 'old' and 'new' information - as a central means of accommodating revisions to perceived communicative intent. In a further demonstration of the importance he places on the sociological aspects of EAP, Swales writes in his general comments on the three case studies adduced in *Genre Analysis* that 'all three reinforce the relevance of discourse communities' (1990: 212). Subsequently, in perhaps the best statement of his position, he asserts more broadly:

...the value of rhetorical perception in general and, more specifically, the benefit of being able to 'second guess' how expert members of various discourse communities will react to particular writings. (Swales 1990: 213)

Perhaps in introducing Swales' work through a case study, I have given the impression that it lacks a theoretical formulation. Such is not the case. The first two sections of *Genre Analysis* provide a convincing account of its origins and motivations, with references to an impressive range of works from both the linguistic and sociology of knowledge perspectives described above (cf. 1.2). In addition, in-depth accounts of key theoretical concepts are provided; namely: discourse community, genre, task, schemata and acquisition. Each of these is informed by Swales' long professional involvement with discourse analysis and the teaching of academic English (e.g., Swales 1980, 1981a, 1984, 1985, 1986, 1987, 1988, 1989). This solid theoretical grounding culminates, however, in the 'nuts and bolts' approach to EAP exemplified above, and I have chosen, therefore, to take this as the most basic and fundamental statement of Swales' position. This choice can be further justified on the grounds that Swales himself
constructs his model with pedagogical practice in mind, explicitly realising that studies such as those dealing with EAP are inevitably founded on pedagogical utility (cf. Swales 1990: ch.1).

1.3.2 Swales approach and the general trend to rhetorical 'second guessing'

Swales' mode of explanation is by no means unique. It derives, rather, from an important trend in the EAP field which has been evolving for at least two decades. In an attempt to make this obvious, presented below are a number of quotations from commentators writing broadly in the field of analysis under consideration:

As I write, I make judgements about the reader's possible reactions, anticipate any difficulties that I think he might have in understanding and following my directions, conduct, in short, covert dialogue with my supposed interlocutor. (Widdowson 1979: 176; cited in Swales 1990: 62)

...the many positions which already make up the field influence the likelihood that a given argument will have effect. An operation may or may not be successful depending on the number of people in the field, the unexpectedness of the point, the personality and institutional attachment of the authors, the stakes and the style of the paper. (Latour & Woolgar 1979: 237)

In order to appreciate the complexity of legislative statements, we need to have a better idea of the communicative purpose(s) these statements are meant to serve... (Bhatia 1993: 102)

These statements all share the idea that text does not end with its interpretation. Widdowson claims that in writing we seek to anticipate how the reader will react to our text. Latour & Woolgar claim that existing discourse affects the interpretation of new discourse. Bhatia says that to understand a text we should follow Wittgenstein's advice and look to its uses. This idea of text as a continuing artefact is also the implication in Swales' comment about 'second guessing' reader reactions cited above.
Although this kind of discourse-affects-discourse explanation of texts is increasingly common in relation to academic writing, its central, unifying features have seldom been formalised or examined. Chapter 2 of this study will attempt to demonstrate that such explanations place a high degree of importance upon what might be called secondary discourse; that is, discourse produced from, or potentially producible from, a text, which affects how that text is subsequently decoded. Terms such as 'communicative purpose', 'reaction' and 'second guessing' - although perhaps pedagogically useful - are merely less rigorous expressions of this idea. It will be argued that a formalisation of the relation of this view to a Peircean semiotics (as expounded in the work of semioticians such as Eco; cf. also Nöth 1990: 40-47; Oller 1995) could be an important step towards a generalised theory of how genre operates. This point, however, will be taken up in more detail in chapter 2.

1.4  A diagrammatic model of the research literature relevant to studies of textbooks

The position within EAP of studies of textbook discourse argued for above is summarised diagrammatically in Figure 1.1 which presents, in approximate terms, a model of the central approaches and their influences.
1.5  **Aims of the present study**

The reasons for the alignment of the present study with Swales' genre analysis approach, as well as its position relative to existing studies of introductory textbooks, have been indicated above. In both NS and NNS academic pedagogy this approach, I feel, is laudable both for its strong focus on the links between analysis and pedagogy, and for its potential to empower students with the often unspoken (if not subconscious) discourse conventions of their disciplines - conventions whose importance had been largely ignored in studies of academic writing until Swales. This seems doubly true in sciences like biology where second language learners often have relatively few problems with sentence mechanics, but are still often unable to construct good 'scientific' prose. There can be little merit in stubbornly adhering to either a linguistic or a sociological approach in the context of improving academic writing and
pedagogy when the task itself demands, above all, flexibility.

While one of the strengths of Swales' EAP approach is the latitude it allows for individual discovery and evolution according to specific discourse needs (cf. Johns 1994), one is nonetheless struck by the lack of a more precise theory of how discourse community members enter, leave, shift or are held stable in their communities, and also by the lack of a more precise account of the deterministic interaction of discourse communities and the function of genre in this process. The task of developing such a theory seems very challenging. It clearly represents, however, the next step forward in genre analysis as developed by Swales, and the present analysis of biology textbooks seems an ideal opportunity to attempt to develop research in such a direction. The aim of this study, therefore, is to present a pedagogically useful analysis of the features of IBTs at use in Australian universities using Swales' genre analysis approach as described in 1.3, and in that analysis to make more theoretically explicit the interactive discourse community processes involved.

1.6 *Organisation of the present study*

In order to address the aim stated above, the present research is structured in the manner outlined in the following description of its contents.

**Chapter 2** develops a secondary discourse model for the identification and explication of IBT features based largely on the work of Swales. In doing so it discusses the concepts of genre, discourse community, secondary discourse and dialogism, with the conclusion that the features of IBTs may be the result of their attempts to resist an interrogation structure which has evolved and is stabilised through the secondary discourse that may be produced from them.

**Chapter 3** investigates the macro structure of the corpus texts to the level of the arrangement of textual segments and identifies some possible functions of this structure. A number of existing macro models of textbook discourse are tested against the corpus texts.
Chapter 4 presents a rhetorical model of the biology textbook chapter based on the concept of an interrogative unit. It then focuses on lexico-grammatical features, testing a number of existing claims against the corpus texts and the interrogative unit concept.

Chapter 5 applies the findings to pedagogy and makes suggestions for aiding both NS and NNS students with IBT use in the light of current practices and beliefs in EAP.

Chapter 6 offers a conclusion.

1.7 Corpus texts

The corpus texts are five textbooks used in introductory first year biology courses at Australian universities in 1995. A list of their titles and the courses in which they were used is at Appendix A.

One aspect of the textbooks that warrants special comment is that they are all originate in the United States. This may have profound ramifications for their presentation of material. Love (1991), for example, found that two geology textbooks - one British, one American - although basically complementary, nonetheless contained 'some striking contrasts' (Love 1991: 99), particularly in their use of 'concrete advance organisers' and in the interplay of text and illustrations (pp. 99-101). Since all the corpus texts in this study are American, such differences do not pose any problems of comparison. It should be kept in mind, however, that the present analysis - simply through its basis in first year biology courses in Australia - is restricted to, and reflects only, the American textbook presentation of biology.

1.8 Summary

This chapter began by highlighting three reasons why a study of IBTs in use at Australian
universities is important:

• the lack of any major study of a similar nature;
• the increasing importance of studies of textbooks as they relate to ESP, particularly in Australia where the number of NNS students studying biology has increased in recent years; and
• the opportunity such a study affords for theoretical modification and improvement.

An overview of the relevant literature was then given. This was seen to consist of two approaches, both relating to the broader rubric of EAP: the linguistic approach and the sociology of knowledge approach. The former was seen to have links to discourse analysis and an empirical view of language; the latter with the general movement known as the sociology of scientific knowledge (SSK). Swales' genre analysis approach was put forward as an eclectic mixture of both orientations. Several of Swales' key concepts were introduced, and it was argued that many of the explanatory terms used could be generalised into a model based on secondary discourse.
CHAPTER 2
KEY CONCEPTS

2.1 Introduction

MENTION WAS MADE in 1.3.1 of the possibility of refining current approaches to genre analysis by formalising the concept of secondary discourse, which, it was argued, is implicit in many common explanatory statements relating to genre features. Chapter 2 assumes the responsibility of attempting such a refinement. It does so using as a starting point Swales' model, whose centrality in the field of EAP and studies of textbooks was discussed in 1.3.

2.2 Swales' definition of genre

After discussing the historical uses and abuses of the term (1990: 33-44), Swales attempts a working definition of genre based on five criteria (1990: 45-58):

1. A genre is a class of communicative events.
2. The principal criterial feature that turns a collection of communicative events into a genre is some shared set of communicative purposes.
3. Exemplars or instances of genres vary in their prototypicality.
4. The rationale behind a genre establishes constraints on allowable contributions in terms of their content, positioning and form.
5. A discourse community's nomenclature for genres is an important source of insight.

The main point emerging from Swales' definition is that genre should not be thought of as a set of generalised features inevitably found in a certain sub-class of texts. Instead, in his words, genre is a 'fuzzy concept' (p. 33), which depends for its explication upon such problematic terms as 'rationale', 'communicative event' and 'prototypicality'. Swales' definition, then, intentionally does little to help us identify genres in any formal sense. Rather it openly presents
genre as a term for refinement in the context of other opaque concepts such as discourse community and communicative purpose. In other words, Swales' criteria - in the established manner of EAP research (cf. Johns 1992; 1994) - are offered as provocations rather than dogma, and their primary function is to delineate a concept of genre that has brought success in pedagogical application. In fact, Swales' comments about genre are quite explicitly offered as a 'working definition' (p.45).

2.2.1 Secondary discourse and genre

Despite their usefulness, then, Swales' criteria still leave us a considerable distance from a theory of genre capable of identifying and explaining textual features - precisely what we now require in order to examine our five corpus IBTs. As noted in chapter 1, it is in bridging this gap that the concept of secondary discourse may be helpful. Before applying this new theoretical tool, however, care must be taken to make explicit what is proposed by it.

A first step in this direction is to differentiate the levels of discourse Swales himself tacitly posits in the five defining points quoted above. At what we may call the primary level in Swales' criteria are communicative events which are classed into genres according to 'some shared set of communicative purposes'. Unfortunately, Swales does not explain who in fact performs this 'classification' of communicative events, or in what manner. Logically, however, it can only be those involved in them, for if someone is not 'involved' in a communicative event he or she cannot know of its existence and therefore cannot classify it. Similarly, the classification of communicative events must, by simple definition, take place within - and constitute part of - this set of communicative events. This classification of communicative events by those involved in them constitutes, then, a secondary level of discourse - of discourse about discourse.

In itself, this may not be a particularly insightful realisation. There are obviously numerous roles of engagement in communicative events - author, recipient, observer, interpreter and so
on. These different roles lead to correspondingly numerous types of classification. An author classifies a work as 'experimental fiction'; a reader calls it 'trash'; a critic analyses it as a 'postmodernist manifesto'. As is evident from this example, the process of classification of communicative events into genres is dynamic and continuous, involving a vast range of participants with a vast range of interaction patterns and perspectives. Artefacts of discourse are labelled and classified in different ways for different purposes under different motivations. The distinction between primary and secondary levels of discourse made above becomes powerful when we consider that, through this process, some discourse labels solidify and persist, and that these labels exert a determining influence over the forms of discourse itself - not just how single texts are read, but how all texts are read (cf. Kristeva 1980). These labels and their transparent treatment are the result of a social process often termed 'agreement', which, it will be argued, is related to the structural exclusion of problematising secondary discourse. The mechanisms of this social process, in fact, are of the utmost interest in identifying and explaining textual features.

It is argued here, then, that Swales' criteria intimate, above all, that genre has no objective existence outside its participants, but is rather an enclosing mechanism through which the ideology of a discipline is realised and evolves. Perceptions of genre are constantly negotiated in the communicative events taking place between discourse members as they objectify, classify and reclassify communicative events. These metadiscoursal acts, we have argued, all reside in secondary discourse.

We might ask why participants would engage in this type of classificatory behaviour. In terms of the theories put forward by Derrida (1976) and Fish (1980: 338-355), one answer might be that genre reduces to a process whereby subjectification always entails objectification, and that this is a necessary part of modern discursive practice. Through delimiting and labelling communicative types, discourse community members can achieve temporary transparency for their own discourse which in turn is delimited, labelled and made opaque by other discourse, and so on ad infinitum. No ultimate meaning is arrived at; instead the system of discourse
merely evolves according to what Althusser & Balibar (1968: II,8) refer to as ‘structural causality’.

To summarise: a text's perceived membership within a genre is the result of secondary discourse - of discourse relating to the classification of other discourse (cf. Jakobson's 1960 'metalingual function'). It is only through secondary discourse - in particular, through its possibilities for production and dissemination - that texts come into being, and through which their position and meaning is ultimately negotiated and fixed. In the following section, the ramifications of such a conception of genre will be contrasted to 'traditional' conceptions in an attempt to show how these latter have been central to the creation and regulation of what they study. Above all, however, the next section can be taken as an indicator of how complex and overreaching the interrelations are between genre and ideology.

2.2.2 Secondary and tertiary discourse: Genre theory and prescriptivism

At this stage it might be pointed out that, despite the diachronic, negotiated nature of genre explicated above, established and recognised generic forms do exist, and that these do exhibit stable formal features, many of which have remained unchanged for centuries. The words 'once upon a time', for example, are clearly a feature identifying fairy tales. Kent (1985: 133) sees this possibility of arriving at 'codifiable conventions' of genres as an instance of a synchronic dimension of genre occasioning a paradox of 'the well known hermeneutical circle' (Kent 1985: 133; cf. also Firmat 1979). We only recognise a genre by reference to its features, yet at the same time we only recognise its features by reference to its membership of a genre.

1Compare this with Eco's (1976) semiotic theory, a feature of which is the concept of discourse producing discourse of the 'nth' degree. Ultimately this 'universe of discourse' determines semiosis itself. For an entertaining illustration of Eco's mode of analysis as applied to popular culture see Eco (1987).

2Swales himself makes use of the term 'metadiscourse' (1990: 188-9; also 206). He uses it, however, as a means of referring to signalling in discourse. This, as well as the considerable number of uses already given to the prefix meta-, motivated the use of a new term 'secondary discourse' in the present study.
Such a paradox can be resolved, however, by seeing genre in the synchronic sense of 'codifiable conventions' as a simple historical privileging of the term genre into a prescriptive function, which, in so far as it succeeds, excludes other 'non-codified' genres. Genre, as an evolving set of labels used to group and problematise discourse, exists in the social realm of power expressed through differential material access to the physical apparatus of discourse dissemination (cf. Foucault 1977; Said 1983). Ultimately, in this context, the only means of proving a certain text to be a member of a genre is to point to instances in secondary discourse of its classification as a member of that genre. This, by itself, is hardly convincing. Insistence - the exclusion of alternative conceptualisations - is necessary. Genre theory, as a formal intellectual activity, therefore, has arisen and been sustained as an academic tool in Western culture as such a means of insisting on genre classifications. The simple fact that a science of genre exists is, in itself, largely sufficient to limit the production of textual types to a structurally supported matrix within which the conventions of secondary discourse can be manifested according to socially valued rules and conventions. By way of an interesting analogy, consider: would language exist without a science devoted to the study of it?

The adversarial structure of western dialectic, centred on a search for absolutes (concepts which cannot be problematised in secondary discourse), has had the historical effect of limiting the paradigm of genre classification - of intervening in and formalising a set of privileged 'conventions' germinal to larger historico-epistemological trends and the structural causality mentioned in 2.2.1. This formal, academic genre theory, of course, only succeeds in so far as it has crypto-prescriptive power - something it derives from the ability of the secondary discourse it evokes to transform what discourse community members think through rather than about (cf. Foucault 1972). In reality this becomes largely the ability to systematically silence opposition and regulate access to discourse, albeit once again structurally rather than individually motivated. Such a functional mechanism explains the predominance of genre theory in literary studies in which an historically academic formation (stretching back, indeed, at least to Aristotle cf. Poetics, 6) has long held the central physical means of disseminating
classifications of texts firmly in its grasp.

If secondary discourse is the function of communicative events that refers to other communicative events with effects of regulation and exclusion, then formal discussion of genre - 'genre theory' - might be referred to as 'tertiary' discourse. It functions to regulate secondary discourse and to limit that discourse and its ability to 'problematise' first order discourse. Such a limitation of discourse about discourse, rather than of discourse itself, results in the possibility of codifying the features of a 'type', which in this sense has often led to use of the term 'genre' as a label (and implicit justification for) a particular labelling system. Any discourse member seeking to refer to and problematise the features of such a canonised concept will encounter the necessity of obeying constraints on secondary discourse which, if challenged, are constantly referred to the legitimacy of tertiary discourse. In other words, it is impossible to criticise or discuss a text on generic grounds without reference to a concept of genre whose meaning, one inevitably discovers, is already fixed by sheer lack of alternatives.

In fact, when seeking to clarify the concept of genre it seems unavoidable that one will become embroiled in certain 'circularities of argument' or 'aporia'. Kent's paradox is a prime example. In the context of the present theory, however, this concept of 'circularity' itself can be seen simply as one of the problematising devices of tertiary discourse which protect and determine the actual determining structures of text.

Genres as sets of codifiable conventions, therefore, can be seen as the prescriptive result of a type of 'genre of genres' or 'typology of types'. While they may have social reality and a role in the structural causality discussed above, they are not the central focus of how systems of texts operate; rather they are a privileged set of classifications regulated and maintained as a canon.

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3Fowler (1982: 256) comments, in fact, that periods of great activity in genre theory have corresponded to periods of 'literary greatness'.

4This point is implicit in Althusser & Balibar's (1970: 25) concept of the 'problematic'; and also in Kuhn's concept of the 'disciplinary matrix' (1977). The term 'problematise' is used here and elsewhere to mean the process of objectification through which a concept (or, indeed a text or group of texts) becomes a centre for secondary discourse.
which governs how all texts are decoded, discussed and recreated.

In contrast to genre theory - which we have argued always plays a prescriptive role in textual systems - the pedagogical focus informing Swales' genre analysis has produced a new approach to explaining texts which at least recognises the role of meta-labelling in the creation of ideology and the maintenance of discursive practices. The genres studied under this new analysis are still the most powerful: literature, research articles, newspaper articles, textbooks. However, the reasons for studying them have changed. Instead of bolstering and reaffirming these texts positions as canons of truth, studies are now more often undertaken with a view to admitting a range of previously excluded individuals to the control of the ideological mechanisms shaping society (cf. Martin 1985: 51-63; Kress & Threadgold 1988).
2.2.3 Genre and interrogation structure

In the above discussion it was suggested that a central feature of communicative behaviour is the tendency to classify communicative events into types. This classification takes place within discourse itself. Through the participation of socially situated individuals, this secondary discourse was argued to organise conceptualisations of communicative events into ideological power structures which sustain certain modes of thought related to that social placement. Traditional conceptions of genre as simple descriptions of objective types possessing codifiable features - 'genre theory' - were seen as an instance of such a sustaining mechanism.

At this point, our central concept of secondary discourse - although useful in establishing the general view of textual classification above - must be made more concrete if it is to be of use in the analysis of our corpus IBTs. One way to achieve this is to introduce a more material conception of its function. It has been argued that secondary discourse regulates the creation and decoding of discourse through its ability to problematise texts and exclude them from the physical dissemination process, and that such discourse is motivated by the opportunities it provides for self-objectification. To a given reader, texts are therefore related to each other by potentials of secondary discourse. But how exactly do these potentials arise, and how are they realised?

It has often been argued that texts are interrogated by their users according to what might be called an 'interrogation structure' whereby the decoding process is in the form of a problem-solution dialogue (cf. Hoey 1983). In terms of our present model this interrogation structure can be related to a reader's conceptualisation of the genres in which secondary discourse relating to a text can be actually disseminated. It is easy to see how, in this way, the system of genres could interlock to stabilise certain forms. Texts, with their differential ability to problematise one another, regulate - or to borrow Foucault's (1977) term 'discipline' - one another through an equilibrated interrogation structure, which involves simply a balance of the possibility of 'objectifying' or 'problematising' a text in secondary discourse with the motivation
for doing so.

Under these conditions, a textual form threatening 'generic constraints' will be interrogated by decoders and problematised in secondary discourse. If that secondary discourse itself successfully navigates generic constraints (and thus has the potential to become widely disseminated) it may marginalise the offending text by curtailing its dissemination or shifting its generic classification into a less threatening genre\(^5\), while at the same time earning itself a place within the discourse community it enters. Although a detailed examination of this process of problematisation and 'self-correction' is beyond the scope of this study, it appears that such a process resides mainly in the exclusionary power of certain concepts in a discipline's 'positivity structure'; that is, the concepts which it accepts as transparent or self-explanatory and does not itself examine (cf. Althusser's 'problematic' 1977: 32). An IBT, for example, has little defence against a charge of 'incoherence', which although having no agreed criteria for identification or substantiation, is nonetheless a most powerful criticism. The IBT's best chance for wide dissemination is to ensure that it affords no opportunity for such critical disapprobation to arise. It does this by anticipating the arenas in which criticism might appear and shaping its discourse to resist the interrogation structures evoking critical labels in those arenas.

Differential positioning of discourse community members is fundamental to the process of interrogation and, consequently, to the features of the texts to which interrogative processes will be applied. A professor of biology, for example, is at least potentially able to write and publish a review of a textbook in a widely read journal, or to omit a textbook from a textbook list, or to praise a textbook to colleagues - all of which are powerful instances of secondary discourse. Students, on the other hand, are able only to complete assignments and examinations with a limited readership, complain to lecturers and tutors, write plaintively to publishers and so on. The textbook, therefore, must be more concerned with the interrogation structure

\(^5\) Compare, for example, how Swift’s *Gulliver’s Travels* and Orwell’s *Animal Farm* began as satires and shifted - at least for a considerable proportion of their audiences - to fairy tales.
imposed by lecturers and only secondarily with that of students if it hopes to become widely disseminated. In other words, channels of communication through which differentially placed discourse community members operate exist not only as physical possibilities for discourse production but also as psychologically real, discipline-specific modelings of individuals' positions in the discourse community derived from those physical possibilities of discourse production (cf. Foucault 1977). As will be seen in chapter 5, this realization is fundamental to 'empowering' students in regard to textbook use.

This interplay between modeling of genres and experiences with actual artifacts regulates itself into an ideological formation for a discipline in which individual differences of perception made concrete in physical dissemination processes hold in check participants' contributions. Structural causality is always at work: the most powerfully placed (professors of biology and experts in particular fields, for example) also have the most constraints applied to their discourse through highly motivated interrogations by peers and iconoclasts. The result of this constraining of contributions is the broader illusion of coherence in the discipline. In scientific discourse this is fixed in conceptions of discourse governed by a strict teleology which, in the context of the IBT at least, plays a role in such larger positive social mythologies as technological progress and education.
2.2.4  Dialogic nature of the discourse community

It has been claimed above that the form of a text is linked to the pattern of discourse that can be produced from it via an interrogation structure. But how do we propose that this interrogation structure comes into being and develops in individual discourse community members? One way to reconcile the internalisation of secondary discourse possibilities with an integrated view of communication and cognition is through the use of a model such as Bakhtin's (1981; 1984; 1986; cf. also Todorov 1984). In this view, members of the discourse community model their own position relative to the communicative possibilities they perceive as open to them, and this model then acts as a guide to interrogating a certain text. In one sense this is self-evident. For if a text is interrogated on grounds unrelated to the powerful secondary discourse channels open to a discourse community member, the discourse produced from such interrogation - being by definition unrelated - will have no outlet for dissemination and will, in effect, not exist.

In passing, I would like to suggest that this interrogative modelling associated with textual systems is related to the concept - developed most predominantly in semiotic theory - of heteroglossia (cf. Todorov 1984; Bakhtin 1986). According to this concept, a number of 'voices' are derived from semiotic experiences with relevant artefacts in a discipline, and these, according to a Peircean model of semiosis, transform interpretation into interpretant through a specific set of cognitive habits (cf. Colapietro 1993: 178). Thus the polyphony of internalised voices gives birth to a new voice originating in the individual that interacts with texts to produce meaning. As will be seen in subsequent sections, this process and its corollary - the derived interrogation structure - is suggested by the interrelated nature of the discourse community, which may be used as a means of demystifying and reifying Bakhtin’s often esoteric model. Before proceeding to a discussion of this, however, it is first necessary to introduce a conception of the environment in which individuals derive and apply their interrogative habits.

2.3  Textbooks as mass communication
In many ways, the view of genre we have argued for can be seen as a placement of academic genres within a mass communication model. This has its origins in Swales' work, which has perhaps been influenced by the considerable attention paid in recent decades to work by McLuhan (1964), Foucault (1972), Eco (1976) and Geertz (1983), all of whom stress the social materialist nature of communication. A review of thinking in this area which makes the connection clear is provided in Bruhn Jensen (1995: ch 8&9), who uses a social semiotic approach deriving from the work of Peirce to model the interplay of signs and the ways in which they determine epistemology and social order in a mass communication framework. Under my own definition, this framework is simply the study of those forms of communication in which reception is informed by a knowledge that others are encountering the same communicative artefacts as oneself. It is easy to see how this would apply the users of IBTs.

Mass communication mechanisms in scientific discourse are becoming increasingly important. As Swales has realised, any study of these mechanisms must centre on the concept of discourse community. Accordingly, the next section attempts to clarify the composition of, and linkages within, the discourse community relevant to the IBT.

2.4 **Discourse communities and the IBT discourse community in particular**

In relation to Knorr-Cetina's (1981) case study of the evolution of a scientific article, Swales (1990: 121) comments that 'the creation of such a linguistic artifact [i.e., a scientific article] is neither simple, nor short, nor particularly natural'. Biology textbooks are much larger than scientific articles and, *ceteris paribus*, it seems reasonable to argue, just as 'unnaturally' (for which we may perhaps read ‘consciously’ constructed). If we wish to adhere to a secondary discourse approach taking mass communication processes into account, it is important in the first instance, therefore, that we ask ourselves a number of questions to do with the actual social circumstances of biology textbooks. Who writes them? Who publishes them? Who distributes them? Who buys them? Who benefits economically from them?
These questions reduce to a concern for the 'discourse community' relevant to the IBT. The term discourse community has already been used in the discussion of genre above and at this point requires clarification. A commentary on 'the original provenance of the term' as well as a seminal discussion of discourse communities themselves can be found in Swales (1990: 21-32). Swales' establishes six defining characteristics of a discourse community:

1. A discourse community has a broadly agreed set of common public goals.
2. A discourse community has mechanisms of intercommunication among its members.
3. A discourse community uses its participatory mechanisms primarily to provide information and feedback.
4. A discourse community utilizes and hence possesses one or more genres in the communicative furtherance of its aims.
5. In addition to owning genres, a discourse community has acquired some specific lexis.
6. A discourse community has a threshold level of members with a suitable degree of relevant content and discursive expertise.

(Swales 1990: 24-27).

While it is not my intention to examine each of these criteria in detail, nor to cast doubt on their usefulness, I would like to suggest that Swales' criteria in fact all proceed from his second assertion - that a discourse community has mechanisms of interaction among its members. This seems to be the only tangible basis for identifying a discourse community. The other criteria seem to be simply refining tests to be made on samples of these 'mechanisms of intercommunication'. A broadly agreed set of common public goals (put forward under Swales' first criterion), for example, is only formulable after an examination and confirmation of criterion 2. It is my contention, therefore, that if we examine any argument adduced in the identification of a discourse community member we will find that this identification rests ultimately upon some artefact of communication (e.g., conversation, published article, lecture).
In his criteria, however, Swales appears to give primacy to the idea of the individual as a controlling agent in a unified social milieu, when it is perhaps more appropriate to take this one step further and view, in the manner of postmodernists, the individual as a 'subject' - a mere sign in a system of signs (cf. Carrithers et al. 1985; Colapietro 1993: 118-119). To some extent Swales recognises this in his inclusion of 'participatory mechanisms'; however, the importance of the deterministic material nature of these mechanisms is not stressed.

Thus, it is the powerful transactions which pertain to a discourse community themselves that we must study for a deeper understanding of its discourse rather than the roles of the participants who produce that discourse. The rhetorical features of IBTs are maintained through the interplay of genres in use in the discourse community rather than through the interplay of discourse community members who, in themselves, are simply socially posited centres of discourse whose physical occupants constantly enter, exit and change seats. Our first task in modelling the discourse of the IBT, therefore, is to plot these centres and establish a model for the flow of discourse between them.
It is suggested here that the IBT, due to its overtly pedagogical function, has, at the broadest level, a two tiered arrangement of discourse community members affecting its production and use. On the first tier are what we might call 'primary' members who directly affect the commissioning of a textbook, its actual writing and physical construction, its revision and publication, and its marketing. The central participants in each of these stages might be: publishing house executives, professors of biology, specialist and non-specialist editors, and marketing executives (cf. Myers 1990: ch.3). On the second tier are secondary members of the discourse community or the 'users' of the textbook. This group includes lecturers who set the texts for use in first year biology subjects, as well as the students who use them for completing exams, assignments and other assessment tasks. The important thing about this distinction is that the behaviour of these secondary members shapes how primary members model the interrogation structure governing the text they produce. An attempt to model this relationship diagrammatically is made in Figure 2.1.

Figure 2.1 Model of function of discourse community relevant to IBTs

2.4.2 The flow of related discourse: the stabilising system
As stated above in 2.4, in our present approach it is important not to give primacy to discourse members, but instead to use these simply as a means of centring the agreed and stabilised communicative channels of the community. This is illustrated in Figure 2.1 in the modelling-feedback loop which shows how certain established forms (such as the book review or economic discourse relating to sales) regulate the textual features of the textbook.

The most important thing to note from figure 2.1 is the differential access to these regulating genres discourse community members possess. As well as the obvious differential ability to create discourse which can resist interrogation (which has been argued relates to a lack of knowledge of the genres in which secondary discourse can be promulgated), much of this differential access is the product simply of social labelling of participants. Without certain qualifications or overt symbols of expertise a member is simply not permitted to enter the most powerful discourse arenas relating to textbook features.

2.5 Secondary discourse and interrogation structure revisited

In the model developed so far we have posited that the IBT exists within a two tiered system of producers and users, and that between these two groups there is a system of feedback embedded in physical channels such as books reviews, lectures, and examination papers, each of which constitutes - through its stabilised use as a label in secondary discourse - a genre. It is now suggested that the textual features of the IBT can be seen as a product of these related genres and ultimately, therefore, of their material conditions of dissemination. In other words, these possible arenas for problematising an IBT and their associated restrictions and constraints represent an IBTs interrogative structure. A book review, for example, may, through a variety of mechanisms, render a book, particularly one suspects a textbook, either bereft of users or in high demand. The IBT relies for its dissemination in part, therefore, on its ability to resist this particular type of secondary discourse.
This is not to suggest, of course, that textbook features are merely a function of book reviewers' biases or predilections. As can be seen in figure 2.1, IBTs exist in a much larger secondary discourse structure than this. At this stage, however, it might be pointed out at that many textbooks do not have a vast amount of actual secondary discourse constructed from them. Often there is simply the odd review, a vote of praise from a lecturer, a simple insertion on a course booklist, a large number of examination answers owing the usual homage to the textbook, and very little else. To reject the secondary discourse line of inquiry on these grounds, however, would be a mistake, for it is not the realisation of secondary discourse that determines textbook features. Rather it is the potential for secondary discourse. This concept of potentialism embodied in material discourse channels has much to do with Bakhtin's dialogic conception of text discussed above in 2.2.5. In large part an IBT succeeds by not evoking secondary discourse. This, in turn, is achieved by obeying the interrogation structures applied by the most powerful discourse community members.

This last point is important. The IBT is interrogated to produce, among other things, such differentially powerful secondary discourse as book reviews, science reports, exam questions and course textbook lists. The stability and nature of an IBT's features are determined by its dialogue with such secondary discourses and the power relations that reside in them. In reality, this largely excludes many discourses from exercising direct influence over the features of a genre. For example, a possible secondary discourse of an IBT might be a parody of the text devised by students; however, such a potential discourse exerts little power over the form of text: the authors of the textbook have not made significant choices when constructing the text to avoid such a parody. (Although we may note that a textbook will take pains to avoid or control centres of discourse which might obviously become targets of parody; cf. Woolgar 1983; Gilbert & Mackay 1984: 172-188; and Swales' discussion of 'Some British Pansies' 1990: 222.)

2.6 The task of an analysis of the corpus texts
As noted in chapter 1, aside from their central position in a popular discipline in Australia, the five IBTs chosen for this study also provide a useful corpus with which to explore the possibilities of a genre analysis extrapolated from Swales' work. Chiefly this will involve attempting to uncover the interrogation structure the texts resist, which, given our placement of potentiality as a key concept, may be a matter of discovering what the texts are not. Formal similarities between texts must be examined with a view to explaining them as products of the possible secondary discourse they could provoke were they other than they are, rather than the discourse they actually do provoke.

It should be said at the outset, however, that one major factor affecting the form of IBTs is the form of earlier textbooks. These earlier texts have already resisted secondary discourse and, with the passage of time, have taken their place as canons within the discipline; their secondary discourse must interact with historical perspectives and is consequently highly resistant to delegitimisation. Recognisable departures from the form of these forbears in new IBTs must be calculated to withstand the considerable criticism such blasphemy creates. In scientific discourse - with its scant regard for discursive innovation - this is exceedingly difficult. Consequently, new textbooks resemble old. The present study - although it recognises the role of past texts in the formation of present interrogation structures - is not able to include any diachronic study of IBTs and leaves this to a future researcher.

A related point, which has already been made but should perhaps be re-emphasised, is the importance of the concept of the 'ideal student' in a textbook's attempts to resist interrogation. It is for this abstract being's benefit that textbooks are ostensibly written. Accordingly, this same 'ideal student' is both the focus and currency of secondary discourse. If a textbook can implicitly appeal to generally held beliefs and mythologies about the learner, it will have gone a long way towards silencing discourse inimical to its dissemination.

2.7 Summary
The nature of the above arguments does not allow easy summary. For ease of reference, however, a derivation and explication of the central claims and concepts informing the remainder of this study is presented below.

- **Genre analysis**, as derived from the work of Swales, implicitly seeks to understand how the labelling function within the discourse of a discourse community organises texts into categories and relationships for conscious or unconscious treatment. This concept of genre analysis is in stark contrast to genre theory which ultimately seeks to regulate labelling and categorising behaviour by insisting on features of texts necessary for their inclusion in a particular category.

- **Secondary discourse** - discourse that objectifies and classifies other discourse, most commonly for purposes of criticism - is the mechanism of labelling that produces genres. Its function is central to the physical dissemination of texts.

- Secondary discourse is realised in the differentially placed individual as an *interrogation structure* - a schema for decoding a given text based upon the perceived possibilities of producing secondary discourse from it.

- The *discourse community* surrounding the IBT is two tiered. The producers of the textbook mediate its features in accordance with an interrogative structure involving perceptions of the users of the textbook. Central to this modelling is the concept of an ideal textbook user who is the main focus of secondary discourse relating to the textbook.
CHAPTER 3
THE HIERARCHICAL SUBORDINATING STRUCTURE AND SOME MAJOR
SEMANTIC PATTERNS

3.1 Introduction

AN IMPORTANT INITIAL challenge for first year biology students is to develop a strategy
to deal with the size and complexity of IBTs. One common approach, for example, is to
overview the textbook in an attempt to gain some understanding of its overall structure. In fact,
given the physical size and level of indexation of the corpus texts, an initial experience of this
sort with the 'macro' layout of the biology textbook seems to be strongly invited: to locate
relevant information a student must be able to navigate the various indices and tables of
contents. Such undoubtedly formative experiences may have profound ramifications for how a
text is processed; for example, they may evoke a range of schemata (cf. Swales 1990: 83-92),
and prepare students to react to the text in a number of important ways. In addition to the
theoretical priorities outlined in chapters 1 and 2, therefore, it is also perhaps appropriate to
begin investigating the corpus texts at the global level for the simple reason that this also is
where most students begin.

3.2 Formal organisation of corpus texts

Appendix B shows in diagrammatic form how each corpus text is explicitly organised.
Although some small variations are found from text to text (the extra division into 'Sections' in
Curtis & Barnes (1989), for example), the 'formal structure' of the corpus texts (cf. Hasan 1985;
Eggin 1994: 34) can be generalised as in Figure 3.1.
Having derived a model of the formal layout of the corpus texts in Figure 3.1 above, it is now necessary to ask how this layout - which we have argued is crucial to a student's use of the text - functions. Our determination of this question will follow from our discussion in chapter 2 of secondary discourse. That discussion suggested that the textbook functions above all to resist an interrogative structure related to its physical dissemination. Abstract pedagogical or ideological goals were seen as merely instrumental in this.

In the present context, one of the most obvious targets for secondary discourse relating to textbooks is their explicit organisation of material, which is regularly perceived by discourse community members as fundamental to effective use of a textbook by students. Our first question, then, should be to ask what tasks the formal structure performs - both actual and apparent - in the IBT's ability to resist the various interrogative structures applied to it.

### 3.3.1 Reduction of formal model by removal of labels which do not directly govern text

As a first step towards a functional model, we may simplify our model of the formal structure by removing labels not relating to how text is positioned within the formal structure. In Figure 3.1, for example, headings at the level of unit - variously called 'units', 'sections' and 'parts' in actual texts - do not function as points of dichotomy for text arrangement. Numbering from five to eleven according to textbook, they appear instead to be a means of grouping chapters with a view to helping students organise a textbook's contents into an efficient 'mental model' (cf. Johnson-Laird 1980; 1983). In this capacity, the seemingly empty division into units acts in a number of ways to quell critical secondary discourse seeking to problematise a texts organisation and coherence. Firstly, units act as an aide de mémoire for recall of chapter titles (of which there may be over 50); secondly, they provide an intermediate structure for ordering chapters into serial semantic patterns; and, thirdly, they strengthen the separation between introductory chapters and the remainder of the textbook. As a first step in the formulation of a
functional model, therefore, these 'extra-textual' organisers governing no actual text can be omitted from our functional model, since the functions described above can be subsumed into the links between the textbook and its first dichotomy into introduction and remaining chapters.

3.3.2 Generalisations about the dichotomous formal structure

The generalised formal structure presented above (3.2) has one very prominent characteristic. At regular points, a section of text most often labelled an 'introduction' branches off from the broader heading before segmentation proceeds to the next level through the remaining element. In other words, at the first point of bifurcation a textbook divides into a first chapter (an introduction to the rest of the textbook), and the remaining chapters. At the second, each chapter divides into an 'introduction' relating to the rest of the chapter and the remaining headed sections. At the third, a section headed in capitals may divide into an introductory section of text and a number of sections headed in lower case. The central point, as we have already noted above, is that the structure of the texts is hierarchical rather than serial: there are opportunities for text insertion at varying levels within the mechanically emphasised structure of headings.

In analysing the function of this hierarchical structure, it is perhaps tempting (although not very illuminating) to examine the formal model developed above and say simply that this structure is one of introduction-content. Such a claim would be hard to dispute, for as Eggins (1992: 38) points out, some sort of introduction-remainder structure is common to all texts. However, to arrive at a more useful idea of the function of this structure it is necessary to make a more precise semantic comparison of the constituents on each side of the dichotomy.

To begin with, let us consider the relation of first chapters to the chapters they introduce. Taking Campbell (1993) as an example, we find in the first chapter, Introduction: Themes in the study of life, large headed sections such as the following:

A Hierarchy of Organisation
Emergent Properties
The Cellular Basis of Life
Heritable Information
Evolution: The Core Theme of Biology

The titles of the subsequent units comprising the textbook (which are used here as a convenient summary of the chapter contents) are:

1. The Chemistry of Life
2. The Cell
3. The Gene
4. Mechanisms of Evolution
5. The Evolutionary History of Biological Diversity
6. Plants: Form and Function
7. Animals: Form and Function
8. Ecology

In what sense, then, does chapter 1 'introduce' the other forty nine? Comparing the above, it seems reasonable to say, albeit in rather vague terms theoretically, that the introduction attempts to provide a general and intelligible statement of the most recurrent concepts. For example, Campbell's introduction, in the large headed section Evolution: The Core Theme of Biology, provides a short discussion of evolution, a topic which features in some guise in most chapters and to which Unit Five is completely devoted. Similarly, the large headed section A Hierarchy of Organisation offers a justification and a preparation for one of the fundamental and recurrent tools of biology: the taxonomy. The inclusion of topics in the introduction, then, marks them as important to the student. Such topics, the textbook intimates, are heuristics that will be referred to constantly and should be understood and accepted as soon as possible.

First chapters also have another function. By prefiguring concepts they suggest to the reader that the textbook is thoughtfully constructed - that it is planned; that it is coherent and ordered. We will have more to say about this as our model develops. It suffices to say at this point that such an integrative feature of the textbooks goes a long way towards resisting a critical interrogation structure. The discourse community relevant to the IBT has a powerful range of
communicative means at its disposal to problematise any material that does not accord with members' conceptions of coherence and integration of material for pedagogical use.

The functions described above for first chapters are repeated within individual chapters. Chapter 28 of Purves et al. (1992), for example, begins with an unheaded section which concludes:

In this chapter we will present some basic anatomical features common to many flowering plants. As always in biology it is important to remember that there are differences from group to group of organisms, and even from species to species...(p. 633)

What follows includes the sections:

- Subclasses of Flowering Plants
- Levels of Organisation in the Plant Body

Clearly the function of the quoted introductory paragraph in the context of the sections that follow is to sublimate 'levels of organisation' as an important concept for the chapter. It does this by introducing differences between organisms as something that is 'important to remember' - a marker which may be read, in our terms, as the foregrounding of a heuristic necessary for the correct assimilation of the material.

Taking two other examples at this level we note that Curtis & Brown (1989) introduce their chapter From an Abbey Garden: The Beginning of Genetics (p. 235) with a discussion about heredity. Elucidated in this discussion is a more general concept of 'self-replication', which is described as 'one of the principle properties of living systems'. Students are obviously intended to take careful note of this presage, and to keep the concept of self-replication in mind during the rest of the chapter. In a similar manner, Keeton & Gould (1986) introduce their chapter Chemical Control in Plants (p. 378) with a short definition of a hormone, something which subsequently occupies a central place in the chapter.
Where it exists, introductory prose at the beginning of smaller headed sections performs the functions outlined above, only on a smaller scale. Keeton and Gould (1986), for example, begin their section 'Control of Flowering' (p. 395) with the sentence, 'Flowering is not a random process'. This emphatic statement signals at the outset that flowering is regular and process governed. In this role it sets up something akin to a problem-solution structure (cf. Hoey 1983) in which the subsequent smaller headed sections act as elucidations of the non-random nature of flowering and arguments against the (textbook created) assertion that flowering might be random.

3.3.3 Generalising to a functional model: the sublimated-subordinated structure

We can conclude from the discussion above that introductory sections perform two primary functions. These may be seen as relating to the two poles of the secondary discourse flow postulated in Figure 2.1.

Firstly, from a student's perspective, introductory sections mark the importance of a concept or heuristic in the 'knowing of biology' (i.e. in its epistemology), and arm the reader with information that will be required in decoding subsequent subordinated text (correct reading of which is important to the formation of a 'proper' epistemic model for the material, allowing material to be organised into a larger, cognitive framework).

Secondly, in relation to those producing secondary discourse relevant to the textbooks, introductory sections, by prefiguring lexical items and topics that will recur, as well as by their simple division of material into a discipline accepted Gestalt (cf. the 'Linnaean tree\(^6\)) suggest that the texts are the result of an organised and coherent epistemology. The discourse community's acceptance of this suggestion and its mechanisms of acceptance are to be found.

\(^6\)Eco (1984) provides an interesting account of the role of this structure in the evolution of western thought, particularly in regard to semantic modelling.
in the broader discursive practices and positive assumptions of the discipline; ultimately, however, introductory sections function to promote the dissemination of the textbooks.

Generalising both these functions, then, introductory sections in IBTs can be said to perform a *sublimating* function relating to the epistemology of the discipline. They mark off what it is most important to know - both in the absolute sense and in the context of reading the more specific material that follows - and, through their interrelations with the subordinated material, go some way towards creating a coherent and ordered epistemological framework. A functional model incorporating labels corresponding to sublimated and subordinated sections of text as developed above is presented in Figure 3.2.

3.4 *Secondary discourse and the functional structure*

Now that we have arrived at a model of the functional structure of the corpus texts, we are in a position to clarify and apply some of the theoretical suggestions made in chapter 2. In particular we might pose ourselves the following question: Why should textbooks be constructed around a structure of the type identified?
Our model suggests that they are constructed in this manner because of the secondary discourse they would evoke if they did not follow such a structure. In chapter 2 the central role of existing textbooks in the historical evolution of 'safe' communicative forms was introduced (2.8). A textbook, it was suggested, is largely invulnerable to secondary discourse in so far as it resembles existing works. This resemblance, however, is obviously not of a literal, verbatim sort. Instead it relates to the how existing works create and modify an interrogation structure applied by discourse community members to new texts. The formal structure examined above, therefore, can be seen as the result of a set of historical discursive practices created and stabilised by the dissemination and canonisation of precedent IBTs (cf. Brown 1993).

But to say that IBTs exhibit this structure because previous IBTs have exhibited it is not a complete answer. Why, in particular, do we find a hierarchical sublimating structure governing the corpus texts? According to our model the answer lies in the types of secondary discourse that could be produced were an IBT not to have this structure. It would be criticised - and ultimately denied a powerful place in the discourse community - on grounds of order and coherence. It would be put aside as 'not well set out'; as presenting possible difficulties for students who need to achieve a workable, defensible model of the discipline in the shortest possible time. In fact, the appeal to the ideal student, as we would expect with a pedagogical work, would be implicit in any powerful secondary discourse such an IBT would evoke.

If we examine it at the epistemological level, this - in one sense quite justifiable - protection of the student can be seen as a stabilising element of a broader ideological structure within the discipline. The hierarchical, sublimating structure is fundamental not only to a coherent textbook, but also to the maintenance of a coherent and ordered discipline. The appearance of coherence and order are pivotal to any science's ability to encompass truth and engage minds (cf. Foucault 1970; Kuhn 1970). In the sense, one might argue that the concepts reified by a discipline simply reduce to a set of structurally supported cultural conventions for excluding and tolerating discourse. A further discussion of this, however, is beyond the scope of the present study. It suffices to say in the present context that the hierarchical sublimating structure
constituting the 'macro-structure' (cf. Van Dijk 1980) of the corpus texts can be seen as the result of its attempt to avoid and resist secondary discourse problematising its 'coherence' - a concept which has close links with the anticipated use of the texts by an 'ideal' student.

3.5  *Filling out the model*

To take our functional model a step further it is now necessary to examine the actual text contained by each section in search of a central unit of discourse. Whereas the structure developed so far has dealt purely with the positioning and sublimation of text, this next step must account for how actual *content* is presented. Accordingly, it will involve, and be governed by, a new range of secondary discourse possibilities. There are, nonetheless, good reasons to believe that a single type of functional unit does predominate. Firstly, the sheer physical size of textbooks seems unlikely if we assign any great level of complexity or diversity to this level of organisation: a basic, iterative form seems a prerequisite to producing a work of such formidable dimensions. Secondly, the material covered in IBTs demands a homogeneity of treatment; indeed, the relevant discourse community with its exhaustive range of favoured biological interests would hardly tolerate differential presentations of material. In the next sections, therefore, we search for this functional unit.

3.5.1  *Some initial clues*

*Prima facie*, the corpus texts possess a number of features interrelated in revealing ways with written text. Three of the most important of these are that:

- All five textbooks contain glossaries which give definitions of key terms;
- Key terms (usually nouns) are bolded or otherwise mechanically emphasised in the text; and
- Items such as 'interviews', 'boxes' and 'methods' are always very explicitly placed outside the larger structure by the use of mechanical devices such as shading and bordering.
These features suggest that the textbook - at least as one of its functions - is seeking to develop a detailed hierarchy of what we might call 'definitions'. The first two features intimate that if a linear reading of the text fails to provide a required definition, then the reader should consult the glossary or skim the text's bolded key terms to locate it. The third invites us to read an interview or other 'special' section, but at the same time warns us not to confuse the material it contains with the definitional hierarchy clearly marked out in the 'real' text.

Davies (1994: 4586-88), using a Hallidayan framework, classifies this function of textbooks as 'ideational' and refers to it as 'the writer as teacher of the subject language'. Similarly, Swales (1981: 107) has commented that definitions in textbooks 'are the pegs from which descriptive garments are hung'. While IBT text undoubtedly does serve a range of functions (such as those outlined in general terms by Davies (1994)), it is nonetheless difficult to avoid the conclusion that their basic functional structure is most strongly continued into the textual level by the evolving series of 'definitions' they present. This was certainly implicit in Kuhn's statement that textbooks aim 'to communicate the vocabulary and syntax of contemporary scientific language' (quoted without reference in Swales 1981: 107). Accordingly, it is proposed here that carefully placed definitions constitute a 'core' textual feature; that is, one which plays a pre-eminent role in shaping the discourse frame upon which other less central textual features are moulded.

3.5.2  Segmentation

A factor in support of the primacy of the 'textbook as teacher of the subject language' function (realised as a textual structure centred around definitions) is the degree of subordinating segmentation exhibited in the functional structure of the corpus texts we established in 3.3.3. Indeed, the most immediately noticeable feature of the corpus texts is the number and variety of their section titles. Upon opening any particular text we are confronted with a Contents so large that it is in every case preceded by a Contents in Brief. In Campbell (1993), for example, there are eight units composed of 49 chapters composed of around 200 sections headed with
bolded capitals which, in turn, are composed of many hundreds of sections headed with bolded lower case. It can hardly be anything but the case that this large number of formally marked sections is a symptom of a more specific structural design based on segmentable units. Within text, what could represent a better means of extending this structural design than a unit based on the definition?

Segmentation, however, has another important corollary that further illustrates how the definitional unit is ideally suited to fulfilling the structural design of the IBT. Sectioning, despite facilitating careful arrangement of text into juxtapositional and hierarchical coherence based on titles, at the same time frees textbook prose from the constraints of 'linear' or 'narrative' cohesion found in other types of scientific prose with more linear objectives, such as, for example, the description of an experiment. Consequently, the textbook does not have to sustain cohesive devices across thousands of words; merely to the next heading boundary. What we encounter in the corpus texts then is not only segmentation but a particular type of *separability* - a reluctance to explicitly interrelate sections of text or to otherwise hinder the sub-division of the text into smaller units. What other motivation could this have than to facilitate prose laden with self-contained statements of a definitional type?

It is not difficult to find pragmatic reasons why definitions should be so structurally important. The textbooks, after all, are designed for use in a range of biology courses offered by a range of teachers with a range of content preferences. A holistic, highly integrated textbook could not hope to satisfy the needs of such a wide audience\(^7\). Instead a textbook must allow material to be easily selected and extracted for course-specific requirements. A definitional form - with its concomitants of segmentability and separability - is ideal for this purpose.

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\(^7\)Interestingly, the requirement for material to be easily 'chunkable' appears to be less pronounced in British textbooks - an observation suggesting a different emphasis in that tradition leading to different textbook interrogation structures. Central to this might be the role of cultural identity in pedagogical practice and its effect on models of the 'ideal student' - a clash of British and American conceptions of learning.
3.5.3 The definition as a functional unit within text

There are certainly many formal, even prescriptive, accounts of definition available (e.g. Robinson 1952; Borsodi 1966; Marciszewski 1981: 86). However, the intention here is not to claim that any such rigorous element pervades the corpus texts. On the contrary, the concept of definition required in the analysis of the corpus texts must be contextually derived; that is, it must be drawn from the texts themselves. The term 'definition' as used so far has been simply a convenient label for a functional unit within IBT text intended to serve an unconscious marker of how the texts should be processed by an ideal student (although no doubt also sharing in this regard some commonality with other textual experiences of 'definition'). Given our theoretical foregrounding of the concepts of secondary discourse and interrogation structure, therefore, it is perhaps better at this point to label this next functional unit with something less rigid in its connotations. The term interrogative unit is proposed for this and will be used to refer what we have so far referred to as the 'definition' in the corpus texts.

Within text, interrogative structure means above all that, in relation to its title, a section must answer (i.e. must allow the production of some secondary discourse considered by the discourse community germane to) the basic interrogation 'What is X?'. There are of course numerous strategies for achieving this, some of them necessarily very subtle and complex; however, the fundamental function of each text is always the same: to resist interrogations as to whether the text actually tells the ideal student (represented most clearly in the structure of assessment tasks) what a concept put forward in the larger structure is. To illustrate this, consider the following examples of section titles and their accompanying text, and how easily a series of what might be called 'base form' interrogative units may be derived from them:

Example 1 The Small Intestine
Section title: The Small Intestine

Defining text: With a length of more than 6m, the small intestine is the longest section of the alimentary canal (its name is based on its small diameter, compared with the diameter of the large intestine)...Campbell (1993: 802)

Derived definitions:
The small intestine is the longest section of the alimentary canal

...is more than six metres long

...is smaller in diameter than the large intestine
**Example 2 Ethylene**

**Section title:** Ethylene

**Defining text:** ...ethylene is, in fact, a regular plant hormone that plays a variety of roles in the life of plants... (Keeton & Gould 1986 :393)

**Derived definitions:**
Ethylene is a regular plant hormone
...is a substance that plays a role in the life of plants

The above examples are not deployed to claim that the corpus texts contain only material relating to interrogative units. On the contrary, text within a section may include many types of information. It seems, however, that it must allow a reader to derive a certain lexico-grammatically simple answer to the question 'What is it?'. This 'problem-solution' pattern (cf. Hoey 1983; 1991) is posited as the basic recursive structure of the corpus texts. Accordingly, the interrogative unit is seen as the fundamental functional unit in the intra-textual structure of the corpus IBTs. In chapter 4, a closer examination of the interrogative unit will be made in which the lexico-grammatical forms selected in the texts will be seen as facilitators of a fundamental linguistic transformation, which, for undergraduates at least, is the dominant means of acquiring and demonstrating knowledge in biology.

3.5.4 *Stability of interrogative unit content across texts*

Further evidence of the fundamentality of interrogative units can be seen in the stability of content included in this form from textbook to textbook. If a concept is included as an interrogative unit in one corpus text, it is very likely to be included in
all others. Consider, for example, the sections introducing the cell nucleus in each IBT (all emphasis in originals):

The largest and most easily seen of the organelles within a eukaryotic cell in the **nucleus**, which was first described by the English botanist Robert Brown in 1831. The word "nucleus" is derived from the Greek word karyon, meaning kernel or nut...(Raven & Johnson 1992: 91)

The **nucleus** contains most of the genes that control the cell (some genes are located in mitochondria and chloroplasts). It is generally the most conspicuous organelle in a eukaryotic cell, averaging about 5µm in diameter...(Campbell 1993: 123)

The **nucleus** is typically the largest of the organelles...It has a diameter of approximately 5µm in most animal cells...(Purves et al. 1992: 70)

Within the cells of most organisms (though not of bacteria), the largest and one of the most conspicuous structural areas is the membrane-bounded **nucleus**...(Keeton & Gould 1986: 111)

In eukaryotic cells the nucleus is a large, often spherical body, usually the most prominent structure within the cell. (Curtis & Barnes 1989: 108)

If this comparison seems anecdotal, one only has to compare the glossaries provided in the various textbooks to be convinced that a set of core interrogative units is common to them all. Furthermore, one is also struck by the consistency of the terms in which concepts are defined across texts. When looking at the above example, for instance, it is easy to see that in relation to the cell nucleus the central determinant of what the nucleus 'is' relates to its spatial dimensions compared with the cell. All corpus IBTs mention that the nucleus is typically the largest and most conspicuous part of the cell.

The selection of concepts to be treated as interrogative units and the forms of those units, then, are highly stable between textbooks. In terms of secondary discourse it is easy to see why this would be so. A textbook omitting a concept present in others would be liable to criticism that it has omitted important material - a serious charge and something from which one would
expect the ideal reader must be protected. To resist this sort of secondary discourse, therefore, IBTs have developed a sort of evolving comprehensiveness. Each new textbook must be careful to include a very significant portion of material found in existing textbooks or it cannot hope to exert force in the discourse community. The existence of other textbooks thus necessitates and reifies a series of interrogative units that must be included in any new work. This compulsory set of concepts evolves over time (that is, in accordance with the gradual extinction of discussion about the concepts’ truth) into the canonised core content of the discipline.

3.5.5  *Functional model of corpus texts incorporating the interrogative unit*

If we take the interrogative unit, then, as the basic intra-textual functional node - that is, as the unit which completes a topic and allows the introduction of the next through regression to a more senior topic - our functional model of the biology textbook can be further developed as in Figure 3.3.

What began as a formal schematic diagram for the corpus texts (3.2) has now taken on clear functional characteristics. The formal headings in the corpus IBTs constitute a taxonomic skeleton upon which hangs the flesh of the pedagogically central interrogative units. In fact, from Figure 3.3 it is quite clear that the corpus IBTs put forward in pseudo-textual form a set of hierarchical definitions which have much in common with the Linnaean classification system so historically fundamental to biology. It is worth noting how the structure of the IBT in many ways acts as a metaphor for one of its own epistemological tools.
3.5.6 Illustration of the functional model

The functional model developed above can be used to map the structural development of specific interrogative units through the texts. By way of example, Figure 3.4 traces the development in Curtis & Barnes (1989) of the interrogative unit 'cell nucleus' presented in the fourth large headed section of chapter 5: *How Cells Are Organised*. As becomes apparent, a simple statement relating to a cell constituent is actually embroiled in a complicated network of hierarchical relations, a network which perhaps only astute and highly strategic readers fully appreciate and exploit. More, however, will be said about this in chapter 5.

3.6 Ordering of material: fundamental semantic progressions

As is evident from Figure 3.3 above, a basic function of the positioning of interrogative units within the texts is to signal which interrogative units may be taken as parts of other, larger interrogative units. At the beginning of the first chapter of each corpus text, for example, an attempt at an interrogative unit relating to biology signals that the entire remainder of the textbook should be hierarchically construed as part of that interrogative unit. This proceeds in what we intuitively feel as a 'general to specific' progression in the texts. Only the relatively broadest concepts are allowable within first chapters (e.g., methodology, disciplinary aims, ethical concerns), while at subsequent levels more specific material is introduced (e.g., the atom, the cell, the gene). This gradual hierarchical incorporation of interrogative unit into interrogative unit represents what we might call the *vertical* component of the semantic ordering of material in the corpus texts. It allows us to predict, for example, that a discussion of the definition of biology might eventually include a discussion of hydrogen bonds, or that a description of a specific mammal is more likely to be found in a small headed section of a non-initial chapter rather than in the introduction.
As well as this hierarchical structure evident *between* levels, however, there are choices made in the ordering of text *within* levels. For example, conventions appear to exist as to which unit to place immediately after the introduction and which to place last in the textbook. Furthermore, such conventions extend into the organisation of interrogative units within chapters and headed sections. These tendencies are in fact semantic restrictions imposed upon *horizontal* ordering of branches in the hierarchical structure.

Researchers concerned with pedagogy from a cognitive science perspective have often seen awareness of this sort of semantic ordering as an important recall device for students (cf. Van Dijk & Kintsch 1983; Mannes & Kintsch 1987), and such training derived from undergraduate courses perhaps ultimately acts as an important cognitive tool for the professional biologist. The following sections, therefore, explore the types of semantic patterning found within each level of the corpus texts.

### 3.6.1 Ordering of units

The unit, as the largest organising segment within the textbook (and hence the most sublimated site of interrogative units beneath the discipline title itself), is an appropriate starting point for an examination of semantic trends in ordering material in the corpus texts. Table 3.1 shows the order of unit titles within the five corpus texts.

The first and perhaps strongest pattern evident in Table 3.1 is a *spatial* movement from part to whole. Biology textbooks begin with atoms and move towards ecology, progressing through the gene, the cell, the plant, and the animal along the way. Each new unit requires a step back from the object of study until the textbook user is forced to view the world as a complete hierarchical system.
But clearly not all progression of units can be explained by this movement from part to whole. Why, for instance, in Campbell (1993) does the unit dealing with the larger entity 'The Cell' (p. 112) precede the unit dealing with the smaller entity 'The Gene' (p. 240)? And why, in the same text, is the unit 'Plants: Form and Function' (p. 670) placed before 'Animals: Form and Function' (p. 778)? After all, aren't plants and animals often of comparable size?

The answer seems to be that such ordering is the result of two types of temporal prioritising. Firstly, departures from the spatial ordering pattern may be made in order to present material in accordance with their perceived order of evolution on earth. In the example from Campbell (1993) above, for instance, the unit dealing with plants is placed before that dealing with animals because, it seems, plants are considered a prerequisite for the evolution of animals and therefore should precede them in the textbook. The ordering of material in this context seeks to act as a metaphor for the development of life on earth.

Secondly, units dealing with entities perceived as being 'discovered' before others may be placed before those others in the text. In Campbell (1993), for example, the unit devoted to the cell comes before that devoted to the gene. This 'discovery order' prioritising is particularly revealing from an epistemological point of view. The spatial and evolutionary patterns examined above are readily understandable in pedagogical terms: for the benefit of the ideal student, the textbook seeks to present the subjects of study and their possible causal relations in a coherent and comprehensive framework. This suggests that the reordering of material to correspond to its order of discovery is also linked with the perceived ease of intelligibility. In other words, it seems that the discourse community deems that the reordering of some material into an anthropocentric 'discovery order' framework makes it easier to learn. From a 'Kuhnian perspective' (cf. Swales 1995: 3) this might be seen as an example of a certain myth of complexity which equates what is older (e.g. cell theory) with simplicity and obviousness, and what is more recent and topical (e.g. gene theory) with complexity and conceptual difficulty. In fact, the sociology of knowledge perspective might view this type of ordering as evidence of an epistemology influenced by sociological rather than purely objective scientific forces (cf.
A further variation on the part to whole pattern outlined above is the placement of what are intuitively feel to be 'abstract' topics. Examples are the two evolutionary units in Campbell (1993) which, having no obvious spatial or temporal attachments, seem to occur in almost random positions. The term 'abstract', however, is much abused and clarification of what is meant in the present context is required. In this regard, Davies (1986), Love (1991; 1993) and other commentators have maintained that the distinction between process and product topics is important and useful within textbook discourse.

Love (1991) offers an explanation of geology textbook structure in terms of product and process, arguing that these concepts are pivotal in the textbooks' 'attempt to establish a cognitive model for the discipline' (Love 1991: 89). Her analysis proposes that a process-product schema 'is realised in the structure of chapters and in discourse cycles within chapters' (Love 1991: 89). In demonstrating this, Love seeks to establish an identity between the authors' stated model of the text - 'Earth history with rocks as "the documents"' (Love 1991: 92) - and their actual presentation. While equating authorial intention with textual realisation is perhaps a hazardous line of inquiry, the case Love puts forward for a process-product schema, based very strongly on a Hallidayan model, is nonetheless in many aspects an attractive one. In regard to the corpus IBTs it does indeed seem that most unit titles can be classified without too much uncertainty into products or processes. For example, in Campbell (1993) we may classify the units as:

| The Chemistry of Life          | Process |
| The Cell                      | Product |
| The Gene                      | Product |
| Mechanisms of Evolution       | Process |
| The Evolutionary History of Biological Diversity | Process |
| Plants: Form and Function     | Product |
| Animals: Form and Function    | Product |
The patterning of process and product labels is an important device in the arrangement of the corpus texts. In fact, the spatial and temporal patterns described in 3.6.1 may be said to be founded on product features. Only products have size and evolutionary significance and discovery dates. Processes, on the other hand, having no physical dimensions, obviously cannot follow part to whole spatial patterns (although they may tend to occur in an order commensurate with the dimensions of the products involved). There are similarly obvious problems with following temporal rules - it is often difficult to know when a process came into being or was discovered. In fact, outside their affiliations with products, there seem to be few restrictions on where process unit titles can occur. This makes the 'abstract topic', as we have defined it, the central source of flexibility in arranging the textbooks on a unit level, and it is interesting to note that on occasions in the corpus texts where topics are presented 'out of order' according to the spatial and temporal constraints we have established, the unit titles are abstracted into processes to allow this. For example, Keeton & Gould (1986) place the unit containing the chapter 'Ecosystems' (Part IV, ch. 36) before that containing 'The Plant Kingdom' (Part V, ch. 39). The units are accordingly given conspicuously abstract process titles; namely: 'The Biology of Populations and Communities' and 'The Genesis and Diversity of Organisms' (compare these with the rigorously ordered 'The Cell' and 'The Gene' found in Campbell 1993). Clearly, deviation from the product conventions of topic ordering is accountable in some sense in the corpus texts. Abstraction of titles into process descriptions functions as a basic strategy in answering this accountability.

3.6.3 Semantic patterning within units: chapter organisation

The patterns described above governing unit organisation are also prominent in the ordering of chapters. Process topics at this level, however, are much more common and play a central role in how material is ordered. The chapters in Curtis & Barnes (1989), Section 1, for example, are:
The spatial ordering from part to whole is immediately obvious in the progression of product topics:

```
Atom and molecule  ▼
Water (a type of small molecule)  ▼
Organic molecules (larger types of molecules)  ▼
Cells
```

The last two topics, however, are process descriptions (How Things Get into and out of Cells, How Cells Divide). A different strategy is at work in their placement. They are quite simply placed after the chapters containing the material relevant to the products they involve. This is an example of a common trend in ordering chapters. Product sections come before relevant process sections. We must first 'see' the participants before we can view the larger picture of the process in which they are involved. This pattern no doubt exists for pedagogical reasons: introducing processes without having first introduced the often arcane participants (like 'protists' and 'phytoplankton') would be disastrously frustrating for students. This pattern may in fact be seen as a very strict epistemological process, and one which is perhaps fundamental to a student's later thinking in regard to biology. The potential biologist is exhorted to first understand products or entities, and only then the processes in which they are involved. In this light, the sequencing of product and process is perhaps not simply important for its organisational function, but is also, as Love (1993: 215) has noted, fundamental to the
unconscious disciplining of sensory experience into product and process categories.

3.6.4 *Semantic patterning within chapters: the separation of functions under rival interrogations*

The increasing separation of titles into process and product categories at the chapter level was suggested above. It should perhaps also be added that this separation, through its ability to suspend spatial and temporal ordering patterns, causes a loosening in the coherence and comprehensiveness of the textbook's hierarchical structure. In comparison with unit titles, chapter titles do not progress neatly from part to whole, oldest to most recent. Instead gaps appear as whole chapters are disproportionately devoted to 'Fungi' (Campbell 1993: 583) and 'The Vertebrate Genealogy' (Campbell 1993: 635), when the student has been promised 'The Evolutionary History of Biological Diversity' (Campbell 1993: 500).

This breakdown into more realistic and manageable units of presentation becomes even more pronounced within chapters. Product and process no longer even follow a participants-process structure. Often chapters deal exclusively with processes whose product participants have been described in a previous or even subsequent chapter. Where products are central or where processes have an established historical order
spatial and temporal ordering patterns often persist, as in:

The Formation of the Earth
The Beginning of Life
Heterotrophs and Autotrophs
Prokaryotes and Eukaryotes
Viewing the Cellular World

(Purves et al. 1992: 88)

The first two headings above clearly follow an historical ordering pattern. The order of the next two headings seems arbitrary, although they are organised internally on temporal grounds. This, however, is not obvious to the novice. Only after one refers to the text beneath these headings (pp. 89-90) does one discover that heterotrophs are listed before autotrophs because they evolved first on earth, and that prokaryotes are listed before eukaryotes in accordance with their evolution in modern cell theory. There is also some semblance of our anthropocentric discovery pattern in the final positioning of 'Microscopy' - a very modern process which, although almost co-temporal with cell theory, has undergone many more recent advances and transformations. Overall, however, it is unlikely one could extrapolate these semantic patterns simply from the headings within the chapter.

In general, then, the patterns of precise, inclusive spatial and temporal ordering we found were so prominent at the unit level appear increasingly confused within chapters. Accordingly, it becomes difficult to predict which pattern will be used to organise a particular topic in a particular text, or what lexico-grammatical form it will be given. Some topics are treated under abstract process headings prototypically involving nominalisation (cf. Love 1993). Others are presented within a historical context. Still others seem included out of mere topicality.

3.6.5 An explication of material ordering in terms of secondary discourse: comprehensiveness meets canonisation

In terms of the model propounded in chapter 2, the changes in titling described above may be
seen as the result of an increasing tension between competing spheres of secondary discourse: one relating to the formal layout of the textbook and the other to its textual content. On the one hand, from what we might call a 'top down' perspective beginning at its division into units, the IBT is subject to criticism that it has not presented the whole coherent story of biology - that it has not laid out its material in a hierarchical schema encompassing the full range of phenomena biology is capable of explaining. On the other hand, from a 'bottom up' perspective focussing on the actual text, the IBT is also open to criticism that it has included uncertain, 'unagreed', or otherwise pedagogically problematic material: in other words, material that does not have 'canonical' status.

Klamer (1990), Myers (1992) and, more generally, Brown (1993), writing in relation to processes of 'canonisation', have provided convincing arguments that the selection and exclusion of material presented in textbooks is ultimately discourse community based. Klamer, for example, traces diachronically the inclusion and exclusion of material relating to Karl Marx in a prominent economics textbook and its coextensiveness with perceptions of communism. Brown (1993) discusses this process more abstractly in terms of Bakhtin's (1981, 1984, 1986) concepts of hetero- and monoglossia, commenting that:

The centripetal process by which a heterogenous and heterodox range of voices becomes integrated into a unified discursive field, is the process of canonization...(Brown 1993: 69)

In terms of our present model it is easy to see how collective priorities as to what is most 'fundamental' or 'important' for the novice to learn might be 'unified' through the concrete mechanisms of secondary discourse which, as has been argued, engender a group as a the discourse community (cf. ch. 2). Any material included in an IBT not generally accepted by the discourse community would be subject to secondary discourse intended to protect the student from the 'doubtful', 'unproven' and 'over-simplified'. In fact, given basic editorial practices in production of academic texts, such material is likely to be problematised in secondary discourse and extirpated long before it reaches publication. However, if such
material does appear it is subject, one suspects, to rapid marginalisation and exclusion. (An exception is perhaps new material fomenting a canonical shift.)

It has already been suggested above that the most stable unit of content across the corpus texts is the interrogative unit, which we may now view as the base form for presentation of canonical material. In support of this formulation, we noted in 3.5.4 that virtually any interrogative unit present in a particular corpus text could be found in all other corpus texts. In contrast, we have now discovered considerably more flexibility in how these units will be placed within the hierarchical functional structure of the corpus texts. Thus, although we find no section headed 'Transposable Elements' in Curtis & Barnes (1989) as we do in Purves et al. (1992: 280), we nonetheless find the interrogative unit it contains ('transposon') in both textbooks:

Many transposable elements discovered later were longer (about 5,000 base pairs) and carried one or more additional genes. These elements are called transposons. (Purves et al. 1992: 280)

...transposons are segments of DNA that are integrated into the chromosomal DNA...(Curtis & Barnes 1989: 335)

This can be readily explicated by our model: within the chapter, where headings begin to govern actual text containing specific interrogative units, titling begins to be less constrained by broader imperatives of disciplinary coherence and comprehensiveness and more by specific requirements of disciplinary content. In practice, this means that rather than attempting to fill out the all-encompassing schema laid down in the unit and chapter framework, topics within chapters begin to take on a form more closely related to the interrogative units beneath them, which we have seen may only include material granted canonical status.

In summary, the underlying IBT structure illustrated in Figure 3.3 can be seen to perform an important additional function: it reconciles and 'defuses' secondary discourse urging both a comprehensive and canonically faithful textbook presentation.
3.7 Coenoscopic and idioscopic patterning of material within chapters

We have noted that within chapters the corpus texts reduce largely to a series of process and product descriptions selected according to their canonical status within the discipline and their interdependence on each other as materials of explanation. By extrapolating findings from higher nodes of textual sublimation, we have also identified a number of patterns loosely present in this ordering of chapter material; namely, spatial and temporal progressions of different types, and a tendency for product descriptions to precede the processes in which they are involved. This latter pattern leads us to consider on what basis new material - that is, new interrogative units - are introduced and arranged within chapters; for if, as has been argued, new processes rely on already explicated products for their intelligibility, on what do new products rely?

3.7.1 The concept of 'coenoscopic' and 'idioscopic' material

It is possible to go some way towards answering the above question through reference to a dichotomy in the referential form of text - specifically to what we may call 'coenoscopic' and 'idioscopic' patterning of material. These terms, originally employed by Bentham (1816), were adopted by Peirce (c.1902: 241-242) in his attempt to better delineate the purposes of science. Colapietro (1993: 65), summarising Peirce, defines a coenoscopic form of inquiry as one that appeals to 'such observations as come within the range of every human being's normal experience'. He goes on to say, 'In contrast, other investigations...are idioscopic: They depend upon focussed observation often aided by special training and/or technology' (p. 65). In our present investigation this distinction between what is readily seen and known, and what is not obvious and immediate and that must be learnt, can be seen as fundamental to the arrangement of material. In fact, as will be seen, the product and process ordering observed above is merely a higher order symptom of this patterning of material from 'known' to 'unknown'.

First, however - if we are to make use of these new terms - a criterion will be required for
identifying coenoscopic and idioscopic material within texts. Fortunately such a criterion is not
difficult to formulate. In essence, all that is required is to decontextualise material and ask
whether one requires special knowledge relevant to the discipline to produce acceptable
discipline-relevant discourse from that material. For example, in Raven & Johnson (1992: 259)
we find the following:

Practically every one of us knows of someone, a relative or a friend's relative, who
suffers from a condition that might be hereditary.

If someone in your family has had a stroke, for example, it is difficult not to
worry about your own future health.

...the laws of genetics tell us about ourselves, our families, our friends, and
our future children.

Of the 23 pairs, 22 are perfectly matched in both males and females and are
called **autosomes**.

The chromosomes that constitute this pair are called the **sex chromosomes**.

Just as in *Drosophila*, females are designated XX and males XY...

Clearly the first three of these examples are coenoscopic. One requires no special knowledge
to understand and process them and continue the process of semiosis by generating more
discourse from them. Families and friends and relatives are the most commonplace of things.
The second three examples, on the other hand, are idioscopic. Their referents are elusive and
concerned with special ways of seeing: with microscopes and chemical inference. Chromosomes and autosomes are neither physically obvious nor culturally transparent. The
uninitiated have problems placing them in their semiotic encyclopedias, and find it difficult to
produce discourse other than of the simple 'What is it?' type - exactly the interrogation the
statements are seeking to evoke and respond to.

In more general terms, we might say that material is coenoscopic if it belongs to everyday
linguistic experience: that is, if it contains no unknown lexis and no unknown relations of
lexical items. Idioscopic material, on the other hand, is composed of lexical elements and
relations outside everyday experience.

The basis for this distinction may be found in secondary discourse. Coenoscopic material evokes no secondary discourse relevant to itself: the material is transparent, obviously part of reality as it exists in cultural consciousness, and therefore immune to the interrogation structure evoked by alien forms. Idioscopic material, in contrast, is initially unintelligible and compels secondary discourse in a range of metadiscoursal directions, resulting ultimately in interpretation and its attendant problematisation of truth - factors which lead, ultimately, to learning.

The task of the biology textbook amidst all this, of course, is to render the idioscopic coenoscopic, for this is precisely how one becomes a biologist: by learning the semiotic propagation techniques of the discipline. Our next question should therefore be: What patterning of coenoscopic and idioscopic material is fundamental in this transformation of the unknown in to the known?

3.7.2 An analysis of coenoscopic and idioscopic examples

Perhaps the most important and recurrent example of a coenoscopic-idioscopic pattern occurs within chapters. To examine this pattern, we can contrast material taken from the beginning of the sublimating field of a chapter (i.e. the opening paragraph(s) of a chapter situated directly beneath the chapter title itself) with material from a subsequent headed section. Consider the following examples from three corpus texts.

<table>
<thead>
<tr>
<th>Example 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statement from chapter introduction:</strong> Every creature now living is a product of the long evolutionary history of life on earth. You, your dog, your cat, the smallest bacterium - all of us share this history. (Raven &amp; Johnson 1992: 232)</td>
</tr>
<tr>
<td><strong>Statement from subsequent headed section:</strong> A modern geneticist would say the alternative forms of a trait were segregating among the progeny of a single</td>
</tr>
</tbody>
</table>
Example 2

**Statement from chapter introduction:** The chemistry of life is both simple and complex. It is simple in the sense that the laws of chemistry can predict with great precision many chemical interactions. But, though often predictable, the chemistry of life is basically mysterious and intangible... (Keeton & Gould 1986: 25)

**Statement from subsequent headed section:** All the positive charge and almost all the mass of an atom are concentrated in its center, or nucleus, which contains two kinds of so-called primary particles... (Keeton & Gould 1986: 27)

Example 3

**Statement from chapter introduction:** Life's most exclusive distinction is the ability of organisms to reproduce their kind. Like begets like. Only oak trees produce oaks, and only condors can make more condors. (Campbell 1993: 244)

**Statement from subsequent headed section:** One chromosome represents hundreds or thousands of genes, each of which is a specific region of the DNA molecule. A gene's specific location along the length of a chromosome is called the gene's **locus**. (Campbell 1993: 245; emphasis in original)

Coenoscopic material is clearly more concentrated in the sublimating field at the beginning of chapters. The classic pattern or 'cycle' (which is perhaps a more appropriate term; cf. Hopkins & Dudley-Evans 1988; and Love 1991) in the corpus texts is to render a concept in coenoscopic terms, develop an idioscopic term from it, then repeat the process using the new term as the coenoscopic base for the next term. Chapters almost invariably begin with coenoscopic material, out of which is developed a link to the first interrogative unit. Often this link is in the form of a problem derived from everyday experience. Such a problem often establishes a problem-solution pattern (cf. Hoey 1983) leading to the first interrogative unit. For example, chapter 30 of Purves et al. (1992), *Plant Nutrition*, begins:

One year, the older leaves of some crop plants turned yellow instead of remaining green as usual... (Purves et al. 1992: 679)

This very everyday opening leads to a consideration of an interrogative unit devoted to deficiency symptoms which in turn leads to one devoted to nutrients. In fact the trail of concepts
developed from this opening run: deficiency symptoms, nutrients, mineral nutrients, autotrophs, heterotrophs, chemosynthetic (Purves et al. 1992: 680). There are both serial and intensional patterns in this progression. As we have seen above through an investigation of the functional organisation of the corpus texts, all concepts in a chapter relate on an intensional level to its title, just as all concepts in a subsection relate intensionally to the subsection title. On the serial level at which a textbook is commonly used, however, it is pedagogically necessary to begin with something the novice can understand without reference to anything outside common cultural experience, or, in our terms, with something coenoscopic. In many cases the coenoscopic 'trope' which introduces a new chain of interrogative units makes use of powerful intertexts (cf. Kristeva 1980). As one would expect, this tendency is most pronounced in the first sublimated field of the textbooks: chapter 1. Campbell (1993), for example, begins with mention of the human affinity for pets. Raven & Johnson (1992) begin with reference to a colour photograph of a replica of the HMS Beagle, the ship on which Darwin sailed. Keeton & Gould (1986) opt for a discussion of the earth's place in the solar system. In each case, we discover that the interrogative structure of the corpus texts demands that the idioscopic be derived from the coenoscopic which necessarily precedes it. Accordingly, any interrogative unit in the texts can potentially be traced back to a sublimated coenoscopic 'trope'. This trope is prototypically an intertextual enlistment of some sort which facilitates cognitive modelling of biological concepts by relating them to known and 'accepted' material.

3.7.3 A pragmatic move model of the biology textbook chapter based on the coenoscopic-idioscopic distinction

The discussion of the coenoscopic-idioscopic structure of the biology chapter above is generalised below into a 'move model' (cf. Swales 1981b). This model, like others in the current proliferation, attempts to add to our understanding of what Bhatia (1993: 30) calls a text's 'cognitive structure'. In the context of IBTs this might be clarified as the processes an 'ideal' student goes through when reading a chapter of the corpus texts. As has been argued, this concept of the ideal student is also fundamental to insights into the composition process of
IBTs.

**Figure 3.5 Coenoscopic-idioscopic move model of the IBT chapter**

**Move 1:** Establish a coenoscopic situation with the first interrogative unit as its solution(description/problem).

**Move 2:** Explicate first interrogative unit (idioscopic) in established terms (coenoscopic).

**Move 3:** Introduce second interrogative unit and subsequent units on the basis of the first through a limited set of causal and descriptive moves.

**Move 4:** Close chapter with reference to Move 1 coenoscopic situation now expressed in idioscopic terms and/or a summary that allows the student to confirm that what was once idioscopic has in fact become coenoscopic.

While a detailed explication of the above model will not be attempted, it is not difficult to see how each move could be seen as a necessary step in resisting secondary discourse relating to the intelligibility of material presented.
3.8 Summary

In this chapter a functional model of the introductory biology textbook was put forward whose two basic features were:

- A dichotomous branching structure which served to sublimate and subordinate sections of text within a hierarchical, Linnaean-like framework; and
- A system of nodes or 'interrogative units' which, as the intra-textual endpoints of the structure described above, represented the stable or canonised knowledge content of the discipline.

At the broadest levels, examination of semantic patterns within realisations of this functional model revealed considerable patterning on spatial and temporal principles. At levels closer to the interrogative unit, placement of participants in processes before the relevant processes themselves became more prominent. At these levels, however, a general breakdown in semantic ordering of material was observed.

This split in ordering priorities suggested two types of broader function within the schematic structure of the corpus texts. One function - most strongly present within the ordering of units and chapters - was epistemic. The hierarchical structure strived to frame biology as a continuous and comprehensive science - to convince the reader that biology was a powerful science with a firm grasp on a logical and continuous subject matter. In contrast, within chapters and headed sections, this function yielded to what are more traditionally identified as pedagogical concerns: participants were described before processes, for example, to allow the ideal reader to decode the text efficiently. The content prefigured in the larger structure as exhaustive and continuous became selective and discontinuous, depending on topicality, explicability and discourse community acceptance for its inclusion or exclusion.

In addition, a key process in the introduction of idioscopic ('unknown') material was seen to be
initial reference to coenoscopic ('known') material. This process typically consisted of intertextual borrowings from culturally diffuse, unproblematic sources.

The tendency towards a pedagogical presentation regulated by secondary discourse will be further explored in the next chapter, where an attempt will be made to show that a number of lexico-grammatical features of the corpus IBTs, like the features explored in this chapter, are the result of their conformity to an interrogative structure. This will primarily involve an extension of the concept of the interrogative unit formulated above.
Figure 3.1 Generalised formal organisation of corpus texts

Textbook

- Introduction
  - Introduction
  - Large Headed Section
    - Introduction
    - Small Headed Section

Parts

Chapters

- Introduction
- Large Headed Sections
  - Introduction
  - Small Headed Section

= division always found
= optional division
Figure 3.2 Functional model of corpus texts showing subliminated-subordinated structure

- Textbook
  - Subliminated Section
    - Subliminated Section
  - Subordinated Section
    - Subordinated Section
  - Subordinated Section
    - Subordinated Section
  - Subliminated Section
    - Subliminated Section
  - Subordinated Section

= division always found
= optional division
IU = Interrogative Unit

= division always found

= optional division

Note: The interrogative units shown at each node merely represent an indefinite number. The actual number will vary according to text and from level to level.
Figure 3.4 Hierarchical positioning of interrogative unit 'nucleus' in Curtis & Barnes (1989)

IU = Interrogative Unit
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The Chemistry of Life</td>
<td>The Cell</td>
<td>The Chemical and Cellular Basis of Life</td>
<td>The Origin of Living Things</td>
<td>The Unity of Life</td>
</tr>
<tr>
<td>The Cell</td>
<td>Information and Heredity</td>
<td>The Biology of Organisms</td>
<td>Biology of the Cell</td>
<td></td>
</tr>
<tr>
<td>The Gene</td>
<td>Evolutionary Processes</td>
<td>The Perpetuation of Life</td>
<td>Energetics</td>
<td></td>
</tr>
<tr>
<td>Mechanisms of Evolution</td>
<td>The Evolution of Diversity</td>
<td>The Biology of Populations and Communities</td>
<td>Reproduction and Heredity</td>
<td></td>
</tr>
<tr>
<td>The Evolutionary History of</td>
<td>The Biology of Flowering Plants</td>
<td>The Genesis and Diversity of Organisms</td>
<td>Molecular Genetics</td>
<td></td>
</tr>
<tr>
<td>Biological Diversity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plants: Form and Function</td>
<td>The Biology of Animals</td>
<td></td>
<td>Evolution</td>
<td></td>
</tr>
<tr>
<td>Animals: Form and Function</td>
<td>Ecology and Biogeography</td>
<td></td>
<td>Ecology</td>
<td></td>
</tr>
<tr>
<td>Ecology</td>
<td></td>
<td></td>
<td>Evolution</td>
<td>Biology of Viruses and Simple Organisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biology of Plants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biology of Animals</td>
<td>Vertebrate Biology</td>
</tr>
</tbody>
</table>
CHAPTER 4
THE PRIMACY OF THE INTERROGATIVE UNIT

4.1 Introduction

IN CHAPTER 3 it was suggested that the corpus texts are constructed around interrogative units. It was proposed that these function as a means of satisfying and resisting an interrogation structure residing within a system of secondary discourse which constantly demands - on behalf of an ‘ideal’ student - an answer to the question, 'What is X?'. An investigation was also made into the fundamental role these interrogative units play in the functional structure of the corpus texts with the conclusion that they act as nodes or endpoints in a hierarchical structure similar to a Linnaean tree. It was also suggested that a stable or canonised content contained in these interrogative units co-occurs in all texts.

This chapter advances the analysis begun in chapter 3 to the lexico-grammatical level. A study is made of the lexico-grammatical form of interrogative units in an attempt to explain several features of IBT prose as textualisations of the primacy of the interrogative unit within the texts' interrogation structure.

Perhaps such an approach requires justification. After all, many researchers have argued that a careful lexico-grammatical analysis should precede rather than follow a functional model. While it cannot be denied that this type of *a posteriori* approach has yielded many important and useful insights, in the present context it has the following limitations:

1. Textbooks are extremely large and complex, and the chances of arriving at meaningful generalisations relevant to broader issues of pedagogy through an *a posteriori* analysis seem extremely remote.

2. A posteriori lexico-grammatical analysis involves the disembodiment of language from its
social function, claiming in effect that such a function is recoverable from a mechanical analysis of the text. Often implicit in this is a model of language as an objective, universal phenomenon which can be reduced to a finite number of analysable formal devices. In the current approach it has been maintained that just the opposite is true (cf. ch. 2).

3. Lexico-grammatical generalisations, once arrived at, are complex and often inconsistent matrices of rules and exceptions. Is it not better - at least in an exploratory study - to begin with the larger unit and work down towards such complexity than to begin with a mass of detail and seek to arrive at a coherent holistic theory? Added to this is the problem of ignoring what may be pivotal, but statistically insignificant, disconfirming instances in that detail.

We begin, therefore, with the functional notion of the interrogative unit established in chapter 3.

4.2    Interrogative units and their lexico-grammatical form

In chapter 3 the concept of the interrogative unit was extrapolated chiefly from an examination of two features of the corpus texts. The first of these was the larger organisation of the textbook, which was found to sublimate and subordinate topics within the textbook into a hierarchical structure resembling a Linnaean tree. It was found that each branch in this structure ultimately ended in segments of text which served to answer the interrogative demands incited by the titles above them - a finding that suggested an interrogative unit. The second such suggestive feature of the corpus texts involved a number of extra-textual clues such as the presence of glossaries, bolding of 'key concepts' in the text, and the careful differentiation of extraneous material from the hierarchical structure by mechanical means. We now proceed to examine the interrogative unit as a function within text with a view to discovering its formal characteristics and its effect on textual patterning.

4.2.1    Examples of interrogative units and their structure
A first step is to consider some examples of text identified, on the basis of the discussion in chapter 3, as containing interrogative units - that is, text which seems formulated to resist the interrogative structure's constant attempts to deconstruct the textbook with the ideal student's question, 'What is X?' Of the following, the first five are taken from chapter 2 of Campbell (1993), and the second five from chapter 20 of Purves et al. (1992) (all emphasis as per original texts):

Chemistry is the study of matter. (Campbell 1993: 24)

...matter is defined as anything that takes up space and has mass. (Campbell 1993: 24)

An element is a substance that cannot be broken down to other substances by chemical reactions. (Campbell 1993: 26)

Trace elements are those required by an organism in minute quantities. (Campbell 1993: 26)

The units of matter are called atoms. (Campbell 1993: 27)

Any group of organisms treated as a unit in a classification system is called a taxon. (Purves et al. 1992: 440)

Taxonomy is the theory and practice of classifying organisms. (Purves et al. 1992: 440)

Systematics is the scientific study of the diversity of organisms. (Purves et al. 1992: 440)

A genus is a group of closely related species. (Purves et al. 1992: 440)

The category above the genus in the Linnaean system is the family. (Purves et al. 1992: 441)

The above examples all exhibit (as was noted in chapter 3) what might be called - for want of a less misused term - 'definitional' form. They all consist of two noun phrases linked by a verb from a highly restricted set (in seven cases a form of be and in the others a passive form of call or define). The formula they follow might be represented as:

Nominal construction + verb from a + Nominal construction
Let us now consider the characteristics of each constituent in turn.

4.2.2 Nominal constructions within the identified interrogative units

The two nominal constructions involved in the above linguistic formula are starkly different. Firstly, in each example, one nominal construction is much longer and more complex than the other - that is, one includes left and right branching modifying elements such as adjectives, prepositions, conjunctions, and verbs, while the other does not. This is highlighted in Table 4.1 on the following page.

An obvious semantic process is involved in this. The thing which is defined (referred to in formal analysis as the definiendum) is in each case lexico-grammatically simple, composed of only one or two items: 'chemistry', 'matter', 'an element'. The nominal construction used to define the definiendum (the definiens), on the other hand, is relatively more complex: 'the study of life', 'anything that takes up space and has mass', 'a substance that cannot be broken down to other substances by chemical reactions'. In the texts, very explicit help is provided in sorting out this relation by bolding of the definiendum. We might note in passing that this bolding relates also to the coenoscopic-idioscopic patterning investigated above in chapter 3.

A second feature of the nominal constructions in our formula for the interrogative unit involves the order of the definiendum and definiens. As one would expect in more 'formal' definitions (such as those found in a dictionary - a powerful intertext
Table 4.1 Nominal constructions in example interrogative units sorted according to complexity

<table>
<thead>
<tr>
<th>Less Complex</th>
<th>More Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>the study of matter</td>
</tr>
<tr>
<td>...matter</td>
<td>anything that takes up space and has mass</td>
</tr>
<tr>
<td>An element</td>
<td>a substance that cannot be broken down to other substances by chemical reactions</td>
</tr>
<tr>
<td>Trace elements</td>
<td>those required by an organism in minute quantities</td>
</tr>
<tr>
<td>atoms</td>
<td>the units of matter</td>
</tr>
<tr>
<td>taxon</td>
<td>any group of organisms treated as a unit in a classification system</td>
</tr>
<tr>
<td>Taxonomy</td>
<td>the theory and practice of classifying organisms</td>
</tr>
<tr>
<td>Systematics</td>
<td>the scientific study of the diversity of organisms</td>
</tr>
<tr>
<td>A genus</td>
<td>a group of closely related species</td>
</tr>
<tr>
<td>family</td>
<td>the category above the genus in the Linnaean system</td>
</tr>
</tbody>
</table>
in the present context), the definiendum occurs most commonly in first position. It is perhaps stating the obvious to say this represents the base or uninverted order for the definition in English.

4.2.3 Verbal constructions within interrogative units

Only three verbs were found in our sample of interrogative units. Their infinitive forms were: 'be', 'be defined as' and 'be called'. The predominance of be as a freestanding copula, and also its occurrence in the passive constructions as an auxiliary, single it out as the central verbal tool of the interrogative unit. This is no surprise when we consider that our posited interrogative structure itself is formed around this verb: 'What is X?' translates most easily into 'X is...'.

But how, then, do we explain the occurrence of call and define? These are certainly not the only alternatives to be in the textbooks, but they are perhaps worthwhile examining briefly as representatives of that set of verbs that appear to function within the corpus texts as alternatives to, or extensions of, the copula be. Why are such variants necessary?

One reason call is found may be due its ability to reorder definiendum and definiens while still marking a statement as an interrogative unit. This is evidenced in the examples above where both instances of call exhibit inverted definiendum-definiens order:

The units of matter are called atoms. (Campbell 1993: 27)

Any group of organisms treated as a unit in a classification system is called a taxon. (Purves et al. 1992: 440)

Call, like define, also introduces a degree of acknowledgement of arbitrariness into the definition with the suggestion that convention has a role to play in the recognition of the

\[ ^{8} \text{The unmarked form of a definition - that is, the form a reader expects - has the definiendum in the first position due perhaps to the layout of dictionaries and encyclopedias. Alphabetic listing requires the definienda to be the first element.} \]
definition. Indeed, this seems to be the primary function of define, as well as an element of other variant copulae such as be referred to, be known as and, to some extent, consists of. This last, however, is more often a marker signalling that a definition consists of a number of interrogative units.

Our generalisation might be that verbs in interrogative units are obliged, via their relation to the interrogative structure, to function and be interpreted as simple variants of be. This verbal pattern is perhaps an example of Foucault's insight that the episteme of science relies most heavily upon a 'patent or secret function of the verb to be' (Foucault 1970: 136). In Foucault's (1970) analysis, science seeks to divide and discipline the visible by means of this special function. Once again, interesting links might be made between this notion and the coenoscopic-idioscopic patterning identified in chapter 3.

4.2.4 Revised model of the interrogative unit

On the basis of our examples and the above analysis, then, we can model the base form of the interrogative unit as:

\[
\text{Nominal construction} + \text{form of } be + \text{Nominal construction}
\]

(Definiendum) (copula) (Definiens)

4.2.5 A rationale for the prevalence and primacy of the interrogative unit

The links between the above linguistic structure and the definition are now clearly evident. In fact, the glossaries provided in the corpus IBTs may be seen as a simple formalisation of this relationship. By listing interrogative units in alphabetical order in a ‘mini-dictionary’ the textbooks make explicit exactly what they are seeking to provide. Above all, the ideal reader must assimilate the glossarised definitions, for these are the most fundamental statements of knowledge it can provide.
At this point it is important to make clear the direction of causality proposed to operate between the functional elements of the corpus texts. It is claimed here that interrogative units, due to their ability to resist secondary discourse, are the central units of the texts. As such they exert organisational power both upward and downward. Upwardly they facilitate a hierarchical organisation which, as we have seen, seeks to define a series of higher terms even unto biology itself. Downwardly they influence the lexico-grammatical organisation of the text which realises them. It is with the latter of these influences that we are now concerned. The next sections will attempt to show how the primacy of the secondary discourse resistant interrogative unit shapes and constrains a number of other textual features of the biology textbook.

4.3 Other patterns and their relation to the canonical pattern

In 4.2.4 we arrived at a basic unmarked linguistic form of the interrogative unit within the corpus texts. We might call this the canonical pattern - that is, the pattern whose contents are most strongly marked as agreed upon within the discourse community. At this stage, however, we must ask ourselves: why does so much in the textbook not conform to this canonical pattern? While we can demonstrate that the form we have identified above is extremely common in the corpus texts, we must also admit that many sections of text which obviously function as 'interrogative units' are not cast in such a form. In the neighbourhood of the
Two or more elements may be combined in a fixed ratio to produce a **compound**. (Campbell 1993: 26)

Neutrons and protons are packed together tightly to form a dense core, or **nucleus**, at the center of the atom. (Campbell 1993: 27)

At first glance, these statements seem to have little in common in a grammatical sense with the canonical pattern derived above. Yet on closer inspection it becomes clear that they share a fundamental relationship to the canonical pattern. Consider these rewritings of the above examples:

- **A compound** is two or more elements combined in a fixed ratio.

- **A nucleus** is a dense core of neutrons and protons at the centre of the atom.

These rewritings contain the same content (there may, of course, be certain pragmatic differences in context) as their non-canonical counterparts, but in canonical form (’NP is NP’). At this point it is necessary to introduce an important novum into our analysis; for, on the basis of the above rewritings, we can conclude that the relationship defining interrogative units is not one of defining formal features but of **transformation**. An interrogative unit is **potentially capable** of being expressed in canonical form rather than something which necessarily possesses that form. By way of defining our interrogative unit, then, we may write:

*An interrogative unit is realised within the corpus texts when the text allows, either through direct quotation or through reasonably simple transformation, expression of that unit in the canonical form:*

\[
\text{Nominal construction} \; + \; \text{copula} \; + \; \text{Nominal construction}
\]

(Definiendum) \hspace{1cm} (Definiens)
At this point it is possible to see clearly why an *a posteriori* lexico-grammatical analysis cannot succeed in revealing what we have seen as the dynamic constraints governing IBT discourse. What is constant and fundamental to the corpus texts is not lexico-grammatical form (although some forms are, *symptomatically*, more prevalent than others) but rather a potential linguistic transformation to a canonical form. It is this potential transformation, derived from the primacy of the interrogative unit and its chosen culturally marked form, the definition, that forestalls or shapes secondary discourse in the discourse community in such a way as to regulate 'allowable contributions' (Swales 1990: 52-53) within the biology textbook. The canonical form is in fact so embedded in the pedagogical practice of biology that it can render silent as 'non-scientific', 'irrelevant' or 'unclear' everything that it is not cast within it. By way of illustration: if a textbook, through circumlocution, omission or misplacement, allows no statement of the form 'Valence electrons are the outer most electrons of the atom' (transformation of Campbell 1993: 32) to be readily derived, a discourse community member can and will create secondary discourse along the lines of 'There is a gap in the textbook's explanation of atomic structure'. This, naturally, is inimical to the textbook's success. Too many such instances of secondary discourse, or one major instance, would lead to a gradual marginalisation (if not forestalling of publication) of the textbook through problematisation of its accuracy. Though it might materially exist, it would lack the dissemination required for entry into discourse community consciousness.

4.4 *A rationale for the canonical form*

The reasons for the primacy of the canonical form are perhaps not far to find. The interrogative structure of the corpus texts is strongly influenced by the prevailing model of the student within the discourse community. One only has to examine the form of undergraduate biology examinations to see that discourse community members presuppose a model of biological knowledge as a set of memorisable propositions. The canonical form we have investigated above has been the positive vehicle for these propositions since at least the time of Aristotle.
Indeed, it could well be claimed that the textual, and in some sense narrative, layout of the modern textbook is in fact little more than a concession to modern pedagogical trends which stress humanist values in education. This will become increasingly apparent throughout the remainder of this chapter which examines several other features of the corpus texts - suggested largely by researchers in other textbook genres - in an attempt to show these to be the result of the primacy of the canonical form expounded above.

4.5 The canonical form and unit, chapter and heading titles

To illustrate the canonical model developed above we can apply it to the more explicitly marked interrogative labels in the higher echelons of textbook organisation. After all, the contents sections of the corpus texts, according to our model, provide a useful and exhaustive listing of interrogative units. What, then, is it possible to say about the form of unit, chapter and section titles?

A vast number of formal observations could be made regarding the lists of titles found in contents sections, but perhaps the first thing we notice is the nominal character of titles. One factor resulting in this impression is the prominent use of nominalisation that so many researchers have found pivotal within scientific prose (cf. Love 1993: 201-204; Bhatia 1993: 148-154). However, we also recognise this nominal character by noting the rarity of verbal complexes, which virtually occur in only one environment; namely, in process titles with so called ‘wh’ words (e.g.,
What is a Species? (Curtis & Barnes 1989: 407); What is a Gene? (Campbell 1993: 338)). In addition to this vague sense of nominal character, some other prominent features of contents sections are:

- The prevalence of the conjunction *and*;
- The prevalence of the prepositions *from, with* and *of*;
- The preference for the prepositional construction with *of* as opposed to use of the genitive morpheme ‘s.

What do these characteristics share in a functional sense? In terms of the model developed in this study the nominal character of titles is immediately comprehensible as a product of the primacy of the interrogative unit. These nominal phrases are the definienda (either conflated or singular) relating to textual segments subordinate to them somewhere in the text. We have said above that part of the modelling of the ideal textbook user demands that the amount of linguistic transformation necessary to derive a canonical form interrogative unit should be kept to a minimum. What we have in titles in the pedagogical sense, therefore, is a directory of definienda for memorisation and hierarchical integration. It is no surprise that these definienda are nominal.

The case, however, is more complex than this, for we have noted above that certain prepositions and conjunctions are common in titles, and that the genitive construction is generally dispreferred. In addition, were titles to be truly definienda and obedient to our rule of minimal linguistic transformation, we would expect them to fit readily into the product and process definienda slots:

- Product Definienda is...
- Process Definienda is a process in which...

Many titles do. For example:
Nucleotides are...(Campbell 1993: 84)
Microscopy is a process in which...(Campbell 1993: 117)

But what do we make of the following:

The Structure and Behaviour of Atoms (Campbell 1993: 27)
Parental Imprinting of Genes (Campbell 1993: 295)
Mutations and Their Effects on Proteins (Campbell 1993: 336)

It is clearly a stretch to attempt to place these in our canonical form slot. They are conglomerations of definienda. The ideal reader must seek two canonical form statements from such a title. The first example from Campbell (1993) above becomes:

The structure of the atom is...
The behaviour of the atom is...

Separate interrogative units for each of these are in fact readily recoverable from the text. The same is also true of the other examples. We might choose to see this process of conglomeration as a way of condensing material (IBTs are, after all noticeably massive), and also as a convenient means of forging links between strongly related interrogative units. The question remains, however, as to why the lexico-grammatical tools used in this process (identified above) are preferred to others.

Nominal constructions in textbooks have, in fact, been afforded considerable study (e.g., Davies 1986; Eggins, Wignell and Martin 1987; MacDonald 1992; Love 1993). Their treatment under the broader rubric of scientific discourse has been even more intense, so much so that the prevalence and centrality of nominal constructions is perhaps no longer in question. However, as yet there still exist several competing models of nominal constructions, and debate
continues over their textualising function within specific genres. Bhatia (1993), for example, comments that: 'Complex nominal expressions of various kinds...have gained a certain degree of notoriety in recent years' (p. 148). His own analysis, drawing on studies by Quirk et al. (1982), Bhatia (1983), Williams (1984), and Salager (1984), focusses on three types of 'nominal expression': complex nominal phrases, compound nominal phrases and nominalisation. Each of these, Bhatia claims, are prominent within a particular genre. There are good reasons, therefore, for seeing the nominal complexes used in titling as important.

As we have noted above, the tools used in the conglomeration of interrogative units into titles in the corpus IBTs are of a restricted type. They allow, above all, the extraction and separation of definienda of canonical form interrogative units. The conjunction and does little more than highlight juxtaposition of capitalised nominals; similarly, the use of prepositions allows easy identification and separation of nominal labels, a trend further evidenced by the avoidance of the genitive morpheme, which might tend to complicate separation. Prepositions and coordinating conjunctions are the chief tools in building titles, therefore, simply because they facilitate dissolution of a complex title into interrogative units cast in canonical form.

This is not to deny that the titles themselves often represent something more than a conglomerate of canonical units. Titles are occasionally of a more abstract, complex form: consider, for example, the section title A Scientific Revolution (Raven & Johnson 1992: 327). Such titles are reinforced, if at all, by what is merely a vague or potential reference to canonical forms. On these grounds we must admit lexical differences that do not fit with interrogative units in the texts into our model of the title. The chief such lexical difference is the occurrence of lexical conflations typically founded upon intensional semantic relations. Campbell's chapter containing sections on The Foundations of Organic Chemistry and Functional Groups, for example, is titled Carbon and Molecular Diversity (Campbell 1993: ch. 4). No interrogative unit relevant to 'Molecular Diversity' is directly recoverable from the text of the chapter. The term does relate, however, to the patterning of titles within the chapter. In other words, titles - rather than always acting as simple definienda - sometimes take on a hyponymous function.
On a deeper level we must ask why a text so devoted to a canonical form at the textual level would have as one of its most stable genre features the casting of the definienda of such forms into conglomerations and conflations? A possible answer to this question has already been suggested above in 3.6.4 where it was argued that the basic form of the biology textbook is determined by two opposing functions - an epistemological function which seeks to convince users of the continuity and order of the discipline, and a canonical function which seeks to present only agreed upon and topical 'facts' of the discipline. It was argued that these operate in opposing directions: the epistemological function from the top down, being most prominent in unit titles (which generally govern no text at all); and the canonical function from the bottom up, being most present in sections of text. What we see in the conglomerational and conflational form of unit titles, then, is the meeting and reconciliation of these two functions. On the one hand, section titles are striving to present an ordered and continuous discipline; on the other, they are attempting to catalogue only the canonised interrogative units condoned by the discourse community. This is demonstrated in the tendency for titles to become more aligned with the canonical function the closer their position to text containing actual
interrogative units. Thus in Campbell (1993) we find chapter titles such as:

- Carbon and Molecular Diversity
- The Structure and Function of Macromolecules
- An Introduction to Metabolism

These represent conflations of interrogative units so severe as to be almost irresolvable into a canonical form statement. At the level of headings for actual text, however, we find titles such as:

- The Hydroxyl Group
- The Carbonyl Group
- The Amino Group
- The Sulfhydryl Group
- The Phosphate Group (Campbell 1993: ch. 4)

These, in contrast, clearly relate to interrogative units fitting the canonical form.

4.6 Features of textbook discourse highlighted by other researchers and suggestions for their explanation by a secondary discourse model

It has been proposed above that the interrogative unit and its relation to a canonical form is the central determinant of the lexico-grammatical form of text within the corpus. Interrogative units, in other words, are the function which determines the form. It is obvious, however, that the corpus texts are not exclusively lists of canonical form statements. In fact it has been shown already that a certain flexibility exists in the form of interrogative units that allows them to be moulded to suit a number of broader exigencies (the inverted order potential facilitating the humanist textual presentation of material mentioned in 4.4, for example). To understand these textual processes supporting and rivalling the interrogative unit more clearly, we need to step back from the interrogative unit and examine the texts once again from the point of view of our secondary discourse model. Unfortunately, the size of this task is prohibitive in the context of the present work. The following sections, however, make a start in this direction. They examine two already established features of textbook discourse in an attempt firstly to confirm their
existence in the corpus texts, and secondly to explain them in terms of our secondary discourse model.

4.6.1  *Diminution of human agency*

One prominent, and often explicitly taught, aspect of scientific writing is the avoidance of explicit reference to human agents. This occurs most prominently through passivisation. Chemicals 'are added'. Test tubes 'are placed'. Results 'are measured'. Much confirming research into this phenomenon has been done in other introductory textbook genres. Myers (1992), for example, in a comparison of passages from a textbook and a research article in the field of genetics, commented that 'both texts have mainly impersonal subjects'. Macdonald (1992) investigated how agents are used to 'emphasize...the possible physical and perceptual phenomenon...in their discipline' (p. 540). Love (1993) used Macdonald's analysis in a study of geology textbooks and commented on the ways in which the subject position in some contexts is often used as a foregrounded slot for abstract or 'epistemic' nouns. Work such as the above recently led Swales to list 'the diminution of human agency' as a 'textbook characteristic' (Swales 1995: 4). An informal survey of any passage in the regular structure of the corpus texts is sufficient to confirm that IBTs are not exempt.

We can be reasonably certain, then, that a paucity of human agents does exist in the corpus texts. To understand the reasons for this we need perhaps to ask ourselves what would happen were human agents to be introduced. This is a multifaceted and perhaps somewhat discipline-specific question. In the corpus IBTs, however, it seems that above all this would entail the introduction of string of new 'second
order' interrogative units of the form:

Human Agent X is the discoverer of interrogative unit Y

(These do indeed exist, as in: 'Priestley's important experiments were the first demonstration that plants produce oxygen' (Keeton & Gould 1986: 197). These are a relative rarity, however, and we will hold them in temporary abeyance.)

Obviously, in the light of our secondary discourse model, discourse community mechanisms somehow function to forestall the proliferation of such statements. The vast majority of interrogative units in the textbooks go uncredited. They are presented simply as incontrovertable facts without discoverers, observers or performers. But suppose an attempt to credit these facts were actually made in a textbook. What would be the result? A probable consequence is that such inclusions would lead to a proliferation of negative claims (i.e., secondary discourse) decrying the 'confused', 'cluttered' or 'unfocussed' layout of such a textbook (which ultimately would either forestall its publication or, were it published, gradually silence it in the discourse arena). In terms used by the relevant discourse community, then, too many human agents lead to a 'confusion' of facts from which the ideal student must be protected.

But this hardly suffices as an explanation for omitting human agents. We must question the use of terms such as 'confusion', 'cluttered' and 'unfocussed', which seem to exist, in this context, as teleological endpoints in the secondary discourse relating to textbooks. What is really meant by 'confusion'? Ultimately it seems these sorts of terms are always enlisted to aid in the protection of a single sacred notion: the epistemological continuity and comprehensiveness of biology. Subtextually, the routine inclusion of human agents in textbooks would make the learning of the 'true' biology more difficult because the 'true' biology contains a sparse and strictly constituted history of its own. The use of human agency in the textbook outside of passages presenting this canonical history might raise the possibility of historiographical
interrogation of the texts. Such an interrogation would be totally inimical to the epistemological function's imperative to maintain biology as a discipline commanding a continuous and ordered - and therefore unimpeachable - subject matter. The diminution of human agency is symptomatic of a systematic avoidance of discourse patterns likely to problematise this continuity and order.

The validity of the above argument is demonstrated through an examination of sites in which human agency does occur. The selection and spacing of these is often impeccably considered to give the impression of continuity and linear development. What is presented in the corpus texts is not a history of biological discoveries, but rather a genealogy in which each subsequent advance is born quite logically from its predecessor (cf. Woolgar 1988). This topic, as Myers (1992: 8) has noted, is deserving of much greater study than it has been afforded to this point; much more, indeed than the present study is able to devote. However, consider, by way of a provocative example, Keeton & Gould's (1986: 197-198) account of 'Early Research in Photosynthesis', which, in typical IBT fashion, traces the discovery of photosynthesis through a pre-modern and a modern stage. In the pre-modern stage a small cluster of developments are noted:

1772           Priestley
1779           Ingenhousz
1782           Senebier
1804           Théodore de Saussure

Of course one might argue, from what Woolgar (1988: 7) calls a 'realist' point of view, that these dates and names represent genuine positive advances in the formulation of the current conceptualisation of photosynthesis. In opposition to such a view, however, we might note the sentence that links these all together:

Thus, early in the nineteenth century, all the important components of the
photosynthetic process were at least vaguely known... (Keeton & Gould 1986: 197)

Clearly, at that stage there was no lexical item 'photosynthesis' as such, but merely the hypothetical possibility that an omniscient observer could have formed such a theory. These independent experimental happenings have been gathered together to construct a systemically necessary history of a pivotal biological concept. The selective mechanisms and implicit historiography involved in this process would be interesting to investigate (cf. Myers 1992: 8). Does the assertion that certain components were 'vaguely known', for example, constitute an objective criteria for the selection of these historical elements? And what justifies the next jump to 1930 when 'C.B van Niel of Stanford University showed that some photosynthetic bacteria...give off sulfur instead of oxygen as a by-product' (Keeton & Gould 1986: 198)? In the 126 years between Théodore de Saussure and van Niel, did nothing really noteworthy happen in the field of photosynthesis to rival the work of the pre-moderns?

In the face of these question, our assertion is that there is some element of selectivity here aiding the historical scaffolding of biological facts into the semblance of coherence. This is evidenced in the tight temporal clustering of the pre-modern advances and their presentation in the text as a logical progression - a progression which implies a certain accretive model of knowledge which is obviously efficient in resisting relevant secondary discourse.

To return to our original point of departure, then, we may conclude that human agency is relatively rare in the corpus texts because its use invites historical interrogation. Opportunities for such interrogation are always carefully controlled in IBTs (if not in all scientific writing) due to a set of strict controls governing cohesion and comprehensiveness in scientific history and historiography - controls which, of course, reside in secondary discourse.

4.6.2 *Paucity of hedging*
Another commonly reported feature of textbook discourse, and one which is perhaps related to the diminution of human agency, is the relative absence of hedging in textbooks. Strong evidence for this in the field of scientific textbooks was provided by Latour & Woolgar (1979: 77) who contrasted textbook discourse with the discourse of scientists in the laboratory through the use of a 'hierarchy of statement types'. Their work was taken up by Myers (1992: 8-9) who explicitly labelled such statements 'hedges' and commented that: 'The fact that textbooks have more...unmodified assertions [i.e. non-hedged statements] can be linked to the textbook attitude toward facts' (p. 9). Myers claimed also that on the rare occasion when textbooks do use hedges it is for 'matters of representation about which there is not yet a clear consensus...' (p. 11).

The term hedging is closely linked to our model of textbook features as products of secondary discourse. A hedge, in this model, can be seen as simply an attempt to delimit a certain type of secondary discourse. Matters about which there is not a clear consensus could evoke powerful accusations of incorrectness were the possibility of an alternative view not clearly marked in the text. The corpus texts enlist a number of strategies in this task (cf. Latour & Woolgar 1979: 75-81); a common feature of a corpus IBT hedge, however, is the more or less explicit use of human agents as a focus of fallibility (cf. the comments made regarding human agency and the example about Priestley in 4.6.1). Thus Campbell writes:

> Researchers have worked out the key steps by which sex hormones and other steroids alter gene expression in target cells of vertebrates...(Campbell 1993: 383)

Any secondary discourse disputing the truth of this statement must be directed firstly against the 'researchers' mentioned, and not against the textbook.

It has already been claimed above, however, that human agents are found only infrequently in the corpus texts, and this accords with the assertion that textbooks contain few hedges. The reason for this is perhaps that the most widely used - and for the novice, most imperceptible - strategy in treating controversial material in the corpus textbooks is simple omission. The
canonical or agreed content of textbooks naturally begins to falter at the hedging stage. If it enters this domain at all it is only because it is forced to do so by its epistemological imperative to project continuity and order of subject matter. This appears to have much to do with topicality. A good example is corpus text sections devoted to environmental concerns. This material has been widely popularised and must therefore be included to satisfy the interrogative structure of the texts relating to comprehensiveness.

On the other hand, however, environmental and other topical issues tend to have natural links to forms of secondary discourse pernicious to the textbook - comparisons with contrary studies and special contexts, for example. Consequently, such chapters tend to contain a comparatively large number of references to studies and individual researchers, and to human agents in general (cf. Campbell 1993: ch. 49; Raven & Johnson 1992: ch. 27; Keeton & Gould 1986: ch. 35). We can ascribe hedging in topical chapters, therefore, to the much larger risk of provoking unfavourable secondary discourse such chapters introduce. This secondary discourse must be re-channelled to other human agents through hedging if the textbook is to maintain its unproblematic position as simple purveyor of established truth. An interesting description of the production processes through which controversial material is selected and framed is provided in an article by Swales (1993) which examines, in his own words, 'the mediation and the marketing of difficult material' (Swales 1995: 4).

In the light of the above discussion we might conclude that hedging in the corpus texts is generally subordinate to simple omission as a strategy for resisting secondary discourse. In fact, it seems that hedging is only compelled by the necessary inclusion of topical or otherwise 'expected' material that is, due to its established links with other forms of secondary discourse, lacking in general agreement.

4.7 Summary

This chapter took the functional concept of the interrogative unit formulated in chapter 3 and
attempted to show how it might exert a determining influence over the lexico-grammatical form of the corpus texts. Central to this was an examination of a recurrent lexico-grammatical pattern consisting of two distinct noun phrases and a stative copula verb - predominantly a form of *be*. Interrogative units, it was argued, must be capable of simple transformation into this 'canonical' form to satisfy the corpus IBT's interrogative structure. This transformation rule rather than a fixed, genre specific lexico-grammatical pattern was seen as a main determinant of textual features.

In addition, two commonly identified features of textbook discourse - diminution of human agency and paucity of hedging - were accorded a possible explanation in terms of a secondary discourse model. Both were seen as exclusionary discourse community mechanisms seeking to protect an ideal student from any problematisation of biology as a continuous and comprehensive discipline.

Chapter 5 will discuss some ramifications of the conclusions drawn in chapters 3 and 4 for ESP pedagogy relating to IBTs.
5.1 *Introduction: current focuses of pedagogy in relation to textbook discourse*

Studies of textbook characteristics have often been taciturn in applying their findings to pedagogy. Frequently they have contented themselves with the presentation of textual features as linguistic facts arising from an opaque code which, implicitly, exists outside a social context. On other occasions they have limited themselves to discussions of their findings in relation to 'cognitive models' (e.g. Bhatia 1993: 30; Love 1993: 197) and 'disciplinary schema' (e.g. Davies 1986: 7). These have generally been so abstract as to provide a framework for almost any type of pedagogical practice. A telling indicator of this tendency presented itself in a recent article by Swales (1995), who commented that the literature relevant to textbook characteristics 'provide[s] us with useful insights' (p. 4) - a statement that stops short of considering that such studies might actually play a formative role in pedagogical practice, or, indeed, that the reverse might be true: that pedagogical practice might shape how characteristics are selected and analysed. Studies of textbook characteristics, in some contexts it seems, are viewed simply as useful additions to an already advanced and dominant pedagogy in regard to textbooks.

A tendency in the work of many researchers, therefore, has been simply to log textbook characteristics and leave the application of findings to teachers in contact with students and their 'real world' demands. This tendency has perhaps been exacerbated, at least in Australia, by the considerable academic controversy (and the resultant secular uncertainty) surrounding the debate between genre and process models of writing and learning (cf. Reid 1987). In this context it is perhaps understandable, and even defensible, that an attempt has been made to separate the identification of textbook characteristics and pedagogy.

There are, however, two main problems with this tendency that urge its redress. The first is theoretical. Implicit in the 'separationist' approach is the assertion that textbook characteristics
can be identified on purely formal grounds without reference to their use or existence as artefacts in a discourse regulated system. Nothing could be more misleading. In selecting textbook features for analysis, and in the analysis itself, reference is constantly made to social concepts and the systems they suggest. Even at the formal level, a researcher, when choosing a subject of study must, before all else, decide what to study. Is, for example, the distribution of a past tense morpheme or the distribution of a certain personal pronoun more important? Such decisions as to which feature to study are inevitably made after reference to their relative importance within the perceived discourse system.

But even if an unlimited number of researchers were available to study all features, they could not study every formal feature of a textbook; a text, in the absence of a model decoder, can produce an infinite number of formal features (which in the terms developed in the present study we might call an infinite amount of secondary discourse). Without a model decoder to limit the possible number of textualisations and thus the number of formal features from which they arise, the text is meaningless. All too often, however, textbook studies have avoided any discussion of how their model of the decoder has informed their selection and exegesis of textbook material. It would certainly be unfair to suggest that studies have not produced 'useful insights' into textbook characteristics (as Swales acknowledges) - such is certainly not the case. The majority of studies have been extremely valuable. A common feature of these studies, however, has been a reluctance to make explicit the a priori assumptions underpinning them, which, in the context of IBTs, are inevitably pedagogical.

The second problem with the separation of linguistic analysis from pedagogy, and perhaps the root cause of the first, is the tendency to exclude methods of analysis from the rigours of the deconstructive methods employed on corpus texts. Many studies of textbook discourse, despite their objectification and problematisation of the ideology of textbooks, maintain for the presentation of their own arguments that truth is a mere function of investigation and of the rigorous application of historically proven heuristics. That is, they demur - like most academic writing - to admit their own place in the universe of discourse and negotiation of facticity,
insisting instead that their discipline alone commands 'scientificity' (Colapietro 1993: 175). They implicitly claim that what their study contains is positive truth - something which has been argued here to mean simply that it is not susceptible to a certain type of secondary discourse. Truth suffices as truth, in this model as in others, often through the silence of opposition.

In opposition to the above, one might argue, of course, that such an assuming, self-centring presentation of findings is necessary for their communication. A regrettable consequence of this adherence to a naive positivism, however, is that, in denying the link with their assertions about their target texts and pedagogy, studies often fail to consider how those assertions are to enter the discourse community affecting pedagogical practice, which, after all, is their *raison d'etre*. Often, in the urgent drive to assert 'scientificity', the implication for pedagogy, if any, is that studies revealing textbook characteristics are to be transmitted in some hermetic manner to a homogenous community of EAP practitioners already possessed of a suitable framework for their application. In this process, the requirement to produce convincing and provocative theories of pedagogy is at risk of being sacrificed to scholastic indulgence and, at best, a maintenance of existing practice. The chief failing in studies to this point, therefore, has been a reluctance to explicitly model discourse communities and to state how results might affect those communities. As I have noted above, this originates in a simplistic perception of the research discourse itself.

Encouragingly, however, a number of researchers appear to have implicitly realised these problems and have attempted to move textbook analysis into a more truly discourse community framework. Swales (e.g., 1990, 1995), in particular, has been instrumental in this, as have the orientations used by Tadros (1985) and Klamer (1990). Even so, however, much of their work may have been constrained by a general academic discomfort with so overt an attempt to link academic endeavour to the mechanisms of its fulfilment (e.g. publication processes, prestige ordering of genres, university strictures). Such attempts often encounter a curious post-romantic notion of the mind that recoils at the idea that intellectual property bears any relations
to its circumstances of production and publication.

In fact, a number of commentators on EAP (Santos 1992; Benesch 1993; Pennycook 1994) have tried to problematise what Allison recently described as 'pragmatic views of English language teaching' (Allison 1996: 85). These commentators descry a disquieting Machiavellian flavour to such pragmatic views, which they feel threatens to maintain an 'unexamined educational, academic and sociopolitical status quo' (Allison 1996: 85). As Martin (1985: ch. 4) has pointed out, however, such concerns may actually work for the status quo and result in the proliferation of many social injustices through an attendant refusal to recognise and teach the discourse skills that empower members of specific interest groups. If the logical modelling of discourse as a relativised system of artefacts is sometimes discomforting, it is perhaps only so because it collides with many of our broader fears for intellectual freedom that, when examined, are (although undoubtedly endemic to life in the latter twentieth century) without substantial foundation. As Eco advises, we should not fight against false enemies (Eco 1987). There is no reason why learning should be divorced, as it so often is, from the means of demonstrating it.
5.2  A suggested approach to applying the present findings to pedagogy

The above criticisms clearly motivate this study to offer an explication of its findings and their relation to pedagogical practice in a discourse community model. The most appropriate focus for this explication in the light of the key concepts developed so far (secondary discourse, interrogation structure and the ideal textbook user) is a comparative analysis of the secondary genres associated with the textbook in its academic context. We have already seen how a particular set of these genres is involved in determining and stabilising textbook characteristics by propagating a model of the ideal reader around which secondary discourse centres (e.g. publisher discourse, the book review, lecturer talk, student feedback). It is now necessary to consider the reverse. What secondary genres operate between the textbooks and the actual first year student users? Given the nexus between textbooks and examinations there can be little doubt that the most important of these secondary genres have to do with assessment.

5.2.1 Assessment tasks as important secondary genres to the textbook

It is hopefully no longer considered cynical (pace Benesch 1993; Pennycook 1994) to point out that the prime purpose of undergraduate study is to complete assessment requirements and possibly to gain access to higher level academic opportunities. Certainly other goals are possible and even ritually bruited (e.g. 'love of learning', 'interest', 'discovery'); however, in terms of which voices will ultimately contribute to the formative discourse of a discipline, these goals exist only in so far as they fulfil the first: at the undergraduate level, nothing is as inseparable from a student's progress into the discourse community of the chosen discipline as assessment.

Of course, assessment takes many forms. At the Australian National University (ANU), for example, Dr Julian Ash, convener of the first year subject Biology 1001, commented that:

...assessment of the Biology 1001 course varies from year to year...[W]ith
larger science courses such as this (with about 200 students) it becomes necessary to adopt assessment procedures which can be administered by several people (11 in this course) and this imposes constraints on the type of assessment that can be administered. Essentially this means constraining most of the items of assessment to yield readily identifiable and simply assessable answers. The exams in Biology 1001 (40-50% of assessment) typically have a substantial multiple choice and short answer section. (personal communication 1996)

Other forms of assessment, such as the essay and practical tasks, are losing ground. At the ANU, Biology 1001 assessment in 1995 included a practical exam; in 1996 it will not. Moreover, Biology 1001 is the only first year biology course at the ANU to retain weekly practical sessions; all others have been forced to abandon them. In the resource constrained world of mass science education, the importance of examinations - particularly the readily mark-able multiple choice and short answer types - are in the ascendancy for reasons of sheer practicality. In terms of what we should examine, these assessment forms are of particular importance.

5.2.2 Other genres related to assessment tasks that may affect the form of the interrogations applied to student responses

Before proceeding to analyse the links between IBTs and assessment tasks, however, the importance of other genres in this relationship must first be recognised. Our chief contention throughout this study has been that discourse features are determined and interpreted by their relation to other discourse types in which they may be problematised. This relationship of potentiality, it has been claimed, functions as an internalised semiotic system in the individual delimited by a series of material constraints on the artefacts of discourse which regulate their dissemination in accordance with their textual features. Each genre has secondary genres. And each secondary genre has its own secondary genres which are in fact tertiary genres to the first. Eco (1987) in fact puts forward the concept of discourse raised to the 'nth' degree, suggesting that ultimately perhaps all genres relate into a semiotic universe comprising human behaviour itself (cf. Rorty 1991; Bruhn Jensen 1995: 48). In the present localised context, however, we could argue that the student's use of a textbook and his or her performance in assessment tasks
will be affected most strongly by:

- Examiner's meetings
- University examination guidelines
- The form of examination reports
- Past examinations
- Study guides
- Information given about examinations
- Sample questions and answers
- Lectures
- Tutorials
- Informal interactions with other students taking the course

Looking at this list, one begins to intuit how complicated and institutionally embedded the relationship is between assessment tasks and textbooks. As we have noted above, assessment procedures are necessarily limited by staffing and resource constraints, as well as by explicit university assessment policies. While a detailed analysis of the workings of these mechanisms is beyond the scope of this study, some initial observations in this direction are necessary to prevent an oversimplification of the links between genres. The textbook may serve as a main resource for assessment task content and student preparation (cf. Swales 1981: 108), but numerous other genres also shape the form and outcomes of assessment transactions.
5.2.3  *A central example: the first year short answer examination*

As argued above, an increasingly important assessment task in introductory biology subjects is the short answer question, which we might describe as a question intended to be answered under timed, 'closed book' examination conditions in around 50 words. Short answer questions are most certainly a genre of their own. They are governed by their own interrogation structure which shares a special set of relations with textbook discourse and the other assessment related genres listed above. It is these relations that we will focus on here. Overall, the main contention will be that pedagogical practice can be best served by developing a closer understanding of the *linguistic transformation tasks* students are expected to perform in answering examination questions when IBTs are important source for these answers.

5.2.4  *The form of examinations and their relation to interrogative units*

What form do short answer questions in introductory biology take? In fact, this is much more difficult to ascertain than one would initially expect. Examples of first year biology short answer questions are not as available as for other university subjects - even other biology subjects. Dr Mary Peat, of the University of Sydney, for example commented that past exams for Introductory Biology at that institution are not made available to students (personal communication 1996). Dr Ash said that this was also the case at ANU. The reason, he said, was that questions are often repeated from year to year (personal communication 1996). Similar situations exist at Flinders University and at the University of New South Wales. In fact, the one concession to student exam preparation in introductory biology subjects is that shortly before exams students are provided with samples of exam questions. The following are some short answer questions of the type made available to first year
biology students at the Australian National University:

1. Describe the structure of collagen and briefly explain how knowing the structure explains its function.

2. What are exons and introns? Show how alternative exon splicing can be used in cells to produce more than one protein from the same gene.

3. Define and distinguish between the terms: disinfection, sterilization, antisepsis and asepsis.

4. Outline the main steps in the lytic life cycle of a bacteriophage.

5. Outline the steps necessary to set up a numerical classification scheme for a group of bacteria.

After our analysis of the structure of IBTs, it is no surprise to find that these questions demand answers structured around what we have called interrogative units. At one level, the process required is relatively straightforward: given the definiendum, the student supplies the definiens. The canonical form underlying the interrogative unit (cf. ch. 4) in this context provides the unit of transport between the IBT and the short answer question.

To illustrate our claims regarding interrogative units in textbooks and examination answers, consider a section of Campbell (1993) relevant to sample question 1 above:

**Quaternary** structure is the structure that results from the relationship between the subunits. For example, collagen is a fibrous protein that has helical sub-units coiled into a larger triple helix (Figure 5.26a). This supercoiled organisation of collagen, which is similar to the design of a rope, gives the long fibers great strength, appropriate to their function as the girders of connective tissue, such as tendons and ligaments. (Campbell 1993: 81)
These interrogative units are positioned in the hierarchical structure of the texts under the following arrangement:

```
Biology
      ↓
The Structure and Function of Molecules
      ↓
Proteins
      ↓
Levels of Protein Structure
      ↓
Quaternary Structure
```

An answer to the examination question requires a methodical selection and a recombination of interrogative units. Firstly, the student must describe collagen. This would involve recall of a series of canonical form units (present in Campbell 1993) beginning 'Collagen is...'. Most likely a complete description would, after Campbell (1993: 82), also involve a diagram. Interestingly, however, this would not be sufficient for a good response. The ideal student must also be able to locate the relevant interrogative units in the hierarchical structure of the texts - something which is made obvious by the second part of the question relating to collagen's function. A simple description of collagen is not enough. More 'abstract' interrogative units relating to Levels of Protein Structure must inform this description. A student must demonstrate that he or she knows the difference between primary, secondary, tertiary and quaternary structure. In other words, the interrogative units relating to collagen must not just be presented without sequence; they must be ordered according to certain discipline approved patterns if they are to resist the interrogations of examiners. Ideally, for example, a student might order the interrogative units relating to the structure of collagen spatially from part to whole - describing primary, then secondary, then tertiary, then quaternary structure. For the second part of the question - having established the ‘products’ - the ideal student would then move to discuss the
process’ topic of the function of collagen’s structure.

Another interesting point is the importance of recognising an interrogative unit’s hierarchical relations. Memorising a passage in the textbook verbatim will be ineffective in comparison to deriving and retaining canonical form interrogative units within a hierarchical structure simply because the short answer question calls for ordered interrogative units governed by a new interrogative structure seldom identical to that contained in the IBT. Presentation of the textbook passage, engaged as it is in its own discourse with its interrogators (cf. ch. 3 & 4), would be unlikely to resist this structure. The passage relating to collagen above, for example, would, if quoted verbatim, lack the Levels of Protein Structure focus demanded by the example short answer question. The emphasis in students’ use of an IBT should be on deriving interrogative units within the hierarchical framework suggested by the textbook, and not on memorisation of actual text.

According to the above discussion, then, a model of how the ideal student is intended to form short answer question responses might contain three central stages:

1. With the potential interrogations that will be applied to examination answers in mind, the ideal student recognises interrogative units during textbook use through their expressibility in canonical form and stores them in memory according to the semantic patterns suggested by the hierarchical structure of the text;

2. The canonical form is subsequently retrieved upon triggering by examination questions, and its position in the hierarchical structure is recognised;

3. Interrogative units are ordered, transformed and combined according to perceived interrogative demands of the question to produce an answer.
5.3 Some ramifications for IBT use in relation to the short answer question: memorisation versus 'understanding'

It was mentioned above that one important corollary for students from our model of how a short answer question functions is that the ability to reproduce the textbook passage relevant to an exam question in itself does not guarantee success. This point bears restatement. Short answer questions are not founded upon quotation. A student must be able to recast the information in a textbook into a form which 'answers the question'; that is, into a form which is not vulnerable to secondary discourse relating to dialectics used by examiners such as 'poor expression', 'irrelevance', 'dogmatism'. An efficient strategy for textbook use in this context would be firstly to derive canonical form interrogative units from the text, and only then attempt to commit them to memory. Recall practice should involve the transformation of these canonical forms into answers conforming to the interrogation structures applied to questions. The process of textbook use in comprehension and interpretation is often thought of as 'unpacking'. Our model would suggest that a more complete metaphor should also include the concept of 'repacking'.

Our analysis leads to an interesting perspective on valued forms of learning. Underlying the short answer question in biology is a commonly drawn, but rarely examined, distinction within academic learning between memorisation and 'understanding'. What has been memorised (i.e. what can be reproduced), in this view, has not necessarily been 'understood'; what has been understood, on the other hand, although not necessarily anchored in anything reproducible, can be transformed into any desired form, be it description, analysis or comparison. The difference in psychological terms, it seems, is perceived as one of sensory versus semantic encoding.

But is it really? In the context of short answer questions at least it appears that the difference is merely one of what is memorised. It would be difficult to deny that memorisation - and indeed the training of memory (cf. Yates 1966; Biggs & Moore 1993: ch. 8) - has a prominent place in IBT use. An important realisation for any IBT user, however, is that memorisation
must be selective and focused upon canonical forms ordered within a hierarchical structure rather than upon blocks of text itself. The much-touted, highly abstract concept of understanding, in fact, might be better thought of as simply a special type of memorisation restricted to canonical form statements together with the set of skills used to derive and recast them.

5.3.1 The purpose of mechanical emphasis and separation devices

Given the model of learning implicit in short answer questions, it is also important for students to recognize the purpose of mechanical devices in textbooks. The processes of memorisation are intended to benefit from coenoscopic movement, careful differentiation of central and non-central material, and bolding of key terms. Once again it is important to realize, however, that these devices are intended to aid acquisition of interrogative units, not text itself.

5.3.2 Exposure to secondary genres relevant to short answer examinations as a means of developing students’ awareness of interrogation structures

An extremely important lacuna in IBTs from a student's perspective is that they offer little explicit help in learning the interrogations that will be applied to examination answers. Generally, this is thought of (if at all) as the domain of the tutorial and other personal contact with staff, or as simply the student's responsibility; above all, it is seen as specific to a particular institution's or lecturer's pedagogical preference. Given our model of the genre-related fixity of textbook characteristics, however, explicit instruction in this area could be extremely useful. Consider, for example, the collagen question examined above. Whether or not to use a diagram in answering the question is of vital importance. Yet the student's decision in this will depend largely upon his or her perception of how exam papers will be read. After using impressively laid out textbooks, many may think hand-drawn diagrams look too unscholarly for use in exams. Others might see the instructions 'use a diagram' present in some questions as a sign that diagrams may only be used in these explicitly marked cases. Others might adduce from a
lecturer's possible avoidance of visual aids during the semester that diagrams are anathema. Furthermore, it is not difficult to imagine the huge role cultural differences could play in these decisions for a NNS. The solution is to teach students - either explicitly or by allowing them access to critical artefacts - how their examination answers will be interrogated.

In such an undertaking the acquisition of canonical form interrogative units should remain central. How these are to be successfully transformed and recombined into answers, however, will largely be a matter of the nature of the interrogations that will be applied to those answers. Consider, for example, how successful responses might differ according to whether the material tested was included as part of a lecture devoted to Ecology or to The Function of Cells; or even according to the stylistic predilections of the examiner.

Unfortunately, however, most information relating to examinations remains relatively protected, both formally and informally. Examiners, if they do comment on the form and purposes of examinations, enter a new and thorny discourse arena and are constrained themselves by the secondary discourse that can be produced from their pronouncements. In other words, 'examination talk' is always hampered by the agendas and conflicting motivations inherent in institutions. Procedures for accessing examiners' reports, corrected examination papers and outcomes of examiner meetings frequently remain vague, and even if made explicit do not generally attract the sort of interest from students the present model claims they merit. Granting that such practices are not likely to alter quickly, one feels that - with the cooperation of actual examiners - exercises in which students research and mimic the processes through which examinations are written and marked are perhaps the best option for EAP pedagogy. These could be of great use to both NS and NNS undergraduates alike.

5.3.3 The optimal developmental path of interrogative unit acquisition: serial and hierarchical use

How a particular first year biology course is designed will determine which interrogative units
students must acquire. Whatever the course specifications, however, there will always remain
the question of the acquisition order. This is in large part a question of how IBTs should be
used. A common view - often held implicitly by both instructors and students alike - is that use
should be serial. One studies a chapter by beginning at the first page and moving through to
the last. In the case of many Asian NNS students experienced in different cultural traditions,
the serial approach can even mean beginning at page one of a textbook and working through
to the glossary and appendices (Robert Parbs, ANU, personal communication). There is no
doubt considerable merit to this serial approach. Often neglected, however, is the hierarchical
functional structure of IBTs that we delineated in chapter 3 of the present study. This structure
itself strongly suggests an order for acquiring interrogative units; namely, in accordance with
the order to be found in the sublimation of material in the textbook. The various semantic
patterns within this structure can be useful aides de mémoire, and also facilitate an appreciation
of some of the larger disciplinary imperatives (e.g. the spatial and temporal ordering rules
allowing causal inference).

Exactly how should a student utilise hierarchical ordering? The short answer is: in order of
sublimation. Suppose, for example that chapter 30 of Campbell (1993) was set as prescribed
reading. The hierarchical structure suggests that the path to acquiring the interrogative units
found in this chapter is to first study chapter 1 - the most sublimated material. This would
involve reading the introduction to chapter 1, then all the large headed sections of chapter 1 (in
reality, of course, this 'introductory reading' is normally undertaken only once at the beginning
of a course). Once these sublimated interrogative units had been acquired, the student could
move to chapter 30 and read the introductory section, all the large headed sections, then all the
small headed sections. This would allow the student to place each interrogative unit in its
'proper' relation to others and to utilise the semantic patterning underlying their organisation.
This implied optimal order of acquisition for Campbell (1993) chapter 30 is presented in Table
5.1. The discontinuity in the sequencing of page numbers clearly illustrates that this approach
demands a different style of textbook use than serial reading.
Serial use of the textbook, while important, has the potential to hinder the cognitive modelling of material by making some semantic links obscure. In an extreme case, for example, a student using Campbell (1993) chapter 30 might read and try to retain the interrogative units in the small headed section *Early Amphibians* (p. 645) before having gained a full appreciation of the broader membership of the Phylum Chordata, several of whose members are only introduced after this detailed description of amphibian origins (e.g. *Class Reptilia*: p. 648).

Certainly, serial reading of IBTs has its place - perhaps even a predominant place. Students and instructors should be aware, however, that hierarchical reading may have benefits that make it a worthwhile complementary strategy.

5.4 *Motivation*

From the outset of this study it has been suggested that discourse is regulated by the balance of opportunity and motivation. Discourse community members decode discourse according to the possibilities they see for creating secondary discourse from it. Their modelling of their position within the discourse community is central to whether they act to produce discourse upon a text or simply see it as irrelevant. It
Table 5.1 Actual page numbers to be followed in acquiring the interrogative units of Campbell (1993), chapter 30, 'level by level' according to the textbook's hierarchical organisation

<table>
<thead>
<tr>
<th>Position in hierarchy</th>
<th>Title</th>
<th>Page no.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction (ch. 1)</strong></td>
<td><strong>Introduction: Themes in the Study of Life</strong></td>
<td></td>
</tr>
<tr>
<td>Introductory section</td>
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<td>2</td>
</tr>
<tr>
<td>Headed sections</td>
<td><em>A Hierarchy of Organisation</em></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Emergent Properties</em></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td><em>The Cellular Basis of Life</em></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td><em>Heritable Information</em></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><em>A Feeling for Organisms</em></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><em>The Correlation Between Structure and Function</em></td>
<td>9</td>
</tr>
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<td></td>
<td><em>The Interaction of Organisms with Their Environment</em></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><em>Unity in Diversity</em></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><em>Evolution: The Core Theme of Biology</em></td>
<td>11</td>
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<tr>
<td></td>
<td><em>Science as a Process: The Hypothetic-Deductive Method</em></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td><em>Science, Technology and Society</em></td>
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Small headed sections None

**Chapter 30**  
The Vertebrate Genealogy

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<th>635</th>
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<td></td>
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<td></td>
<td><em>Chordates without Backbones</em></td>
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<td></td>
<td><em>The Origin of Vertebrates</em></td>
<td>637</td>
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<td></td>
<td><em>Vertebrate Characteristics</em></td>
<td>638</td>
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<td></td>
<td><em>Class Agnatha</em></td>
<td>640</td>
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<td></td>
<td><em>Class Placodermi</em></td>
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<td><em>Class Chondrichthyes</em></td>
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<td><em>Class Osteichthyes</em></td>
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<td></td>
<td><em>Class Amphibia</em></td>
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</tr>
<tr>
<td></td>
<td><em>Class Reptilia...etc</em></td>
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Small headed sections *Chordate Characteristics*  
*Subphylum Cephalochordata* 636
*Subphylum Urochordata* 637
*Early Amphibians* 645
*Modern Amphibians* 646
*Reptilian Characteristics* 648
*The Age of Reptiles* 648
would be amiss, therefore, if we did not make some comments as to the importance of motivation in regard to pedagogy involving IBTs.

Motivation has of course been a feature of pedagogy for many years. In second language acquisition it has taken on quite a formal appearance. Studies by Gardner and Lambert (1972), Gardner (1979), and Brown (1981), for example, have established links between various types of motivation and success in language learning. More broadly, the branch of individual learner differences devoted to motivation is now a major field in educational psychology (cf. Biggs & Moore 1993: ch. 10 & 11).

While it is beyond our scope to attempt to integrate the model used here into a general model of motivation, the central importance of motivation to pedagogy must be stressed. Regardless of all else, any strategy for improving the use of textbooks should firstly address the issue of student motivation.

Our present model suggests that a significant factor in improving student motivation in regard to IBTs would be to promote secondary discourse among textbook users - a process commonly identified with 'empowerment'. As has already been suggested above, students should be given access to means of disseminating discourse. By doing so they can become involved in a discourse community relating to the IBT that will promote both textbook use and, perhaps more importantly, the learning of those interrogation structures that govern biology discourse.

Opportunities for course conveners to promote secondary discourse creation currently exist in the field of information technology. Although undoubtedly distorted by the unusually equal placement of discourse community members, electronic bulletin boards and e-mail provide a uniquely non-threatening means of initiating students into the ways in which biology is read. Through the simple yet pivotal process of involvement, interaction of this type students can teach students which discoursal aspects of biology discourse are sacrosanct, which problematic, and which taboo. In the context of the rise of electronic forms of communication this would
perhaps not be an exercise limited simply to student discourse about IBTs. Rather it might be a way for students to participate in the evolution of the scientific discourse that will inevitably contain the 'truths' of the future.

5.5 Summary

In this concluding chapter it has been argued that room exists for studies of textbook characteristics to become more involved in the broader pedagogy of the disciplines in which they are central tools, and from which they ultimately derive. The secondary discourse model developed in this study was used to make suggestions for how this might be achieved. Specifically, the linguistic links between IBTs and assessment task genres were viewed as fundamental to student success in assessment tasks. IBTs were seen to provide a canon of material, certain elements of which must be recognised, selected and retained according to the form of interrogative targets implicit in the discourse used to demonstrate knowledge. The form of short answer examination questions was a case in point. Linguistic transformation tasks centring on a canonical form of the interrogative unit were suggested to be fundamental to success in answering such questions.

Suggestions were also made as to how students might be taught to recognise interrogative units and to transform those units into a transportable canonical form. It was noted in this regard that the semantically ordered hierarchical structure of IBTs may be utilised by students in a number of non-serial usage patterns to aid recognition, selection and recall of interrogative units. Above all, however, it is argued that better exposure to a full range of authentic secondary discourse relating to assessment tasks can aid students by raising their awareness of the interrogative structures applied to their assessable work. A final suggestion is that such a measure might also have favourable effects on motivation.
CHAPTER 6
CONCLUSION

The title of this study (Secondary Discourse in Academic Texts) sought to give some impression of my ideological position in relation to academic discourse - a position which I developed through an analysis of the discourse features of five introductory biology textbooks. In general terms, my central claim has been that objectifying discourse about these textbooks relates to how they are interrogated, disseminated, decoded, written and rewritten - in other words, to their textual features.

If the concept of secondary discourse has encountered any limitations in demonstrating the usefulness of the above claim, I feel these limitations may have been - paradoxically - the result of the concept's own validity. Texts are a universe and this study was able only to focus on a solar system in a comparatively small galaxy. In accounting for the effects of a few nearby stars, perhaps it has been easy to ignore other immense, though relatively distant, sources of gravity.

I remain confident, however, that academic texts as a whole are amenable to a general theory of secondary discourse. Such a theory might interrelate the 'structural causality' governing the shape and function of academic discourse with a semiotic theory of academic texts and their shifting iconic and indexical relations. Indeed - given our metaphor of the textual universe - this expanded theory would become more powerful the more general it were to be in its conception.

Even without a more general framework, secondary discourse remains a useful means of deconstructing and clarifying popular (but often vague) discourse analysis concepts such as 'accountability', 'rhetorical effect' and 'communicative purpose'. Above all, however, my hope is that this study will stimulate some of the very 'secondary discourse' it has described, for such discourse - although operating through mechanisms of exclusion and constraint - serves, in the proper context, only to enrich and broaden our academic endeavour.
The corpus texts were selected on the basis of their use in first year biology courses at Australian universities - either as prescribed or recommended reading - in 1995. A list of institutions and subjects in which the corpus texts were used is presented below. References for each corpus text can be found in the bibliography.

<table>
<thead>
<tr>
<th>Textbook</th>
<th>University</th>
<th>Subject</th>
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<tbody>
<tr>
<td>Campbell (1993)</td>
<td>Flinders University</td>
<td>Biological Science 1</td>
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<td>ANU</td>
<td>Biology 1001</td>
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<tr>
<td></td>
<td>University of NSW</td>
<td>Biology A</td>
</tr>
<tr>
<td>Purves et al. (1992)</td>
<td>University of Sydney</td>
<td>Biology 1</td>
</tr>
<tr>
<td>Curtis &amp; Barnes (1989)</td>
<td>University of New England</td>
<td>Biological Sciences 101</td>
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<td>Biology 1001</td>
</tr>
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<td>Flinders University</td>
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</tr>
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APPENDIX B
DIAGRAMMATIC REPRESENTATION OF THE FORMAL LAYOUT OF EACH CORPUS TEXT
Keeton & Gould

Introduction

Large Headed Section

Introduction

Small Headed Section

Parts

Chapters

Introduction

Large Headed Sections

Introduction

Small Headed Sections

Curtis & Barnes

Introduction

Large Headed Section

Introduction

Small Headed Section

Parts

Section

Chapters

Introduction

Large Headed Sections

Introduction

Small Headed Sections

→ = division always found

→→ = optional division
BIBLIOGRAPHIC DETAILS OF INTRODUCTORY BIOLOGY TEXTBOOKS REFERRED TO IN THIS STUDY


BIBLIOGRAPHY


