CHAPTER 1

Introduction

In the last two decades or so, philosophy of biology and philosophy of medicine, here collectively called philosophy of the life sciences, have come of age. Many books and articles are now published each year in this area. The emphasis is on advanced level work. Hence this textbook, which may fill up the lacuna.

In philosophy controversies are more prominent than in science. Therefore writing a textbook on applied philosophy is a hard job. Of course one can concentrate on elementary logic and methodology which is relatively uncontroversial in philosophical circles. I will be doing that, but it is not enough. If you want to evaluate scientific theories and explanations with philosophical tools, you will have to address philosophical views on the subject. You would soon find out that there is no consensus in philosophy about the nature of theories and explanations.

I have tried to come to grips with this problem by doing philosophy in a style which is more common in science than in philosophy. Philosophers typically aim at generally valid models and theories about science. Scientists also cherish generality, but they tend to be more modest. If a model they have developed is not generally valid they may duly note exceptions and apply it to a restricted domain. I will deal with philosophical models in a similar fashion. They can be quite useful in some contexts even if they are apparently invalidated by counter-examples.

Some of the philosophical questions and distinctions which are central in this book are best introduced by an example. Let's briefly consider the subject of aging.

To some extent man is an exception among the animals. Some biologists regard the prevalence of aging in man as an important example. Many people *in our culture* reach old age and so come to experience the process of aging. Animals—in the wild—seldom do. Neither did people in prehistoric times.

The thesis that aging is rare in nature, if true, is important for theories of aging. Many theories are alleged to explain aging (see Warner *et al.*, 1987). There is no clear winner yet. I will briefly describe one theory, which some have declared a loser on the ground that aging is rare. The theory says that aging occurs because it is genetically determined, or programmed. The idea behind it is that development is controlled by a genetic program. Aging should be controlled in the same way because it belongs to a process of continuous development.

Hayflick (1987) has mounted the criticism that genetically programmed aging could not have evolved through natural selection. There have not been enough aged organisms for selection to work on. From this he concludes that aging cannot be genetically programmed. He apparently presupposes, without explicitly saying so, that all genetic programs are the result of natural selection.

Suppose we set out to evaluate Hayflick's line of reasoning. What questions should we ask about it? In the first place there are *questions concerning* the *truth or falsity* of statements representing evidence. Is it true that aging is rare in nature? Is it true that genetic programs are the result of natural selection? These questions must ultimately be answered by an appeal to facts.

'Ultimately' indeed. We should not confront these statements with facts unless we understand central *concepts*. Is the meaning of 'aging', 'genetic program' and 'natural selection' clear? I will indicate by comments on one concept that such *questions about meaning* are sometimes crucially important. 'Genetic determination', a concept embedded in the more complex concept of 'genetic program', will do.

Let's try a *definition*. 'A feature is genetically determined if genetic factors are among the causes of the feature.' Would this be an appropriate definition? No, it wouldn't, however plausible it may look at first sight. It is a plain truth of biology that *all* features of organisms result from genetic *and* environmental influences. If we adopt the definition we should say that all features are genetically determined. Those who distinguish genetically determined features from environmentally determined ones must have something different in mind.

The following definition will not do either. 'A feature is genetically determined if it is caused exclusively by genetic factors.' On this definition, there would not be *any* genetically determined features.

On the first definition, the thesis that aging is genetically determined is a trivial truth which makes a confrontation with evidence superfluous. On the second definition we get a thesis which is quite obviously false. How then should we define 'genetic determination' to get out of this curious situation?

The solution is that *we should not attribute genetic (or environmental) determination to features of individual organisms. Instead, we should consider differences between organisms*. The following definition is on the right track. The difference in feature *F* between organism *x* and organism *y* is genetically determined if the difference in *F* is due to a genetic difference between *x* and *y*. The unqualified statement that some feature is genetically determined obviously means that differences between organisms in this feature are always due, exclusively so, to a genetic difference. Few features are *genetically determined* in this *strong sense*. Eye color in adult humans is an example.

Conceptual analyses can have important consequences for the evaluation of evidence. What kind of *evidence* would we need for the thesis that aging is genetically determined? Perhaps we are able to demonstrate that a particular gene plays a causal role in aging in a particular organism. However, this would not be evidence in support of the thesis. The comments above show that we rather need information on *differences* between organisms.

Currently available evidence suggests that aging is not genetically determined in a strong sense. It is probable, though, that there is *genetic determination* in the *weaker sense* that *some* differences in aging are due to genetic differences or partly so. Concerning a genetic program for aging I will not hazard a conclusion. 'Genetic program' is a complex metaphor which involves much more than genetic determination alone. It is often used in biological texts without any clarification of its meaning. That's why I wouldn't know how to recognize evidence pointing to a genetic program.

Suppose we would come to the conclusion that the statements put forward by Hayflick are clear enough, and that they are likely to be true. That obviously would not suffice to accept his argument. In addition we will have to ask *questions about validity*. An *argument* is valid if its conclusion is necessarily true *if* the statements which are meant to support the conclusion—the premises—are true. We can easily see that Hayflick's argument is valid if we reconstruct it as follows. All genetic programs have evolved through natural selection. If there is a genetic program for aging, then it is not the case that all genetic programs have evolved through natural selection (this particular program being an exception). Therefore, there is no genetic program for aging.

If we use the symbol '*A*' for the statement 'All genetic programs have evolved through natural selection', and '*B*' for 'There is a genetic program for aging', Hayflick's argument takes the following form. '*A*; if *B*, then not-*A*; therefore: not-*B*.'

This is clearly a valid argument. Notice that *validity* is wholly *determined by form*. Whatever statements we care to substitute for '*A*' and '*B*', we will always get a valid argument.

It goes without saying that the premises of Hayflick's argument must themselves be based on arguments. (He does not provide arguments in an explicit form.) Thus the thesis that all genetic programs have evolved through natural selection is assumed to follow from premises that belong to evolutionary biology. We would have to analyse implications of evolutionary theory to reach a verdict on Hayflick's view (for more information see Rose, 1991, who endorses an evolutionary view of aging).

The discipline of *logic*, broadly defined, is concerned with the analysis of concepts and arguments forms. My comments above indicate that applications of logic are indispensable in scientific work.

Questions concerning the logic of science are relatively concrete and specific. In the evaluation of scientific reasoning we should also ask more general questions that belong to *methodology*, a branch of *philosophy of science*. Scientists elaborate *theories* by *testing hypotheses*. The theories are used to *explain* and *predict* phenomena. Methodology characterizes the nature of theories, tests, and so forth, in general terms, and formulates criteria they must satisfy. Methodology, like logic, is indispensable in science.

Logical criteria such as validity are relatively straightforward. *Methodological criteria* are more elusive. By way of an example, I will briefly consider the nature of *scientific theories* and the criteria they must satisfy. In physics, theories typically consist of laws of nature, highly general statements which are well-confirmed. Not so in biology. There are many theories of aging, but to my knowledge no law of aging has ever been formulated.

If we would take the view that scientific theories must satisfy the methodological criterion of *generality*, biology would compare poorly with physics. It would have few adequate theories if any. I regard this as an unreasonable view. My conclusion is rather that *the category of theories is heterogeneous.* Some theories are general, others are not.

Many methodological criteria for theory assessment have been considered in the literature: clarity, empirical content, realism, testability and confirmation by tests, consistency, coherence, generality, simplicity, explanatory power and predictive power. It should be obvious that *theories will seldom satisfy all* these *criteria* at the same time.

For example, generality may be at odds with realism. Should one opt for a theory which is general, or for one which is realistic? That is a question without a general answer. Theories about drug effects had better be realistic if we want to use them for calculating dosages of drugs which patients need. Such theories will not be general since they must deal with highly specific situations. In contrast to this, those who want to understand the spread of epidemics may well be content with general mathematical theories which disregard many factors with minor effects. More realistic epidemiological theories tend to be mathematically untractable.

The importance of methodological criteria obviously depends on the context, on the purposes we have.

The criteria of *clarity and empirical content are important* because they are presupposed by various other criteria. Therefore they will get much attention in this book. I guess I need not clarify clarity.

Empirical content is an elusive notion. A statement has empirical content if its truth or falsity depends only on the way it deals with *facts.* The term 'fact' in this connection must not be taken in the broad sense of ordinary language. We normally use the term 'fact' for many different things. It is a fact that 2 + 2 = 4, that murder is bad, that I am now writing a book, that all metals expand when heated, that all bachelors are unmarried, and so forth. In science and philosophy the concept of fact mostly has a narrower meaning. It stands for things covered by statements that describe situations or events at a particular time and a particular place.

The statement that I am now (July 5, 1992, 1 a.m. local time) writing a book is true because it expresses a fact. Thus it has empirical content. The statement that I am not writing a book now likewise has empirical content. It is false because what it expresses is at odds with a fact—the same one. The general statement that all metals expand when heated describes a multitude of facts rather than a single one. It obviously has empirical content.

The statement that 2 + 2 = 4 is different. Its truth does not depend on facts expressed by it; indeed it does not express any facts. Truth in this case is determined by linguistic 'facts' concerning the meaning of concepts ('2', '+', '=', '4'). So the statement has no empirical content.

Philosophers call statements with empirical content synthetic statements. I will use a more easy-sounding terminology and simply call them *empirical statements*.

Statements with truth or falsity depending on meanings are called analytic statements by philosophers. In addition to this, statements are also called analytic when their truth or falsity depends on form. 'I am a man or I am not a man' is an example. This statement is true but its truth depends neither on facts nor on meanings. Its *form* is '*p* or not-*p*'. *Any* statement with this form must be true. Likewise the form '*p* and not-*p*' will always yield false statements.

The truth or falsity of analytic statements can be determined by logical analysis, that is an analysis of meanings or of logical form. Because the concept of analyticity is seldom used outside logic and philosophy, I will speak of *logical statements* instead of analytic statements. Notice that I am using this expression for two categories of statements, those which are true or false in virtue of meanings, and those which are true or false in virtue of logical form.

Various philosophers, most notably Quine (1953, 1960), have rejected the distinction of logical and empirical statements since there is no sharp boundary. I would argue that the distinction is quite useful if we are willing to take the *context* into account. Statements take on meaning in the context of a particular *discourse*. Hence it is possible for a statement to be logical in one discourse and empirical in a different discourse. 'All bachelors are unmarried' is a logical statement if the term 'bachelor' is used for unmarried persons. In a different discourse, 'bachelor' may stand for persons who do not live with a partner. 'All bachelors are unmarried' would be a false empirical statement in that discourse, since some persons who do not live with a partner are in fact formally married.

Empirical statements and logical statements are *cognitive statements*, statements which are true or false. In addition to this there are *non-cognitive statements*, which cannot be true or false. Commands ('Shut the door')—if looked upon as statements—are an obvious example. What to think of 'Murder is bad'? It has the ring of a true statement. However, it would not be easy to specify what truth depends on in this case. On second thought we may come to doubt whether the statement can be true or false. In philosophy opinion on this is divided.

'Murder is bad' belongs to the category of *normative statements*. Statements in this category express values ('Murder is bad') or norms ('Murder must be punished'). I will stay on the safe side and refrain from applying the concepts of truth or falsity to normative statements. Instead I will call them *acceptable* or *unacceptable*.

The first few chapters of this book introduce the logic of concepts and arguments. Subsequently I consider topics such as hypothesis testing and explanation, which are more obviously in the domain of philosophy of science. In chapters *9* and *10* the focus is on relations between science and the domain of the normative. These chapters put science, philosophy and ethics in a broader perspective. Throughout the book, the emphasis is on applications in the life sciences.