3 History: Reproduction and Heredity

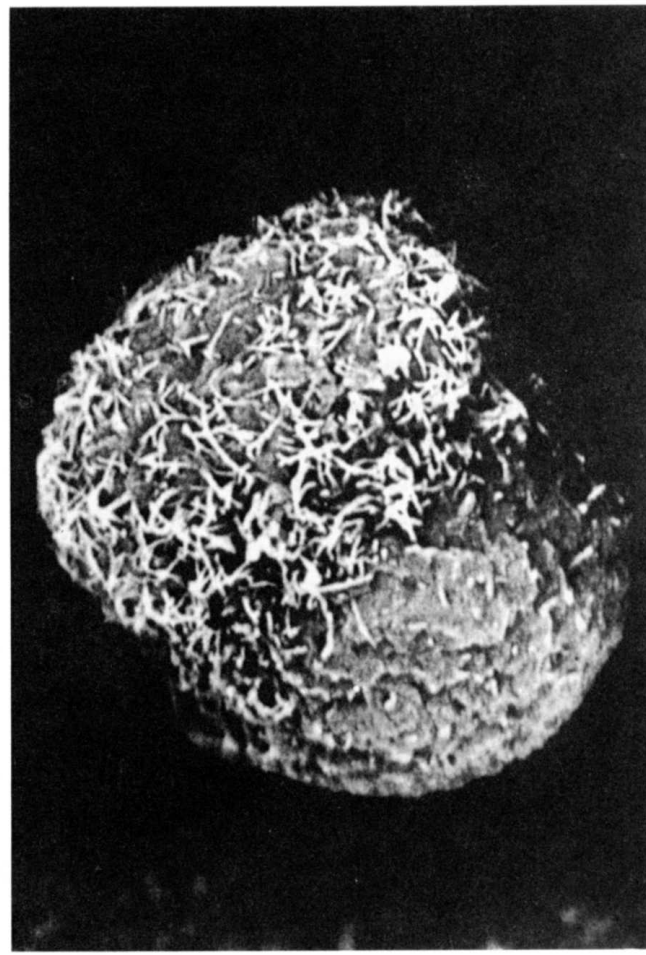


Fig. 14. One of the first divisions of a mouse embryo.

This chapter deals with reproduction and heredity. There are two compelling reasons for this. One of them is that as living beings (and, as we shall see, as social beings), we have a history: we are descendants by reproduction, not only of our human forebears but also of very different forebears who go back in the past more than 3 billion years. The other reason is that as organisms, we are multicellular beings and all our cells descend by reproduction from the particular cell formed when an ovule united with a sperm and gave us our origin. Reproduction is therefore inserted in our history in relation to ourselves as human beings and to our individual cell components. Oddly enough, this makes us and our cells beings of the same ancestral age. Moreover, from a historical standpoint, this is valid for all living beings and all contemporary cells: we share the same ancestral age. Hence, to understand living beings in all their dimensions, and thereby understand ourselves, we have to understand the mechanisms that make living beings historical beings. To this end, we shall examine first the phenomenon of reproduction.

Reproduction: What's It All About?

Biology has studied the process of reproduction from many points of view, particularly regarding cells. It has long since demonstrated that a cell can originate another cell through division. We speak of cell division (or mitosis) as a complex process of rearranging cellular elements that brings about a plane of division. What happens during this process? Reproduction generally consists in one unity, by some specific process, giving origin to

Historical Phenomena

Each time in a system that a state arises as a modification of a previous state, we have a *historical phenomenon.*

another unity of the same class; that is, it gives origin to another unity that an observer can recognize as possessing the same organization as the original one.

It is evident, therefore, that reproduction presupposes two basic conditions: an original unity and the process that reproduces it.

In the case of living beings, the original unity is a living being, an autopoietic unity; and the process—we shall say later exactly what it is—must end with the formation of at least one other autopoietic unity distinct from what is considered to be the first.

The careful reader must have realized by now that by looking at reproduction in this way, we are implying that it is *not* constitutive of living things and therefore (as should now be evident) does not play a part in their organization. We are so used to regarding living beings as a list of properties (and reproduction as one of them) that this may appear shocking on reflection. Nevertheless, what we are saying is simple: reproduction cannot be a part of the organization of living beings because to reproduce something, that something must *first* constitute a unity and have an organization that defines it. This is simple logic and we use it every

Organization and History

The dynamics of any system can be explained by showing the relations between its parts and the regularities of their interactions so as to reveal its organization. For us to fully understand it, however, we need not only to see it as a unity operating in its internal dynamics, but also to see it in its circumstances, i.e., in the context to which its operation connects it. This understanding requires that we adopt a certain distance for observation, a perspective that in the case of historical systems implies a reference to their origin. This can be easy, for instance, in the case of man-made machines, for we have access to every detail of their manufacture. The situation is not that easy, however, as regards living beings: their genesis and their history are never directly visible and can be reconstructed only by fragments.

day. Therefore, if we carry this ordinary logic to its consequences, we will be forced to conclude that in speaking of the reproduction of a living being, we are implying that it must be capable of existing without reproducing itself. It is enough to think of a mule to realize that this must be so. Now, what we are discussing in this chapter is how the structural dynamics of an autopoietic unity becomes complicated in the process of reproduction, and the consequences of this in the history of living beings. To *add* anything to a structural dynamics, however, is quite different from changing the essential characteristics of a unity; the latter implies changing its organization.

Modes of Generating Unities

To understand what happens in cell reproduction, let us look at varied situations that give rise to unities of the same class.

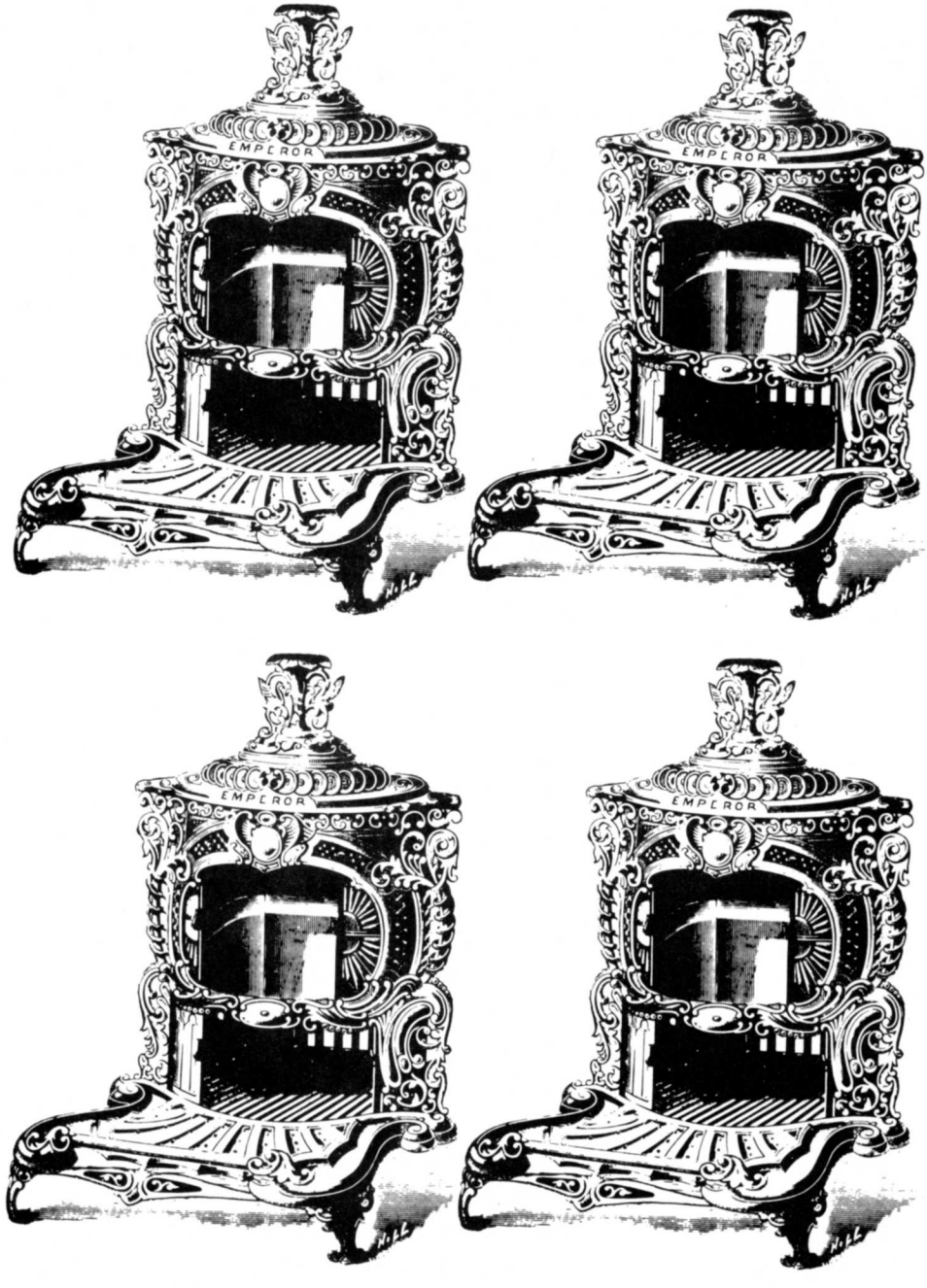
Replication We refer to replication (or, at times, production) whenever we have an operating mechanism that can repeatedly generate unities of the same class. For instance, a factory is a large productive mechanism which, by repeated application of one same process, turns out series of replicas of unities of the same class: fabrics, cars, tires (Fig. 15).

The same happens with cell components. We see this very clearly in protein production, where ribosomes, messenger and transfer nucleic acids, and other molecules constitute together the productive machinery and the proteins constitute the product.

Basic to the phenomenon of replication is the fact that the productive mechanism and the product are operationally different systems, and the productive mechanism generates elements independent of it. Note that as a consequence of how replication takes place, the unities produced are historically *independent* of each other. What happens to any one of them in its individual history does not affect what happens to those that follow in the series of production. What happens to my Toyota after I buy it in no way affects the Toyota factory, which will imperturbably continue producing its automobiles. In short, unities produced by replication do not constitute among themselves a historical system.

Copy We speak of a copy whenever we have a model unity and a projective procedure for generating an identical unity. For instance, this page put through a Xerox machine yields what we call a copy. Hence, the model unity is this page, and the process is the method of operating with an optically projective mechanism (the Xerox machine).

Fig. 15. A case of replication.



Now, we can distinguish in this situation two basically different cases. If the *same* model is used to make many successive copies, we have a number of copies historically independent of each other. But if the result of one copy is used as a model to make the following copy, a number of historically connected unities are generated, for what happens to each of them during the time they become individual, before being used as a model, determines the characteristics of the following copy. Thus, if a Xerox copy of this page is copied in turn by the same machine, it is clear that the original and the two copies differ slightly from each other. If we repeat this same process, at the end of many copies, as is obvious, we can note the progressive transformation of those copies into a lineage or historical succession of copied unities. A creative use of this historical phenomenon is what is known in art as anamorphosis (Fig. 16). This is an excellent example of historical drift.

Reproduction We speak of reproduction when a unity undergoes a *fracture* that results in two unities of the same class. This happens, for instance, when a piece of chalk is broken in two or when a bunch of grapes is broken into two bunches of grapes. The resulting unities are not identical with the original one nor are they identical with each other; however, they belong to the same class as the original; that is, they have the same organization. Such is not the case when a radio or a check is fractured. In these cases, fracture of the original unity destroys it and leaves two fragments, not two unities of the same class as the original one.

In order for a fracture to result in reproduction, the structure of the unity must be organized in a

distributed and noncompartmentalized way. Thus, the plane of fracture separates fragments with structures capable of embodying independently the same original organization. The chalk and the bunch of grapes have this type of structure and admit many planes of fracture, because their organization includes all their components repeating themselves in a distributed and noncompartmentalized way throughout their extension (calcium crystals in chalk and grapes in a bunch).

Many systems in nature satisfy these requisites; hence, reproduction is a frequent phenomenon. Examples are mirrors, sticks, communities, and roads (Fig. 17). On the other hand, a radio and a coin do not reproduce, because their defining relations are not repeated in their respective extensions. There are many systems in this class, such as cups, persons, fountain pens, and a declaration of human rights. This incapacity to reproduce is a frequent pattern in the universe. Interestingly, reproduction as a phenomenon is not confined to a

particular space or to a particular group of systems. The core of the reproductive process (unlike replication or copy) is that everything happens in the unity as *part* of the unity, and there is no separation between the reproducing system and the reproduced system. Nor can it be said that the unities resulting from reproduction preexist or are being formed before the reproductive fracture occurs. They simply do not exist. Further, although the unities resulting from the reproductive fracture have the same organization as the original unity and therefore have structural aspects similar to it, they have structural aspects also different from it and from one another. This is so not only because they are smaller but also because their structures derive directly from the structure of the original unity at the time of reproduction; and when forming, they receive different components of the original unity which are not uniformly distributed and which are a function of its individual history of structural change.

Fig. 16. A case of copy with replacement of model.