FOUNDATIONS

The cell as a biological elementary unit

From R. HOOKE's discovery (1663) disclosing more than 300 years ago that the bark of the cork-oak consisted of elements similar to honeycombs, all along to modern cell biology a fascinating way leads into ever deeper fields of knowledge. Owing to the «rimmed» cavities seen in the microscopie section, the structures were called «cells». This observation was not introduced into the scientific standard knowledge until the middle of the 19th century. M. SCHLEIDEN (1838) stated that the cell was the basic unit of all plant structures, TH. SCHWANN extended this axiom to animals and plants. With R. VIRCHOW's cell research and his formulation that all life came from cells, cell morphology began to influence and to largely characterize human-medical thinking.

However, nearly another century went by before deeper dimensions were reached from the «little clot protoplasm» or from the «simultaneous existence of nucleus and cellular plasma». The picture of the cell, from historical and modern angles, reflects the technical potentialities of cell research. The structures watched in the light microscope had possessed the mental conceptions for nearly 300 years till the electron microscope opened morphologically new dimensions, till molecular biology and genetics accomplished the step from the mere contemplation of form (structure) to function. This process paralleled the discovery of subcellular structures and elements of organization, which, necessarily, raised the question of their significance (= function within the biological order). Though we believe to have a good conceptual power about the cell, most of the questions of functional interplay within and between the cells are obscure. What we do have, optically, is nothing but a skeleton of structures made visible by chemical influences (colouring) or physical processes (electron-microscopical sections). These methods provide conceptions of structures and space arrangements constituting just the rough brickwork of a house that only allows suppositions about its life and installations. Observations in vivo and cytochemical methods, therefore, help to explain the function of the elementary organization unit of life, namely of the cell.

The *ground plan* of the cell reflects the phylogenetic order. From the most primitive cells, the mycoplasmacateae, the evolution goes via the bacteria, blue algae, the higher plant cells to the complex system of the cells with membrane barriers and complete organelle fitments in multi-cellular and higher organized organisms. The further evolution will probably not continue through variations of the cytoorganelles but will depend on a further differentiation of the interrelations between the cells.

The obligatory building elements of the higher cells include:

1. *Nucleus*
2. *Nucleolus*
3. *Nuclear membrane*
4. *Nucleopores*
5. *Endoplasmatic Reticulum (Ergastoplasm)*
6. *Ribosomes*
7. *Golgi-apparatus*
8. *Vesiculae*
9. *Vacuoles*
10. *Granules of secretion*
11. *Lysosomes*
12. *Mitochondria*
13. *Centriol*
14. *Microtubuli*
15. *Cell membrane (Plasmalemm)*
16. *Desmosomes*
17. *Basic plasma (matrix)*

The form and function of the cell organelles are subject to functionally determined variations of a uniform building principle. The task in the functional unit cell can just be sketched in the scope of this survey.

The *nucleus* consists of chromatin containing DNA, the *nucleolus* constitutes a ball consisting of RNA (ribonucleic acid) in the nucleus. The *nuclear membrane* consists of 2 leaves, the outer lined with ribosomes and going over into the *endoplasmatic reticulum;* it is interrupted by nucleopores. The so-called *perinuclear space* is between the two membranes.

The *Golgi-apparatus* has various forms, consists of membranes, forms *sacculi, double membranes, vacuoles* and *vesiculae;* it serves for tasks of synthesis and controls and eliminates products of synthesis, which are conveyed on by vesiculae, vacuoles and secretion granules and eventually are eliminated through the cell membrane. The Golgi-apparatus and the endoplasmatic reticulum are connected by the *Gerl complex.*

The protein synthesis takes place on the ribosomes of the *endoplasmatic reticulum.* The density and dimensions of this system (referred to also as *ergastoplasm*) of tubular membranes reflects the synthetizing activity of the cell (see fig. 2).

Mitochondria are elliptic, spheric, rod-shaped and filiform structures 0.3–5 µm in length; thanks to their enzymes, they provide the energy for the cell, and therefore are also called energy stations or transformers. According to the activity of metabolism, a cell consequently contains more or fewer mitochondria.

The *microtubuli* and *fibrillary structural elements* are referred to as «metaplasm». Microtubuli have a diameter of 200–300 Å, are of different length and traverse the cytoplasm, but are chiefly oriented in the direction of centriol.

The *centriol* is near the nucleus, mostly in the middle of the cell, at the concave side of the Golgi-apparatus; this area is also called *centrosphere.* Nine groups about 0.5 µ in length of three mictrotubuli (triplets) form a cylinder of some 0.25 µ in diameter. The cylinder is surrounded by spherical satellites. The centriol contains extrachromosomal DNA, determines and controls cell division and –

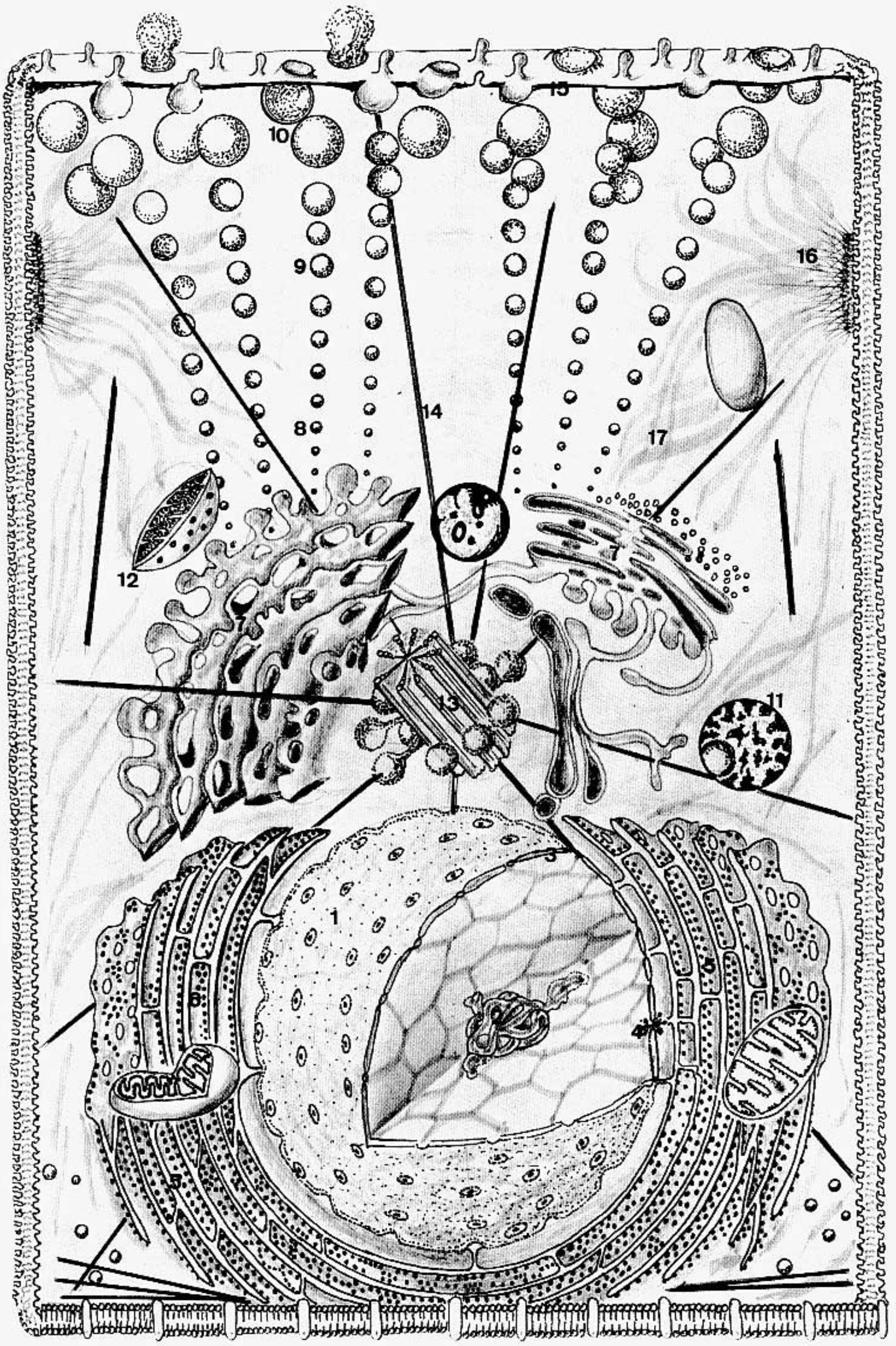

Fig. 1:
Idealized scheme of a *polar cell*

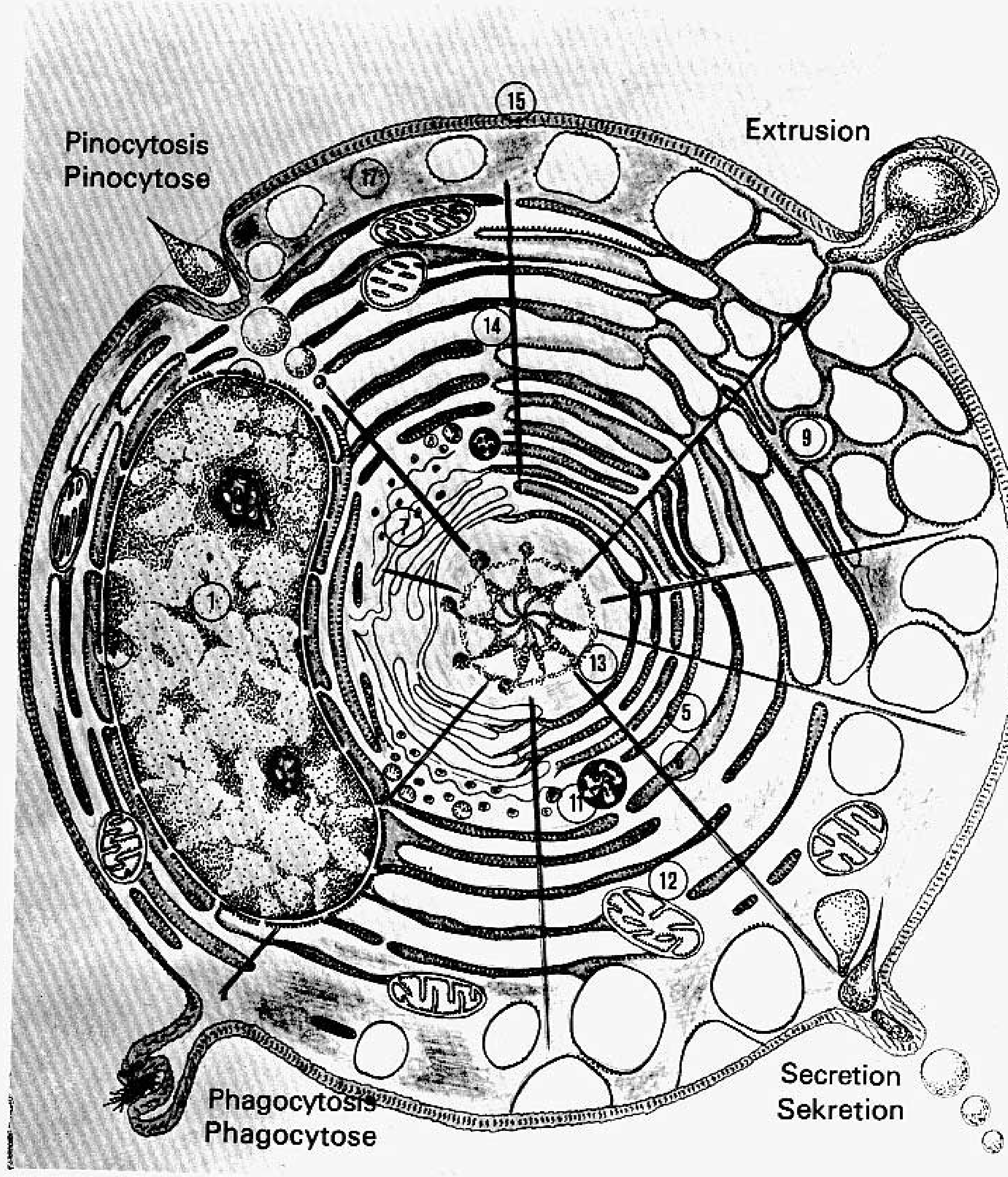

Fig. 2:
Idealized scheme of an *unpolar cell*, immunocyte in the stage of synthesis.

1. *Nucleus*
2. *Nucleolus*
3. *Nuclear membrane*
4. *Nucleopores*
5. *Endoplasmatic reticulum (ergastoplasm)*
6. *Ribosomes*
7. *Golgi-apparatus*
8. *Vesiculae*
9. *Vacuoles*
11. *Lysosomes*
12. *Mitochondria*
13. *Centriol*
14. *Microtubuli*
15. *Cell membrane (Plasmalemm)*
17. *Basic plasma (matrix)*

like the mitochondria – is considered as semi-autonomous in the cell organization.

Lysosomes are spherical to oval, of various density and serve for the intracellular digestion – perhaps also for «auto-cleaning».

The *cell membrane* (Plasmalemm) consists of 3 layers, has an average thickness of 75–100 Å, and is semipermeable; it regulates the interrelations with the extracellular space and can take up into the cell liquid (pinocytosis) or solid particles (phagocytosis) by advancing and retiring movements (fig. 2). The cell membrane contains enzymes and receptors to recognize foreign substances, hormones and other cells.

Desmosomes are organelles specialized as suctorial discs serving for the cohesion of cells; this clinging function appears from clusters of tonofibrils. Depending on whether the cell moves single in the liquid medium or is bound in the tissue, it is an unpolar (radiary) or polar cell.

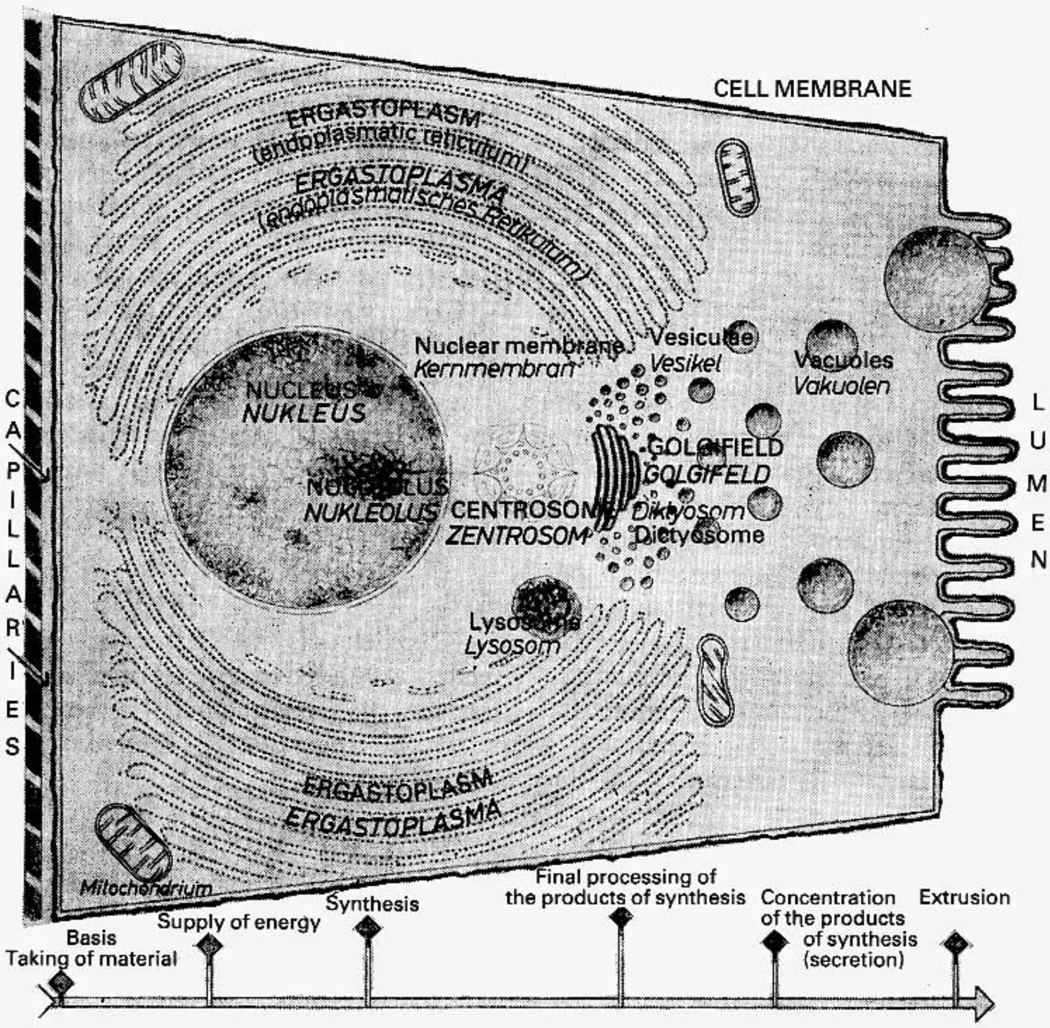

Fig. 3:
Functional scheme of a polar cell (e. g. pancreatic cell)

The *unpolar cell* (fig. 2) has the form of balls or ball-like rotation ellipses and adapts its shape to streaming conditions. The ingestion of material is effected from the surface from various directions, the elimination into various directions determined by laws of structure. The ways of transport are radiary into and out of the cell. Prototypes of these unpolar cells are the blood and exudate cells, specially monocytes, histiocytes and plasma cells. The cells have usually various tasks, are pluripotent and have, partly, kept the omnipotence of embryonal cells.

Cells bound in the tissue are chiefly specialized and polar. As far as they produce secretions (see fig. 3), 3 zones in the course of function must, theoretically, be

1. From a *supply base* via capillaries, biochemical substances are infiltrated into the cells, mostly in connection with fluids.
2. The *zone of synthesis* includes the ergastoplasm, the Golgifeld and the system of vesicles and cisterns.
3. The *products* of synthesis are controlled by the Golgi-apparatus, collected in secretion granules and cisterns, transported towards the apical cell membrane and there, via the cell membrane, deposited either to the nearest cell or into a cavity.

Cells bound in the tissue lose, when specialised, the pluripotence of unpolar cells in the fluid medium and mostly serve for selective tasks of metabolism.