Resumen por el autor, C. V. Cowdry.

La tendencia conservadora en la nomenclatura citológica.

El autor considera con cierta aprehensión la multiplicidad creciente de los términos citológicos. Un análisis demuestra que algunos de ellos han sido introducidos para indicar ciertos atributos morfológicos; otros para designar ideas relativas a la constitución química; otros, de nuevo, para recordar los descubridores (introduciendo de este modo todo el problema de la prioridad) mientras que los más confusos han sido ideados para proclamar alguna interpretación funcional más o menos teórica. La confusión resultante es perjudicial para el pensar claro y retarda definitivamente el progreso de la citología, pero ha de empeorar aún más hasta que los investigadores se hagan cargo suficientemente de la situación, considerando la introducción de nuevos términos sin buenas razones, como una especie de ofensa. Un cierto grado de tendencia conservadora es necesario. El autor indica que sería útil que alguna asociación nacional determinase los principios que han de inspirar la nomenclatura citológica para uso de los investigadores.

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CONSERVATISM IN CYTOLOGICAL NOMENCLATURE

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Repeated and ill-advised invention of new terms to designate cytoplasmic structures has resulted in considerable confusion.

A pathologist, for instance, who wants to review the literature on mitochondria is apt to be discouraged when told that, in order to be on the safe side, he must look for papers under at least a dozen different headings: bioblasts, chondriosomes, plastochondria, etc.

It is not without reason that biochemists and physiologists, who are able to help so much, are content to remain ignorant of advances in cytology. They are confronted by a mass of almost meaningless words which cannot be defined with anything approaching the accuracy to which they are accustomed. All too frequently they meet hypotheses which are absurd in the light of recent advances in physics and chemistry. A barrier is built up where the closest coöperation is needed. New and delicate methods are being devised for the measurement of temperature, electrical potential, ionization and other phenomena, which are of the utmost value to cytologists, but which their limited knowledge of physics and chemistry prevents them from using. Not infrequently the inventors themselves are unaware of the nature of the problems for which they are unconsciously supplying the means of solution.

The cytoplasmic material commonly called mitochondria (Benda, '98, p. 397) presents certain general properties, though the fact that it varies slightly in different cells suggests that it is in reality a mixture of chemical substances:

1. It may be easily seen to occur in living cells in the form of granules, rods, and filaments, and occasionally of networks, which vary in shape and in number in different conditions.

2. It gives a characteristic color reaction in living cells when janus green B (diethylsafraninazodimethylanilin) is applied in a solution as weak as 1:500,000. It first assumes a bluish-green color, then turns pink (diethylsafranin), and finally bleaches to the leucobase. The delicacy of the reaction is shown by the fact that janus green (Grübler) and janus green C will not stain mitochondria specifically, though they differ only in the substitution of an H_2 or $(CH_3)_2$ group in place of the (C_2H_5) .

3. Its solubilities are characteristic, and in fixed tissues it stains more or less specifically by the methods of Altmann, Benda, Bensley, and others.

The term 'mitochondria' is well known and has been widely used for over twenty years. It indicates variability in morphology, from threads to granules, and carries no theoretical or functional interpretation whatsoever (Cowdry, '18, p. 47).

Mitochondria did not altogether escape the older authors, who, with their relatively crude methods, observed and described them, often in confusion with materials of quite different nature, under many terms of which the following may be mentioned:

Archoplasma-schleifen (Hermann)	Neurosomen (Held)
Basal filaments (Solger)	Nucleus of Balbiani (Van der Stricht)
Centrophormien (Ballowitz)	Plastidulen (Maggi)
Chromidia ¹ (Hertwig)	Plasmosomen and Plasmomiten (Arnold)
Cytomicrosomes (Heidenhain)	Protoplasma supérieur (Prenant)
Ergastoplasme (Garnier)	Pseudochromosomen (Heidenhain and Van der Stricht)
Fila (Flemming)	Q and J granules (Holmgren)
Fuchsinophile granules (Galeotti and others)	Sarcosomen Retzius
Granula (Metzner)	Sphären (Rhode)
Granules (of Schridde)	Sarcosomen (Retzius)
Interstitial-Körner (Henle and Koelliker)	Sphéroplastes of Protozoa (Fauré-Fremiet)
Leucoplastids (Schimper)	Vermicules (Laguesse)
Microsomes (Van Beneden)	Vegetative filaments (Altmann)
Mitom (Flemming)	Vitellogene Schicht (Van der Stricht)
Nebenkern (Butschli)	
Nematoplasten (Zimmermann)	

¹ In the days of confusion with 'chromidia' it is highly probable that mitochondria were described under this heading, though, in reality, they are wholly different.

Since their recognition as a definite class of cell granulation the literature has been flooded with new terms introduced by the authors with the best intentions and, in each case, in the firm belief that they would finally clarify the situation:²

Benda ('98, p. 397)	Chondriomitom	A feltwork of mitochondria
Benda ('99, p. 332)	Chondriomiten	Thread-like mitochondria
Benda (Van der Stricht, '04, p. 105)	Chondriorhâbden	Shaft-like mitochondria
Benda (Van der Stricht, '04, p. 105)	Chondriosomen	A generic term to include all forms of mitochondria
Benda (Van der Stricht, '04, p. 105)	Chondriosphären	Spherical mitochondria
Renaut and Dubreuil ('06, p. 230)	Perinème	Mitochondria as they occur in certain connective tissue cells
Renaut and Dubreuil ('06, p. 230)	Pericaryonème	Mitochondria as they occur in certain connective tissue cells
Koltzoff ('06, p. 468)	Mitogels	Large mitochondrial masses formed by confluence
Koltzoff ('06, p. 468)	Mitosols	Mitochondrial droplets
Koltzoff ('06, p. 468)	Mitochondrosols	Mitochondrial droplets
Duesberg ('07, p. 284)	Mitochondrial apparatus	A general term, same as chondriom (Duesberg, '08, p. 261)
Meves ('07, p. 401)	Chondriokonten	Rod-like mitochondria
Meves ('07, p. 403)	Chondriom	Cytoplasmic content of mitochondria
Giglio-Tos and Granata ('08, p. 14)	Chondriotaxie	The arrangement of granular mitochondria in threads
Giglio-Tos and Granata ('08, p. 1)	Chondrioderese ³	Division of mitochondria
Regaud ('09, p. 921)	Eelectosomes	To indicate supposed property of picking up substances from the surrounding medium and elaborating them
Meves ('10, p. 150)	Plastosomen	Generic term to include all forms of mitochondria
Meves ('10, p. 150)	Plastochondrien	Granular mitochondria supposed to play a definite part in histogenesis

² Rosenstadt's ('18, p. 193) 'tetrasomen' terminology is difficult to correlate.

³ Comes (p. 423) claims priority over Giglio-Tos in the invention of this term. Since, however, he confuses the mitochondria with the reticular material, it is not clear under which heading it should be given.

Meves ('10, p. 150)	Plastochondriomiten	Rows of granular mitochondria
Meves ('10, p. 150)	Plastoconten	Long rod-like mitochondria
Laguesse ('11, p. 276)	Ergastidions	To indicate supposed relation to ergastoplasm
Romeis ('12, p. 139)	Chondriolysis	Solution of mitochondria
Comes ('13, p. 423)	Condrio-cinesi	Changes in mitochondria during cell division
Comes ('13, p. 423)	Condrio-dieresi	Changes in mitochondria during cell division
Comes ('13, p. 423)	Idio-condrioma	Mitochondria supposed to play a definite part as carriers of heredity
Comes ('13, p. 423)	Trofo-condrioma	Mitochondria supposed to be concerned in nutrition
Asvadourova ('13, p. 293)	Chromochondries	To indicate supposed part in pigment formation
Wildman ('13, p. 428)	Karyochondria	To indicate supposed nuclear origin
Ciaccio ('13, p. 725)	Plastolysis	Solution of mitochondria
Ciaccio ('13, p. 725)	Plastorhexis	Breaking up of mitochondria into granules and vesicles
Ciaccio ('13, p. 725)	Präplastorhexis	Changes preliminary to plastorhexis
Champy ('13, p. 157)	Chondrioplastes	To indicate supposed part in formation of plastes
Arndt ('14, p. 55)	Caryosomochondria	To indicate supposed origin from the caryosome
Jordan and Ferguson ('16, p. 94)	Myochondria	To indicate supposed mitochondrial origin of myofibrils
Gatenby ('18, p. 223)	Micromitochondria Macromitochondria	Small mitochondria which are less dense than the larger ones and behave differently in the spermatogenesis of certain invertebrates
Gatenby ('18, p. 210)	Macromitosome	Used synonymously with the mitochondrial coil (nebenkern or paranucleus) of Lepidoptera
Meves ('18, p. 273)	Chondriomer	Suggests termination 'er' for purely morphological nomenclature
Guilliermond ('19, p. 239)	Mitochondries elaboratrices	To indicate mitochondria supposed to differentiate into chondrioplastes in the animal cell and into plastides in the vegetable cell

Guilliermond ('19, p. 239)	Mitochondries vegetatives	To indicate non-functional mitochondria which are thought to perpetuate the chondriome
Dangeard ('19)	Plastidome	(Quoting from Guilliermond '21, p. 73)

The reticular material cannot be so precisely defined, but we do know that under certain conditions it (or its mordant) has an affinity for silver; that after long immersion it blackens with osmic acid; and that, when fixed by appropriate methods (Bensley, '10, p. 191), it presents the form of a system of clear uncolored spaces. It may also be recognized by its morphology and by its position in the cell. Golgi ('98, p. 1) was the first to refer to its reticular shape. By substituting the general term 'material' in place of 'apparatus,' the idea of a definite system of canals is not sustained (Cowdry, '21, p. 8).

Like the mitochondria, it was occasionally seen by the older authors and described, together with other materials under many headings of which I have selected the following:

Archoplasm (Boveri)	Nebenkern (Butschli)
Boyaux incolores (Van Beneden)	Primitivröhrechen (Nansen)
Centrodeutoplasm (Erlanger)	Vasa serosa intracellularia (Adamkiewicz)
Cytozoon (Gaule)	Zentralkapsel (Heidenhain)
Mitosome (Platner)	

Stimulated by the discoveries of Golgi, Holmgren, and Kopsch, new terms are being devised wholesale:

Holmgren ('99, p. 139)	Saftkanälchen	Reticular material as clear canals (negative picture)
Nelis ('99, p. 102)	Spiremes	Reticular material in the form of clear, uncolored spaces
	État spiremateux du protoplasma	Reticular material in the form of clear, uncolored spaces
	Bandes incolores	Reticular material in the form of clear, uncolored spaces
Kopsch ('02, p. 934)	Binnennetz (Netzapparat)	Blackened reticular material
Holmgren ('03, p. 9)	Trophospongium	To indicate canals which penetrate the cell from the exterior. Evidently not the reticular material, which is purely cytoplasmic, though sometimes applied to it.

Cajal ('04, p. 25)	Aparato tubiliforme	Same as 'red endocellular de Golgi'
Fuchs ('04, p. 501)	Fadenknauel	Same as Saftkanälchen or reticular material in the form of clear, uncolored spaces
Sánchez ('07, p. 167)	Appareil réticulaire de Cajal-Fusan	Homologue of 'Appareil de Golgi-Holmgren'
Cajal ('08, p. 123)	Conduits de Golgi-Holmgren.	Reticular material as clear canals
Perroncito ('09) (Duesberg, '11, p. 884)	Dittocinesi	To indicate the process of breaking up of reticular material into fragments during mitosis
	Dittosomi	The individual fragments
Bensley ('10, p. 179)	Canalicular apparatus	Reticular material as clear canals
Maccabruni ('10, p. 447)	Retzius-Holmgren-schen Kanälchen	To indicate tubular nature and discovery by Retzius and Holmgren
Kuschakewitsch ('13, p. 310)	Sphärosomen Sphärotheca	Reticular material during a phase of spermatogenesis
Terni ('14, p. 68)	Formazioni periid- iozomici	Reticular material grouped about the centrosome
King (Gatenby, '16, p. 418)	Acroblasts	"Dictyosomes or individual units of the Golgi apparatus" (Gatenby and Woodger, '21, p. 279)
Stockard and Papanicolaou ('18, p. 39)	Idioectosome Idiophthartosome	Reticular material as it appears in certain stages of spermatogenesis
Gatenby ('18 a, p. 403)	Chondrioplasts	Same as 'Golgi rods' (i.e., rod-like masses of reticular material)
Penfield ('20, p. 303)	Retispersion	To indicate dispersion of the reticular material to the cell periphery
Penfield ('20, p. 303)	Retisolution	Solution of the reticular material
Saguchi ('20, p. 388)	Intracellular network	"The apparatus which can be made manifest by various methods, such as Kopsch's and Wiegler's osmium method, Sjovall's formalin-water-osmium method, Cajal's uranic nitrate-silver method, and Golgi's arsenic method"
Saguchi ('20 a, p. 15)	Urano-argento- phile apparatus	"Filamentous or granular corpuscles which can be made manifest by the Cajal uranic nitrate method"

The so-called 'chromidal substance' is another cytoplasmic constituent of wide distribution encountered by many investigators, who, failing to realize the substantial similarity of the fundamental vital processes in different tissues, have called it all kinds of names. Specific granulations, occurring only in certain cell types, give us much less trouble.

We cannot take refuge in priority, which is very difficult to establish, because modern cytology is resolving itself more and more into a gradual approximation to a logical interpretation of living materials observed for the first time years ago with the aid of Abbe's condenser and the newly introduced apochromatic lenses. Newly recognized protoplasmic constituents are, for the most part, specific in nature, like secretion antecedents, not general in distribution, like the mitochondria, and are only revealed by refinements in microchemical technique. It is but natural that investigators should introduce terms indicative of their theoretical conceptions, but the habit is a bad one, because our ideas are changing so rapidly. Altmann's choice of the term 'bioblasts,' to indicate his belief that small fragments of material, which we now know to be mitochondria, were independent micro-organisms, attracted so much criticism and ridicule that his valuable discoveries were soon forgotten and investigations along this line were set back many years. Terms of this kind indicative of the supposed functional activities of cellular structures are often invented one year only to be cast aside the next, but they remain in the literature to mystify visitors from other sciences.

I question also the wisdom of using special terms to indicate slight differences in morphology; which after all can only be detected with oil-immersion lenses. In the case of mitochondria, we are dealing with fragments of material of microscopic size. Changes in form occur from moment to moment and are merely the expression of interaction between the mitochondria and the surrounding medium; only rarely do they indicate noticeable differences in chemical constitution.

Realizing that the cell is a living unit, which is changing continually, our terms should, it appears to me, be general and comprehensive, not limited and specific. While the materials in

question continue to defy chemical analysis, the probability that they undergo progressive and important chemical changes, which are not revealed by our imperfect methods, should be entertained, and speculations as to their physiological rôle should be advanced with caution. Most of the structural differentiations recognized by cytologists are mixtures, not pure chemical substances, so that the problem is by no means a simple one.

Perhaps the greatest difficulties are met with during cytomorphosis. In spermatogenesis, for instance, the mitochondria appear to change into some kind of material fairly resistant to acetic acid and of different morphology and staining reaction. At what stage should we cease calling them mitochondria and speak only of the product, whatever it may be? The same difficulty is met with in the case of the reticular material. The introduction by Stockard and Papanicolaou ('18, p. 39) of the following terms, in connection with the development of the idiosome, is, in my opinion, of questionable value: *calyptosome*, *karyogranulomes*, *idiogranulotheca*, *idiophthartosome*, *idiosphaerosome*, *idiosphaerotheca*, *cytogranulomes*, *cryptosome*, *idioectosome*, *idioendosome*, *idiogranulomes*, *spermiocalyptrotheca*. I am inclined to agree with Duesberg's ('20, p. 8) usage in this connection. Since we are ignorant of the chemistry of the cytomorphic change, we have to come to some arbitrary decision in each instance, for every cell in the body as it grows old presents the same problem with respect to all its structural components.

So many and so varied are the structures which can be recognized in the nucleus and cytoplasm in normal as well as pathological conditions, the chemistry and physics of which we know next to nothing, that hundreds of terms are in every-day use, many of them synonymous. Specialization is carried so far that students of the cytoplasm become bewildered when first they interest themselves in nuclear structure, and investigators familiar with the nucleus have to go slowly in the terminology of leucocytic granulations and secretion antecedents, if, indeed, they ever consider them.

Our main problem is not an etymological one, but confusion in nomenclature reflects inaccuracy in methods of cytologic

analysis and in the coördination of our knowledge of cellular physiology. It arises from the fact that our information regarding the chemistry of protoplasm is largely indirect and deducive. With the discovery of new methods of direct analysis and the strengthening of the mechanistic point of view, that we must try to explain vital phenomena in terms of physics and chemistry, investigators will be less ready to advance theories without carefully considering the chemical changes which they hypothecate, or to make unqualified statements of the transformation of one cytoplasmic material into another without knowing the constitution of either and the probability or improbability of such a change. With more accurate knowledge will come conservatism; the useful terms will gradually be sorted out and the bad ones consigned to oblivion. But this rapprochement between cytology and the more exact sciences will be a slow process extending over many years. In the meantime are we to follow the command of the old Chinese philosopher, Lao Tzu: "Practise inaction; content yourself with doing nothing"?

Some will say that it is not a matter which warrants group action, that the individual must continue to be a law unto himself, and that the very haziness of our knowledge of cellular structure will make it impossible to arrive at any *modus operandi*. The Basel anatomical nomenclature of visible structural components, a much easier task, has on the whole been of the greatest help. In chemistry, certain conventions in terminology are recognized even in respect to compounds about which very little is known and concerning which there is much speculation.

Individual preference will of course continue to be followed, but I cannot help thinking that an attempt by some national organization, or group of individuals, not to dogmatize further on terms, but rather to determine guiding principles in cytologic nomenclature for the use of investigators would be desirable. To yield the best results this committee or group should consist of students interested in the structure of both the nucleus and the cytoplasm as well as of a botanist, a protozoologist, and a biochemist, because cytology, dealing as it does with the minute structure of living material, is the broadest of biological sciences.

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