

第1章 细 胞

Chapter 1 Cell

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【 目的要求 】

1. 掌握细胞核、细胞膜的结构及组成。
2. 掌握细胞质内细胞器的组成、电镜结构特点。
3. 熟悉细胞骨架的组成及结构特点。
4. 了解染色体的核型、染色质 / 染色体的变化特点。
5. 了解细胞周期、细胞分裂过程及各阶段的细胞形态特点。

【 Objective 】

1. To master the structure and composition of cell nucleus and membrane.
2. To master the composition of the cytoplasmic organelles and their features under electron microscopy (EM).
3. To be familiar with the composition and structure of the cytoskeleton.
4. To understand the characteristics of chromosome karyotype, changes of chromatin / chromosome.
5. To understand the cell cycle, cell division and their morphological characteristics at different stages.

【 示教图片 】**【 Teaching Pictures 】****① 图片 1: 细胞核**

图 1-1a (电镜, EM) 显示细胞核中淡染均质区域为常染色质 (1), 深染区域为异染色质 (2), 核中央为核仁 (3)。图 1-1b 显示核外周为核膜部分, 核膜为双层膜结构, 核内膜 (1) 与核外膜 (2) 由核周腔 (3) 相分隔。核膜上有许多核孔 (4), 介导细胞核与细胞质之

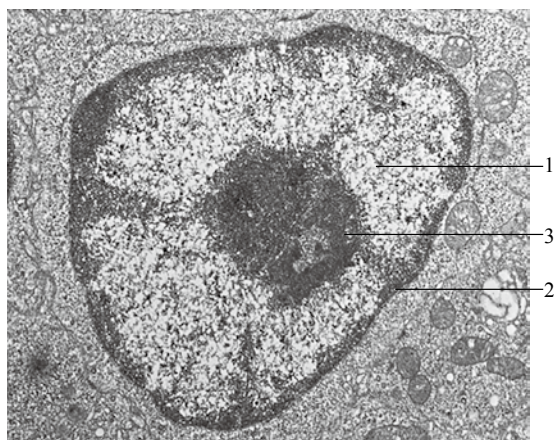


图 1-1a 细胞核 (EM, 12 000×)

Fig.1-1a Nucleus (EM, 12 000×)

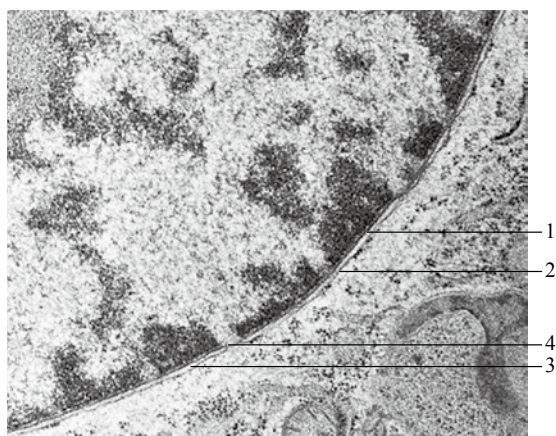


图 1-1b 核膜与核孔 (EM, 30 000×)

Fig.1-1b Nuclear membrane and pores
(EM, 30 000×)

间的物质交换。

1. Picture 1: Nucleus

Figure 1-1a (Electronic Microscope, EM) shows the pale-stained homogenous region as euchromatin (1) and dark-stained region as heterochromatin (2) in the nucleus. The nucleolus is located in the nucleus center (3). Figure 1-1b shows peripheral nucleus membrane as bilayer membrane structure. The inner membrane (1) and the outer membrane (2) were separated by the perinuclear cisterna (3). There are many nuclear pores (4) that allow the exchange of material between nucleus and cytoplasm.

② 图片 2: 粗面内质网与核糖体

图 1-2 显示细胞核 (1) 周围, 粗面内质网 (2) 为一膜性网状结构, 其膜表面附有核糖体 (3)。细胞质内也有游离的核糖体 (4) 存在。

2. Picture 2: Rough endoplasmic reticulum (RER) & ribosome

Figure 1-2 shows that around the nucleus (1), RER (2) is a membrane network structure that has ribosomes (3) attached to the cytoplasmic surface. Ribosomes also exist in cytoplasm (4).

③ 图片 3: 滑面内质网

图 1-3 显示滑面内质网为细胞质内膜性网状结构, 其表面没有核糖体附着。

3. Picture 3: Smooth endoplasmic reticulum (SER)

Figure 1-3 shows the SER is a membrane network structure in the cytoplasm which contains no ribosomes attached to its cytoplasmic surface.

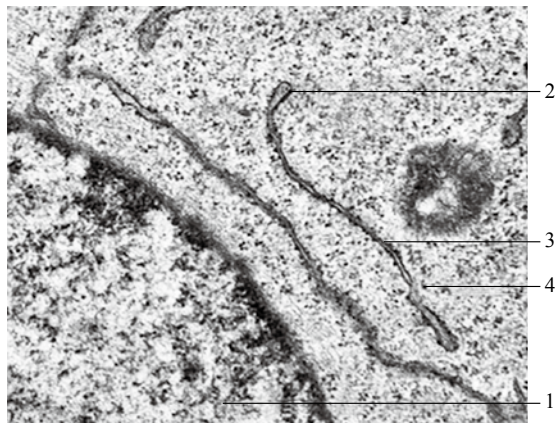


图 1-2 粗面内质网与核糖体 (EM, 60 000×)

Fig.1-2 RER and Ribosomes (EM, 60 000×)

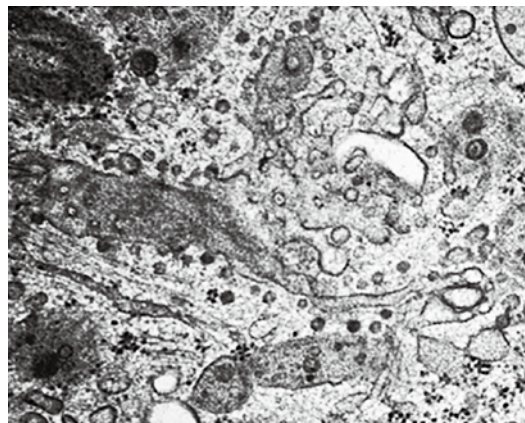


图 1-3 滑面内质网 (EM, 40 000×)

Fig.1-3 SER (EM, 40 000×)

④ 图片 4: 高尔基复合体

图 1-4 显示高尔基复合体为膜性网状结构, 由扁平囊重叠排列。高尔基复合体存在凸面 (顺面) (1) 和凹面 (反面) (2), 凸面接受粗面内质网新合成的囊泡 (3), 凹面将加工修饰的蛋白质浓缩小泡 (4) 释放出来。

4. Picture 4: Golgi complex

Figure 1-4 shows that the Golgi complex is a membrane network structure, which is arranged

in an overlapped flat saccule. Golgi complex has cis-face (1) and trans-face (2). The former receives vesicles newly synthesized by RER (3), and the latter releases the modified protein condensing vacuoles (4).

5 图片 5: 溶酶体

初级溶酶体外有单层膜包被, 色泽均匀, 染色深。图 1-5 显示次级溶酶体 (1) 形态可有不同, 内含物 (2) 色泽不均匀。残余体也称三级溶酶体。

5. Picture 5: Lysosome

A primary lysosome is enclosed by one membrane and has homogeneous, electron-dense granularity in its lumen. Figure 1-5 shows a secondary lysosome (1), which has partly digested material (2) in its lumen. Residual body is also named tertiary lysosome.

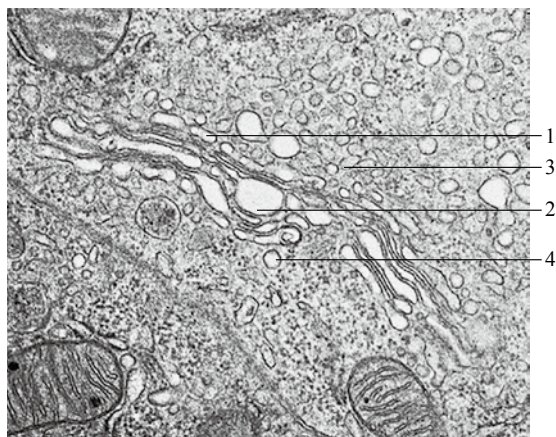


图 1-4 高尔基复合体 (EM, 50 000×)

Fig. 1-4 Golgi complex (EM, 50 000×)

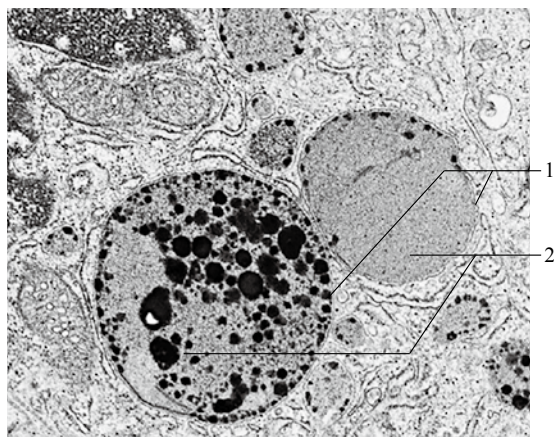


图 1-5 次级溶酶体 (EM, 20 000×)

Fig. 1-5 Secondary lysosome (EM, 20 000×)

6 图片 6: 线粒体

线粒体截面呈圆形、椭圆形或哑铃状等, 图 1-6 显示由外膜 (1)、内膜 (2)、膜间隙 (3) 和基质 (4) 组成。线粒体内膜向内突出形成线粒体嵴 (5), 嵴的横切面可呈囊状、管状或板层状。细胞质内见粗面内质网 (6) 和核糖体 (7)。

6. Picture 6: Mitochondria

Cross sections of mitochondria are round, ovoid or dumbbell shapes. Figure 1-6 shows that the mitochondrion consists of an outer membrane (1), inter membrane (2), intermembrane space (3) and matrix compartment (4). The inner membrane projects into the mitochondrial matrix and forms the mitochondrion cristae (5), which show as cystic, tubular or lamellar shapes at transection sections. RER (6) and ribosomes (7) are in the cytoplasm.

7 图片 7: 过氧化物酶体

图 1-7 显示过氧化物酶体 (1), 含有精细的颗粒基质 (2) 和晶体核心 (3)。

7. Picture 7: Peroxisomes

Figure 1-7 shows peroxisomes (1), which contain a finely granular matrix (2) and a crystalline core (3).

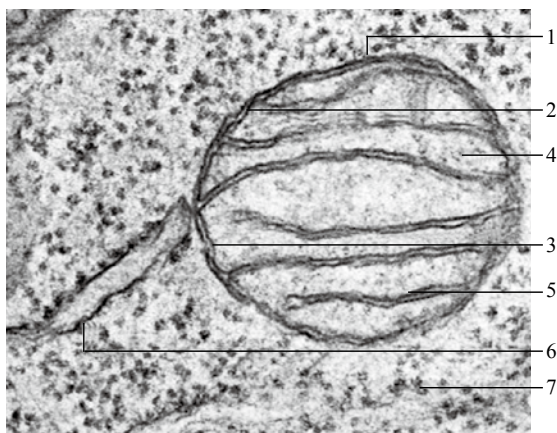


图 1-6 线粒体 (EM, 50 000 $\times$)
Fig. 1-6 Mitochondria (EM, 50 000 $\times$)

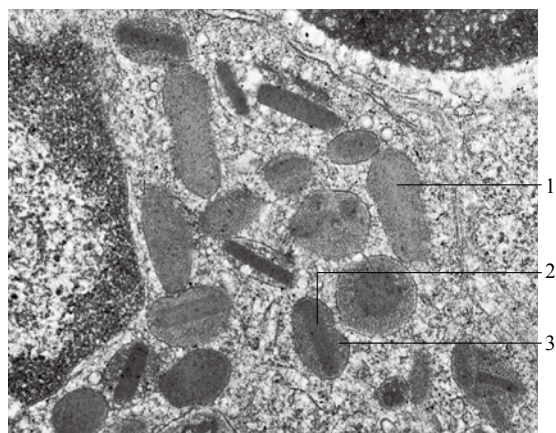


图 1-7 过氧化物酶体 (EM, 60 000 $\times$)
Fig. 1-7 Peroxisomes (EM, 60 000 $\times$)

8 图片 8: 微丝 (肌动蛋白丝)

图 1-8 显示小肠微绒毛的纵切面。微绒毛 (1) 为细胞膜和细胞质共同伸出的指状突起, 含有肌动蛋白丝 (2) 构成的致密结构轴心。

8. Picture 8: Microfilament (Actin filaments)

Figure 1-8 shows the longitudinal sections of the microvilli of small intestine. Microvilli (1), protrusions of plasma membrane, contain dense axis composed of actin filaments (2).

9 图片 9: 微管

微管是细长中空的圆柱形直管。微管蛋白为球形二聚体, 先装配成原纤维, 再由 13 条原纤维平行排列成单微管 (1) (图 1-9a), 特殊结构可存在二联微管和三联微管。图 1-9b 显示在培养中的细胞用抗 α -微管蛋白抗体和 DAPI (2-(4-氨基苯基)-6-吡啶甲酰胺二盐酸盐, 细胞核染色液) 进行荧光免疫染色后, 微管 (红色) 在细胞质中的分布。细胞核显示为蓝色。

9. Picture 9: Microtubule

Microtubule shows as a slender hollow cylindrical tube. Tubulin is spherical dimer,

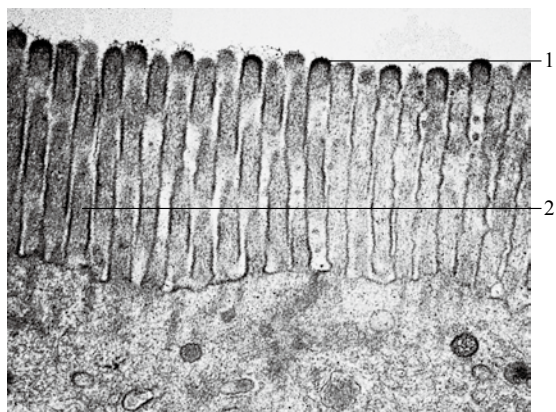


图 1-8 微丝 (电镜, 20 000 $\times$)
Fig. 1-8 Microfilament (EM, 20 000 $\times$)



图 1-9a 微管 (电镜, 100 000 $\times$)
Fig. 1-9a Microtubule (EM, 100 000 $\times$)

assembled into fibrils, and then 13 fibrils arranged in parallel which form a single microtubule (1) (Figure 1-9a). Special structure can exist as double microtubules and triple microtubules. Figure 1-9b shows that immunofluorescent staining with anti- α -tubulin and DAPI (2- (4-Amidinophenyl) -6-indolecarbamide dihydrochloride, nuclear staining solution) for cultured cells, the microtubules (red) extend throughout the cytoplasm. Nucleus is blue.

10 图片 10: 中心体

图 1-10 显示细胞核周围一对相互垂直的中心粒 (1) 结构。中心粒为低柱状, 由 9 组三联微管 (2) 组成。中心粒与其周围的细胞基质共同组成中心体。有丝分裂过程中, 中心体通过微管蛋白的聚合, 参与纺锤体等结构的形成。

10. Picture 10: Centrosome

Figure 1-10 shows a pair of centrioles (1), which are oriented perpendicular to each other around cell nucleus. Each comprise a ring of nine sets of fused microtubule triplets (2). The centrioles and pericentriolar matrix compose of centrosome. In mitosis, centrosome involves in the development of the mitotic spindle by polymerization of tubulin.

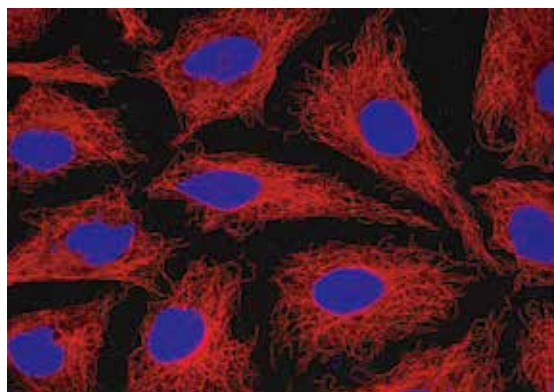


图 1-9b 微管 (免疫荧光染色, 400 $\times$)

Fig. 1-9b Microtubule (IF, 400 $\times$)

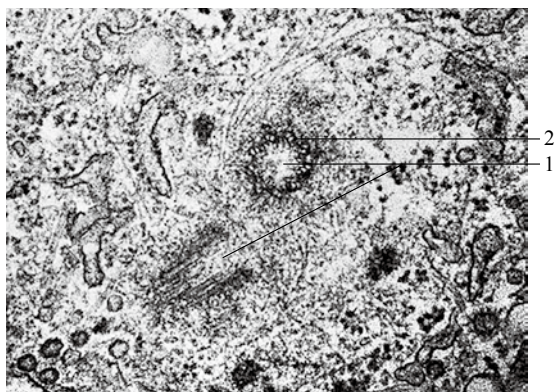


图 1-10 中心体 (电镜, 100 000 $\times$)

Fig. 1-10 Centrosome (EM, 100 000 $\times$)

11 图片 11: 脂滴

电镜下, 脂滴为大小不等的泡状结构, 没有界膜包绕, 内容物一般为均质状, 每个脂滴的电子密度不一, 与脂滴的大小、内容物的性质以及固定染色的方法有关。图 1-11a 显示应用苏丹 III 染色, 细胞内的脂滴 (1) 呈橘黄色; 图 1-11b (电镜) 显示肝细胞内呈球状的脂滴 (1)。

11. Picture 11: Lipid droplet

In EM, lipid droplets are vesicular structures in varying sizes, with no membrane, and have homogeneous content. Its electron density varies, which is related to the size of the droplet, the content, as well as the method of fixation and staining. Figure 1-11a shows lipid droplets (1) in the cytoplasm as orange by Sudan III staining; Figure 1-11b (EM) shows the spherical lipid droplets (1) in a hepatocyte.

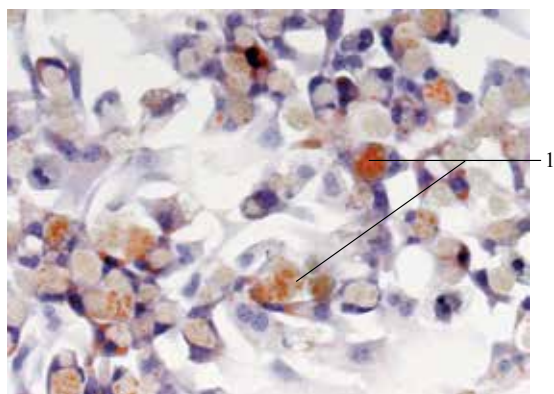


图 1-11a 脂滴 (苏丹Ⅲ染色, 200×)
Fig. 1-11a Lipid droplet (Sudan III staining)

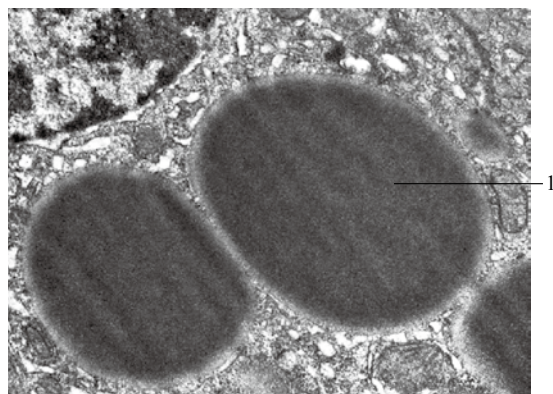


图 1-11b 脂滴 (电镜, 10 000×)
Fig. 1-11b Lipid droplet (EM, 10 000×)

12 图片 12: 糖原颗粒

糖原在通常切片中不易被观察, 光镜下往往应用过碘酸-雪夫染色 (图 1-12a, PAS 染色), 显示为细胞内粉紫色结构 (1)。电镜下, 糖原颗粒无界膜包绕, 电子密度比较高, 形状不规则。图 1-12b 显示肝细胞内, 糖原 (1) 形成较大颗粒成簇存在。

12. Picture 12: Glycogen granules

Glycogen is not usually seen in routine sections. In light microscopy (LM), the glycogen is shown as pink-purple (1) by periodic acid-Schiff staining (PAS staining, Figure 1-12a). In EM, glycogen appears as nonmembrane-bound, higher electron-dense granules with an irregular shape. In liver cells, they (1) often form larger, rosette-like aggregates (Figure 1-12b).

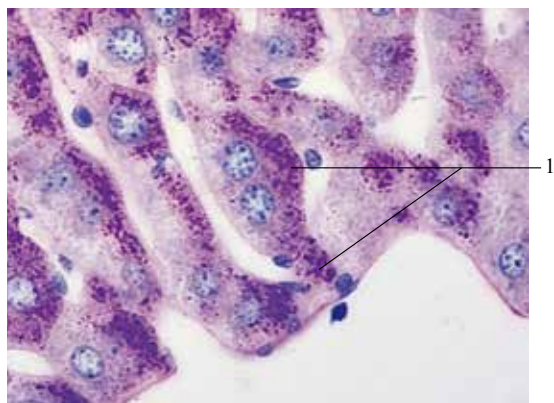


图 1-12a 糖原 PAS 染色 (光镜, 400×)
Fig. 1-12a Glycogen PAS staining (LM, 400×)

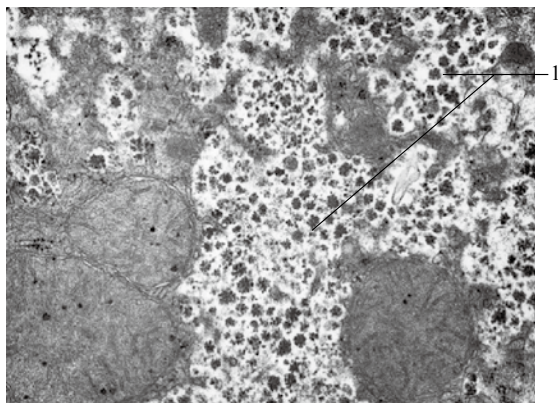


图 1-12b 糖原颗粒 (电镜, 25 000×)
Fig. 1-12b Glycogen granule (EM, 25 000×)

13 图片 13: 细胞周期

细胞周期指细胞从一次分裂完成开始到下一次分裂结束所经历的全过程, 分为间期与分裂期两个阶段。间期分为静止期 (G_0 期)、DNA 合成前期 (G_1 期)、DNA 合成期 (S 期) 与 DNA 合成后期 (G_2 期); 分裂期又分为前期、中期、后期和末期四期。图 1-13 (免疫荧光染色) 显示细胞分裂的部分时期, α -微管蛋白抗体和 DAPI 进行染色后, 对比其他核蛋白染色

(绿色), 微管定位于细胞质, 并显示为红色, 细胞核显示为蓝色。

13. Picture 13: Cell cycle

Cell cycle is the whole process from the conclusion of one cell division to the end of next cell division. Its two major phases are interphase and mitosis. The interphase comprises a quiescence (G_0 phase), DNA pre-synthesis (G_1 phase), DNA synthesis (S phase), and DNA post-synthesis (G_2 phase). Mitosis is divided into prophase, metaphase, anaphase and telophase. Figure 1-13 (Immunofluorescence, IF) shows a part of phases of cell cycle, in which microtubule is stained as red, and the nucleus as blue.

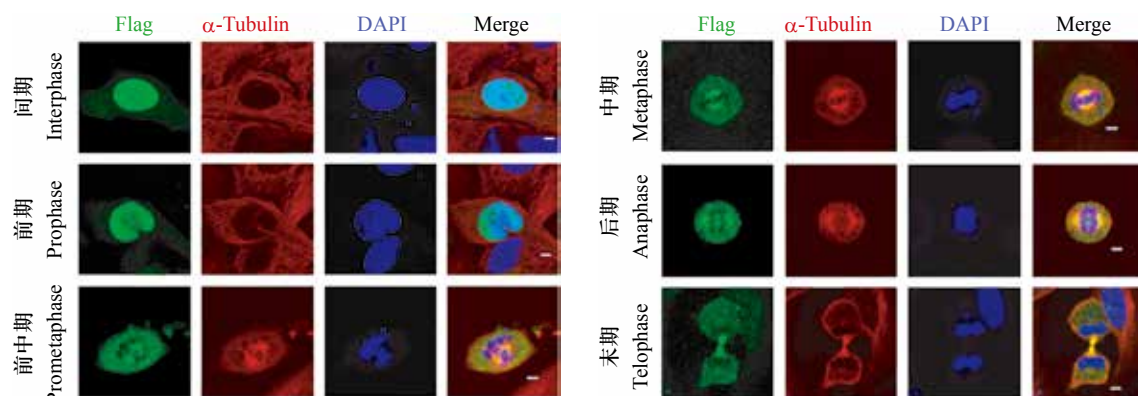


图 1-13 细胞周期 (免疫荧光染色, 630×)

Fig. 1-13 Cell cycle (IF, 630×)

【思考题】

1. 细胞质内常见的细胞器有哪些? 其各自的主要功能是什么?
2. 什么是细胞骨架? 其主要结构的基本组成及功能是什么?
3. 常染色质与异染色质的区别是什么?
4. 细胞周期包括哪些阶段?

【Questions】

1. Please list the common cell organelles, and describe their main functions respectively.
2. What is the cytoskeleton? Describe its basic compositions and function.
3. What is the difference between euchromatin and heterochromatin?
4. What are the stages of a cell cycle?

【临床与科研联系英文阅读材料】

【English Reading Material for Correlations with Clinic and Scientific Research】

Mitochondrial encephalomyopathy, abbreviated to MELAS (Mitochondrial Encephalopathy,

Lactic Acidosis and Stroke-like episodes), is one of the family of mitochondrial cytopathies, which also include MERRF (Myoclonic Epilepsy with Ragged Red Fibers) and LHON (Leber's Hereditary Optic Neuropathy). It was first characterized under this name in 1984. A feature of these diseases is that they are caused by defects in the mitochondrial genome which is inherited purely from the female parent; however, it is important to know that some of the proteins essential to normal mitochondrial function are produced by the nuclear genome, and are subsequently transported to the mitochondria for use. As such, mutations in these proteins can result in mitochondrial disorders, but can be inherited from both male and female parents in the conventional fashion. The disease can manifest in both sexes. MELAS is a condition that affects many of the body's systems, particularly the brain and muscular system (encephalo-myopathy). MELAS is caused by mutations in the genes in mitochondrial DNA.

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