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Injury of Oxidized Dietary Oil on Growth and Health of Grass Carp

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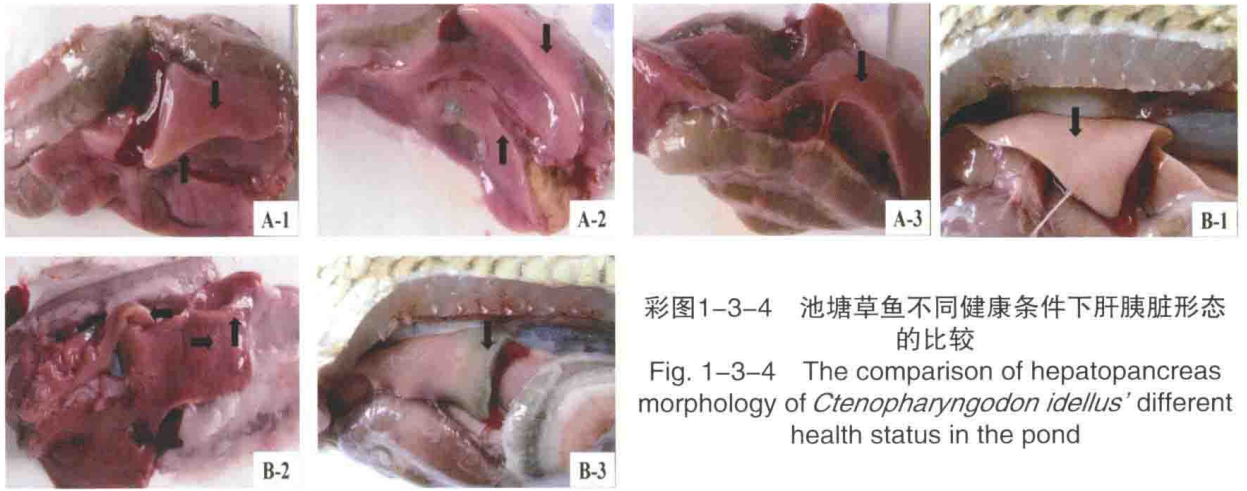
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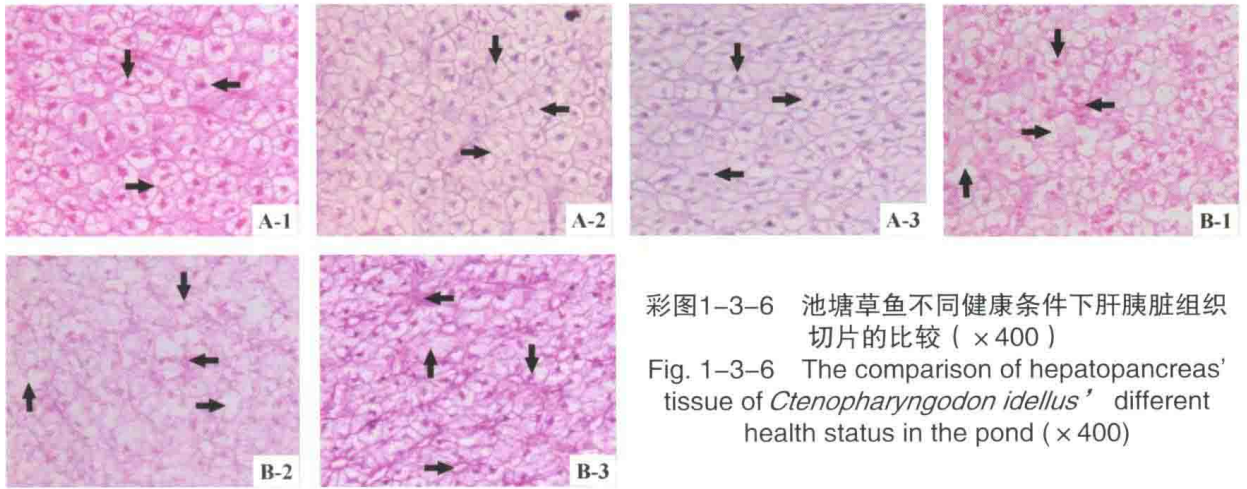
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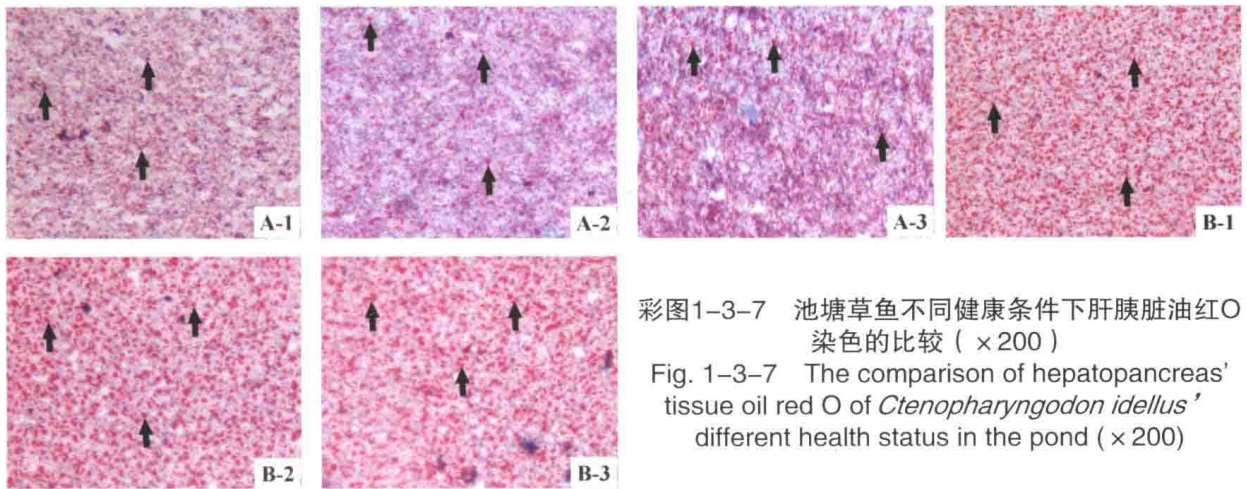
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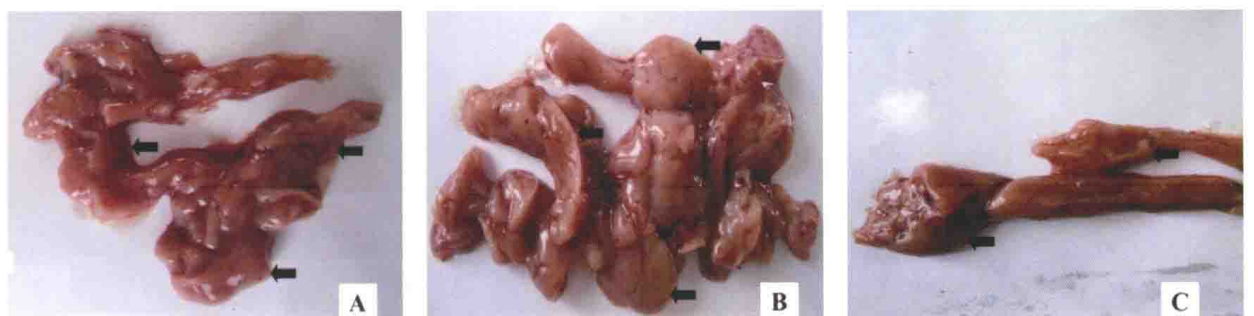
彩图1-3-4 池塘草鱼不同健康条件下肝胰脏形态的比较
 Fig. 1-3-4 The comparison of hepatopancreas morphology of *Ctenopharyngodon idellus*' different health status in the pond



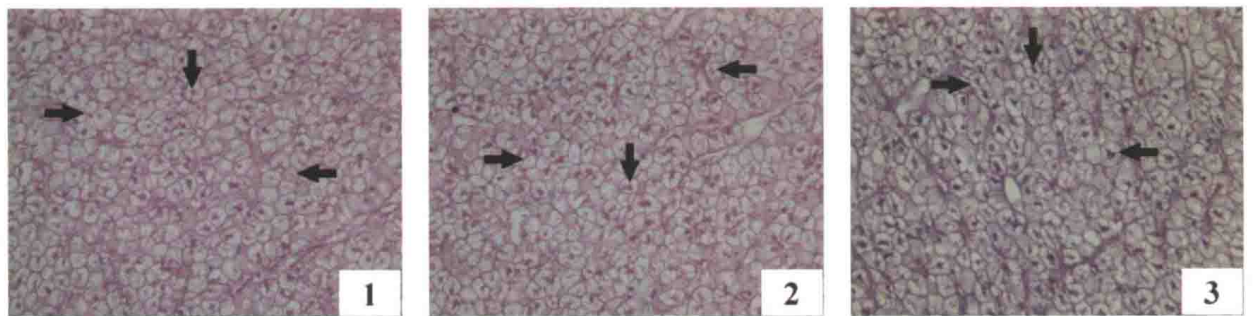
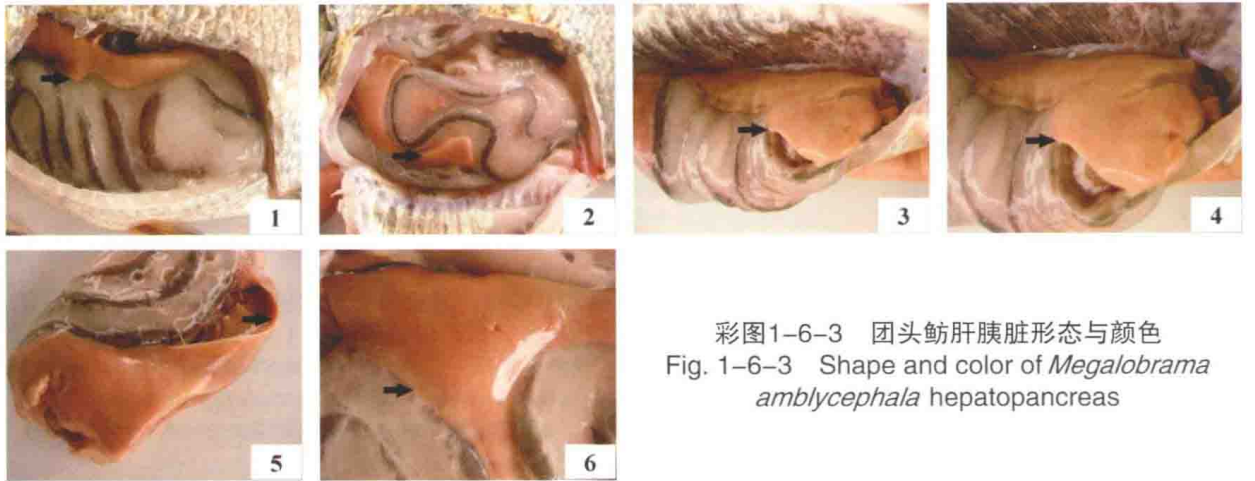
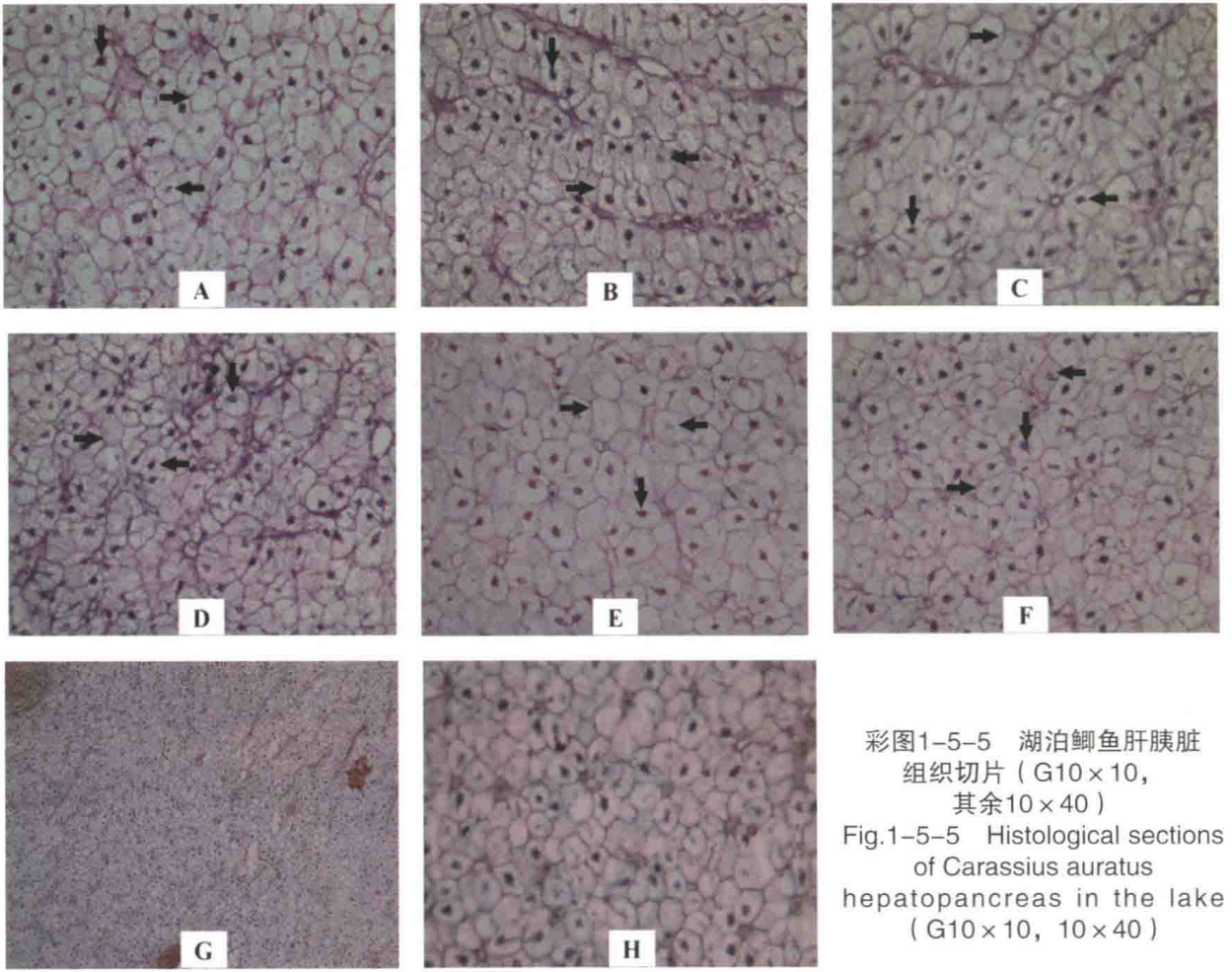
彩图1-3-6 池塘草鱼不同健康条件下肝胰脏组织切片的比较 (×400)
 Fig. 1-3-6 The comparison of hepatopancreas' tissue of *Ctenopharyngodon idellus*' different health status in the pond (×400)

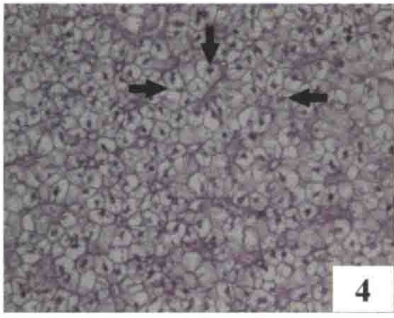


彩图1-3-7 池塘草鱼不同健康条件下肝胰脏油红O染色的比较 (×200)
 Fig. 1-3-7 The comparison of hepatopancreas' tissue oil red O of *Ctenopharyngodon idellus*' different health status in the pond (×200)

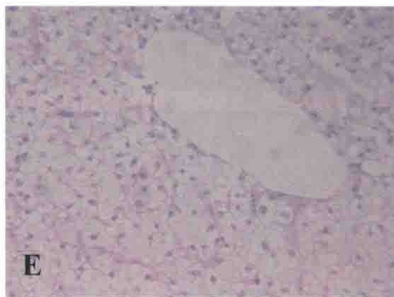
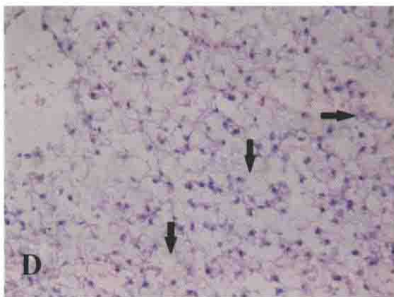
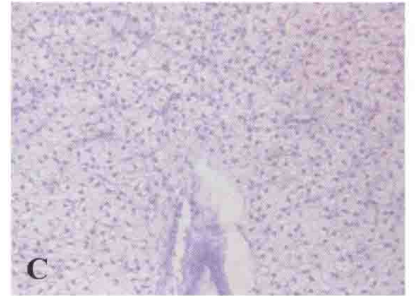
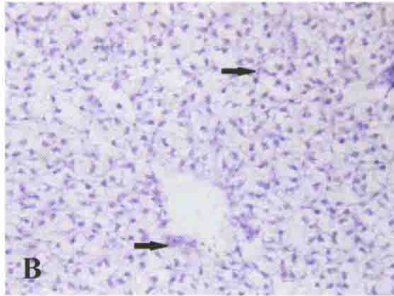
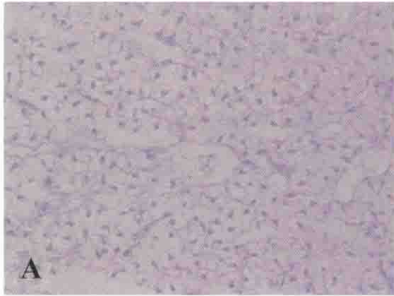


彩图1-5-3 湖泊鲫鱼肝胰脏
 Fig.1-5-3 The hepatopancreas of *Carassius auratus* in the lake

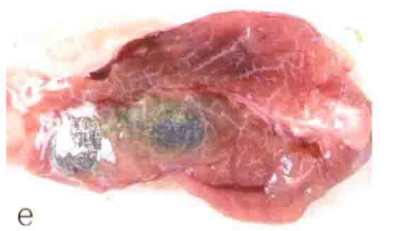
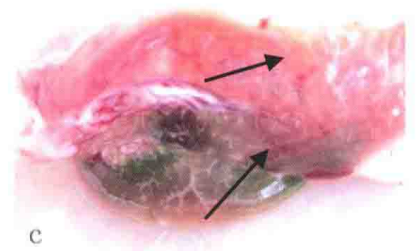
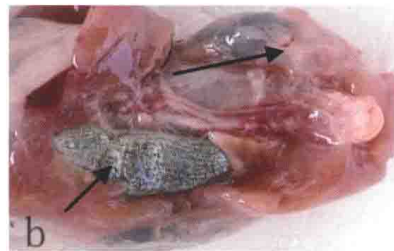
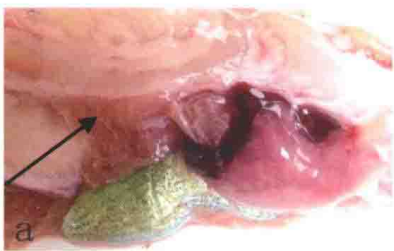




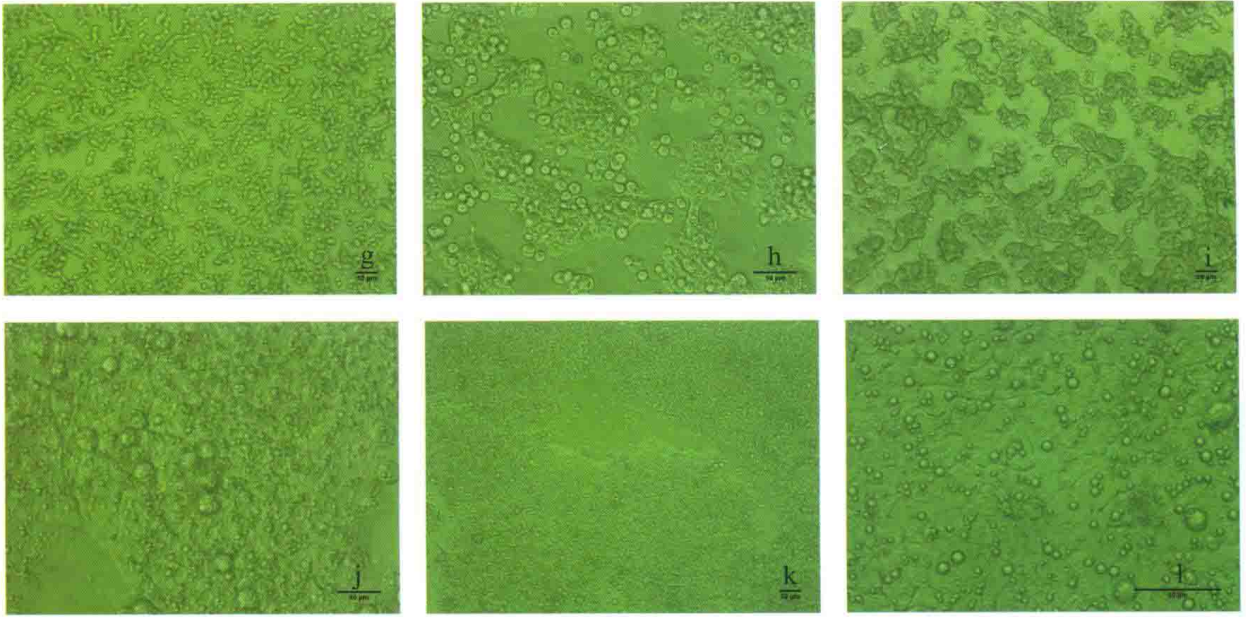
彩图1-6-5 团头鲂肝胰脏组织切片 (10×40)
 Fig. 1-6-5 Histological sections of *Megalobrama amblycephala* hepatopancreas (10×40)



彩图3-4-3 4周草鱼肝胰脏组织HE染色
 Fig. 3-4-3 4-week-grass carp hepatopancreas tissue HE staining
 图表说明：→处为肝细胞炎症浸润，↓处为肝细胞脂肪病变，↑处为肝细胞胶原纤维



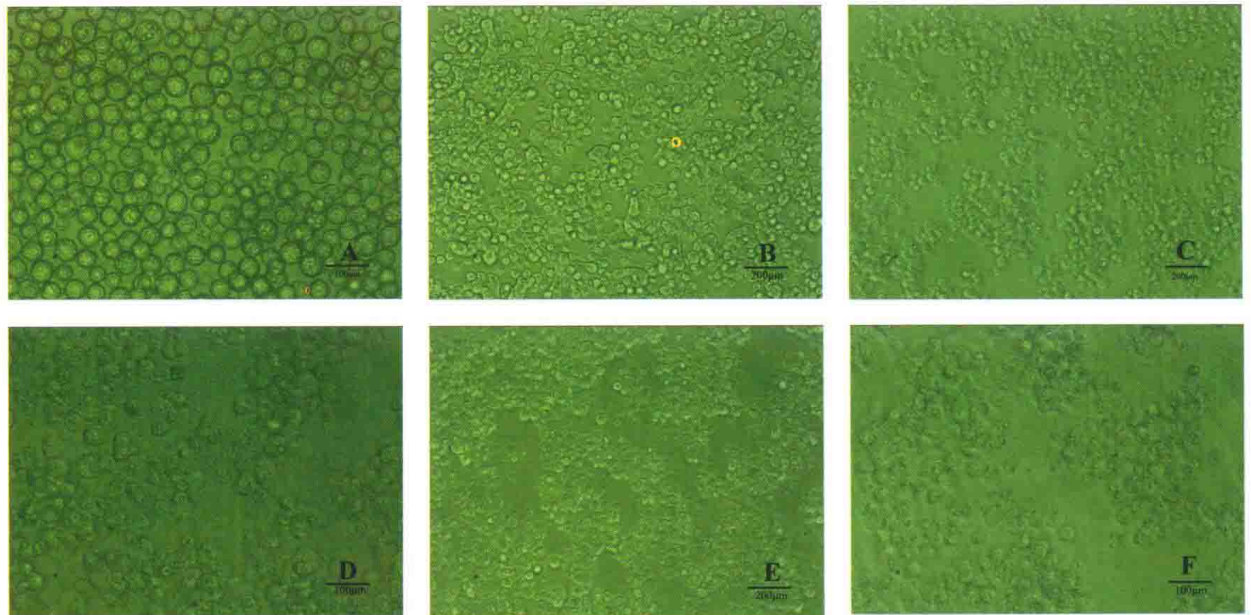
彩图3-4-4 10周草鱼肝胰脏观察
 Fig. 3-4-4 Observation of 10-week-grass carp hepatopancreas



彩图4-3-1 倒置荧光显微镜下观察的草鱼肝细胞形态

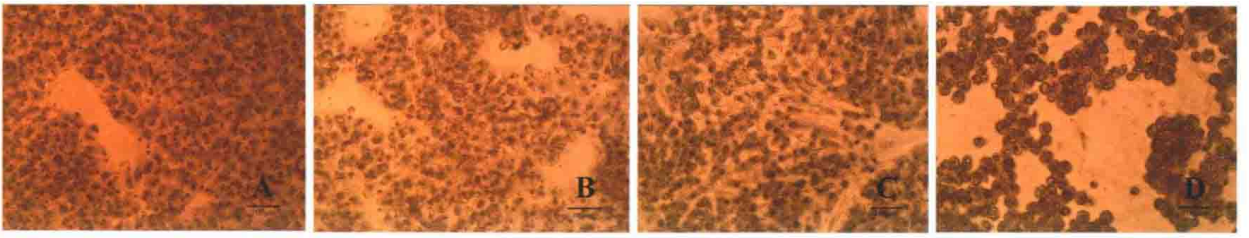
Fig. 4-3-1 Configuration of *Ctenopharyngodon idellus* hepatopancreas under inverted fluorescence microscope

a: 未加红细胞裂解液分离培养的肝细胞($\times 100$, 箭头所指为红细胞); b: 添加红细胞裂解液分离培养的肝细胞($\times 100$); c: 刚分离出来的肝细胞($\times 100$); d: 刚分离出来的肝细胞($\times 200$); e: 生长24h的肝细胞($\times 100$); f: 生长24h的肝细胞($\times 400$); g: 生长48h的肝细胞($\times 100$); h: 生长48h的肝细胞($\times 200$); i: 生长72h的肝细胞($\times 100$); j: 生长96h的肝细胞($\times 200$); k: 生长144h的肝细胞($\times 100$); l: 生长144h的肝细胞($\times 400$)



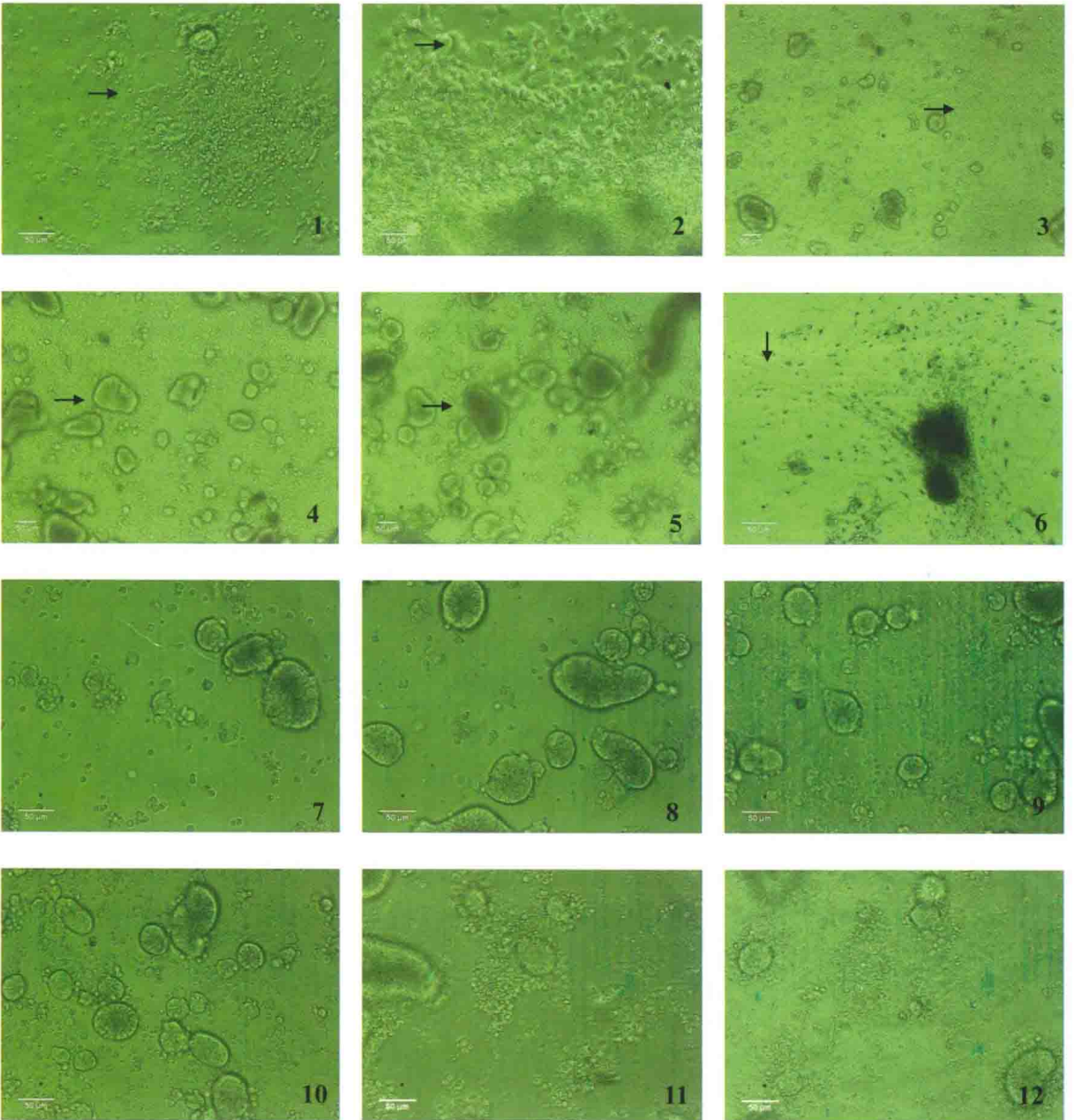
彩图4-4-1 a: 0h刚分离的草鱼肝细胞 ($\times 400$); b: 对照组生长24h的草鱼肝细胞($\times 200$); c-d: 氧化豆油水溶液作用3h试验组 ($\times 200$; $\times 400$); e-f: 氧化豆油水溶液作用6h试验组 ($\times 200$; $\times 400$).

Fig.4-4-1 a: Configuration of freshly isolated hepatopancreas($\times 400$); b: Configuration of hepatopancreas on 24 hours($\times 200$); c-d: The hepatopancreas of water-soluble matter of oxidized soybean oil effect 3 hours($\times 200$; $\times 400$); e-f: The hepatopancreas of water-soluble matter of oxidized soybean oil effect 6 hours($\times 200$; $\times 400$).



彩图4-4-2 a: 油红O染色对照组($\times 400$); b: 油红O染色试验组($\times 400$); c: 碱性磷酸酶染色对照组($\times 400$); d: 碱性磷酸酶染色试验组($\times 400$).

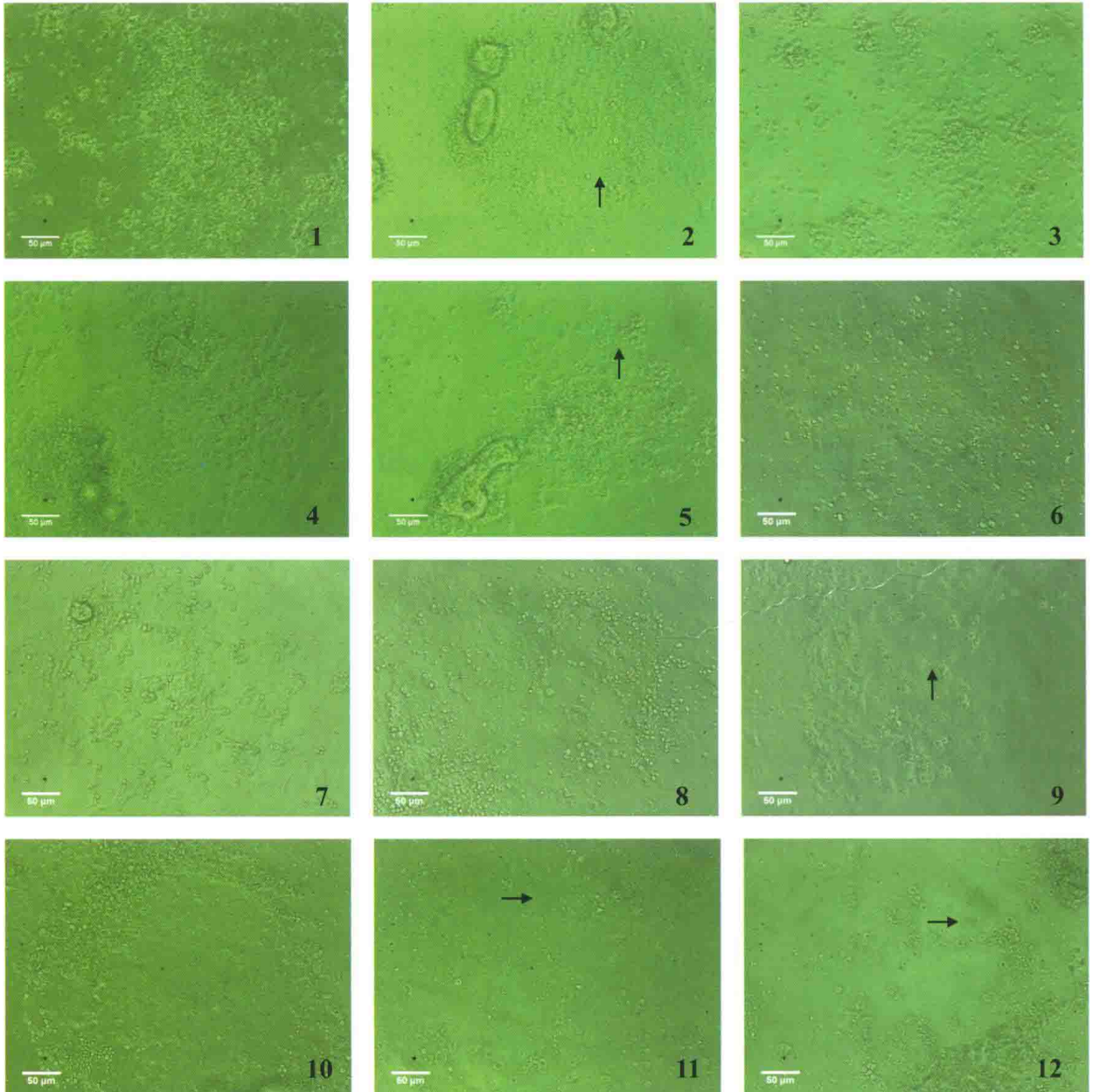
Fig. 4-4-2 a: The control group of oil red O staining ($\times 400$); b: The experimental group of oil red O staining ($\times 400$); c: The control group of alkaline phosphatase staining ($\times 400$); d: The experimental group of alkaline phosphatase staining ($\times 400$).

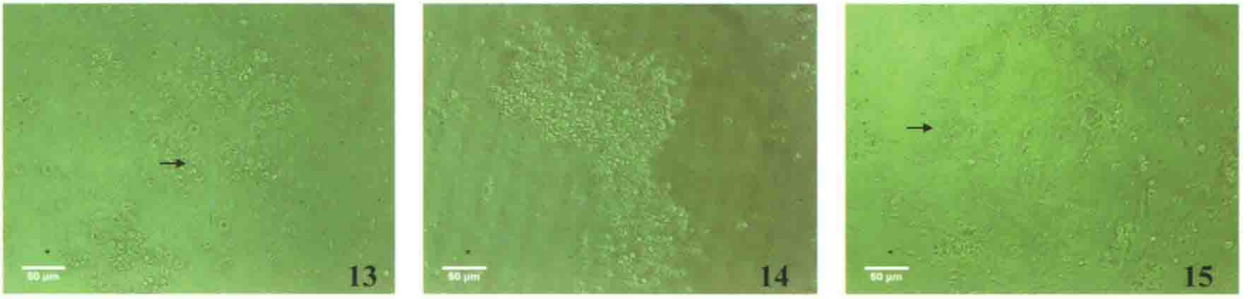




图版5-1 (荧光倒置显微镜观察)

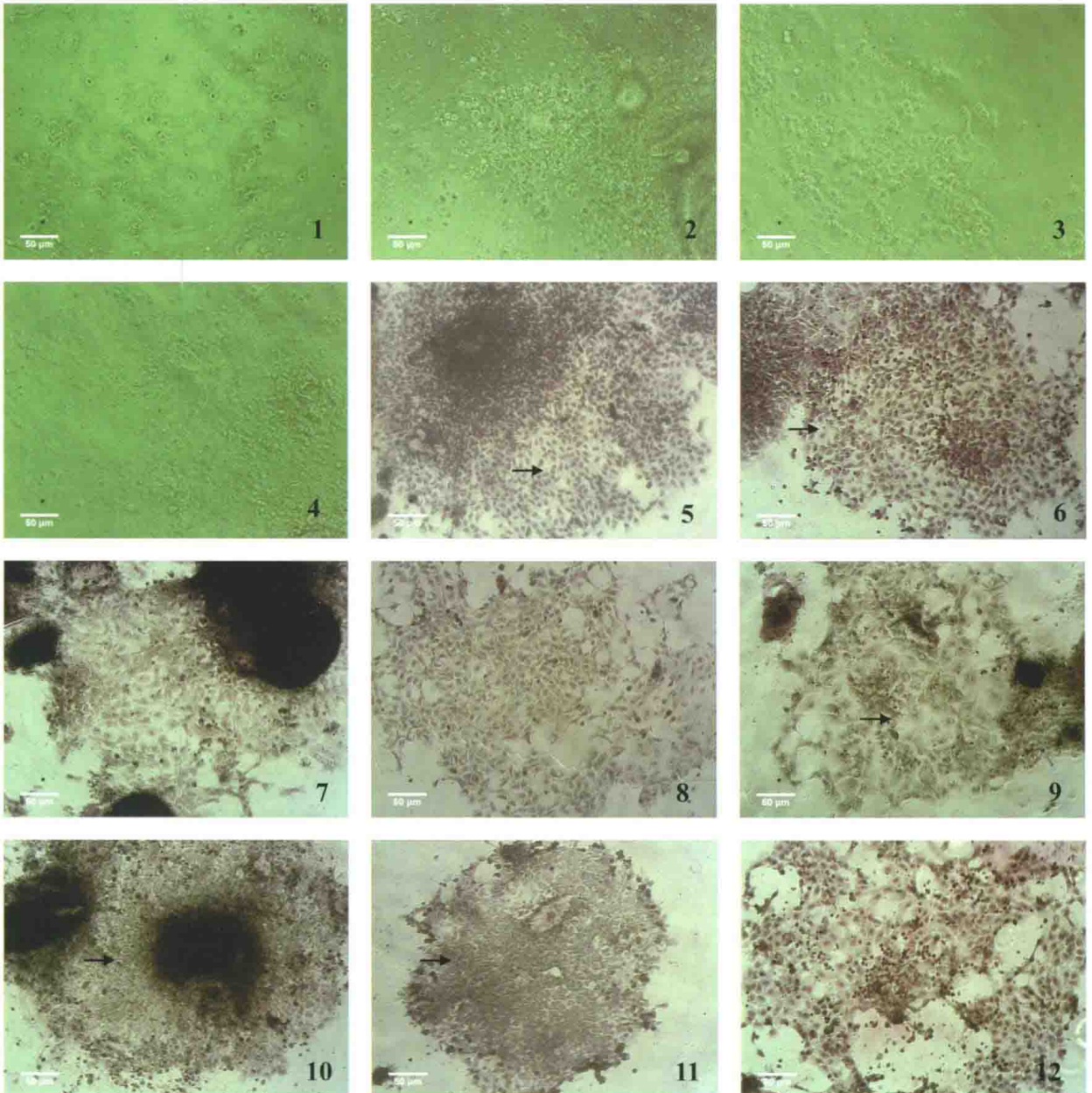
1:投喂强化饲料前, 24h后细胞状态, 增殖贴壁细胞(↑), ×200; 2: 投喂强化饲料后, 24h后细胞状态, 增殖贴壁细胞(↑), ×200; 3: 机械剪碎消化法, 单个细胞(↑), ×100; 4: 肠囊翻转消化法, 肠道黏膜细胞团(↑), ×100; 5: 机械刮取消除法, 肠道黏膜细胞团(↑), ×100; 6: 机械剪碎消化法, 细胞培养24h后, 成纤维细胞生长(↑), ×200; 7: 200r/min转速离心, ×200; 8: 400r/min转速离心, ×200; 9: 600r/min转速离心, ×200; 10: 800r/min转速离心, ×200; 11: 添加0%浓度胎牛血清, 培养48h后, ×200; 12: 添加15%浓度胎牛血清, 培养24h后, ×200; 13: 接种浓度 2×10^3 (个/孔), 48h后细胞汇片(↑), ×100; 14: 接种浓度 2.8×10^3 (个/孔), 48h后细胞汇片(↑), ×100; 15: 培养12h, 细胞团增殖的游离细胞(↑), ×200





图版5-Ⅱ (荧光倒置显微镜观察)

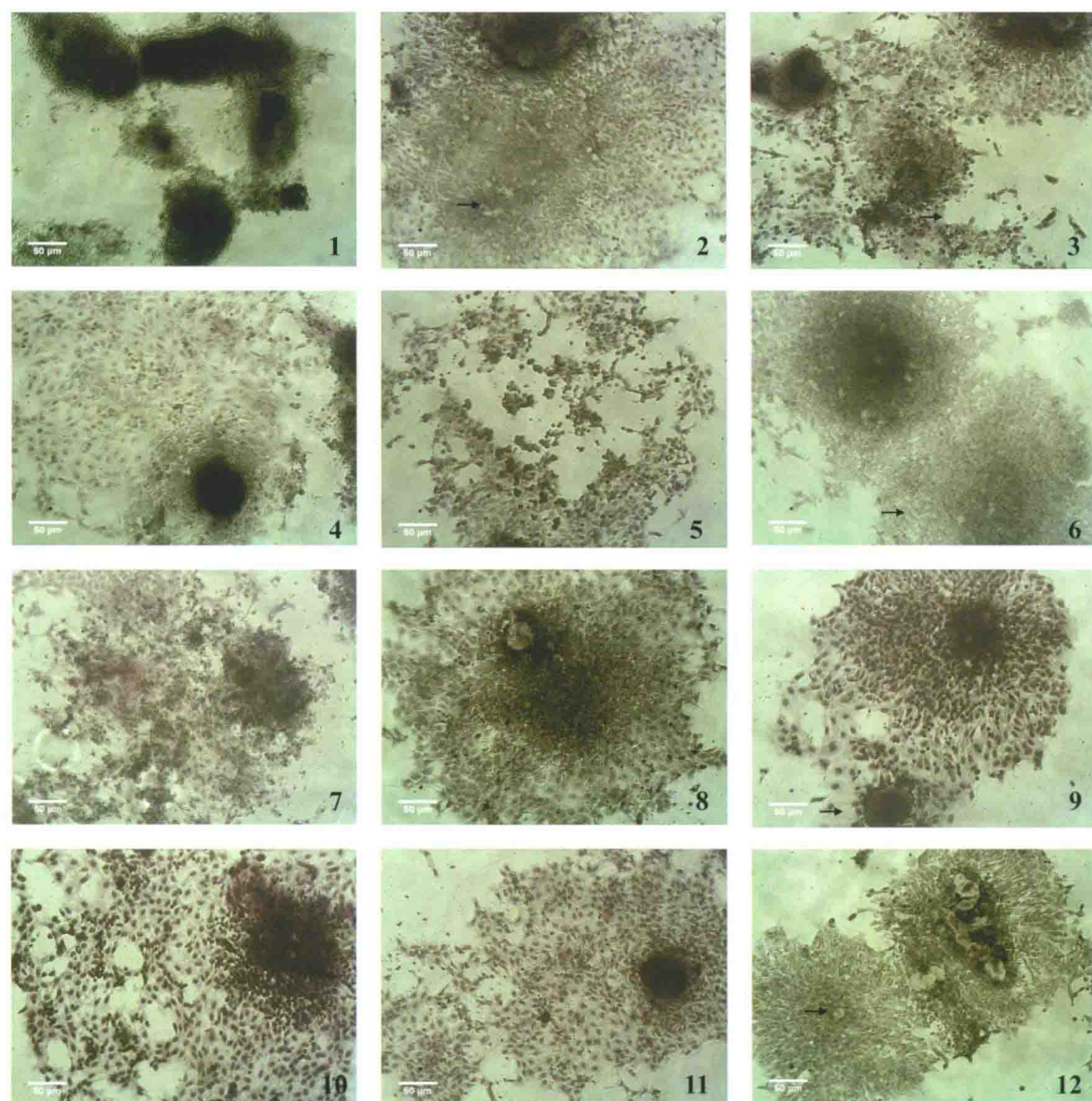
1: 培养24h, $\times 200$; 2: 培养36h, 贴壁的IECs细胞 (\uparrow), $\times 200$; 3: 培养48h, $\times 200$; 4: 培养60h, $\times 200$; 5: 培养72h, 细胞凋亡萎缩 (\uparrow), $\times 200$; 6: 对照组, 3h, 细胞集落 (\uparrow), $\times 200$; 7: 对照组, 6h, $\times 200$; 8: 对照组, 9h, $\times 200$; 9: 对照组, 细胞胞质丰富 (\uparrow), 12h, $\times 200$; 10: 氧化豆油水溶物1-4组, 3h, $\times 200$; 11: 氧化豆油水溶物1-1组, 6h, 折光性差的圆球状细胞 (\uparrow), $\times 200$; 12: 氧化豆油水溶物1-2组, 6h, 折光性差的圆球状细胞 (\uparrow), $\times 200$; 13: 氧化豆油水溶物1-3组, 6h, 折光性差的圆球状细胞 (\uparrow), $\times 200$; 14: 氧化豆油水溶物1-2组, 12h, $\times 200$; 15: 丙二醛1-3组, 3h, 折光性差的圆球状细胞 (\uparrow), $\times 200$

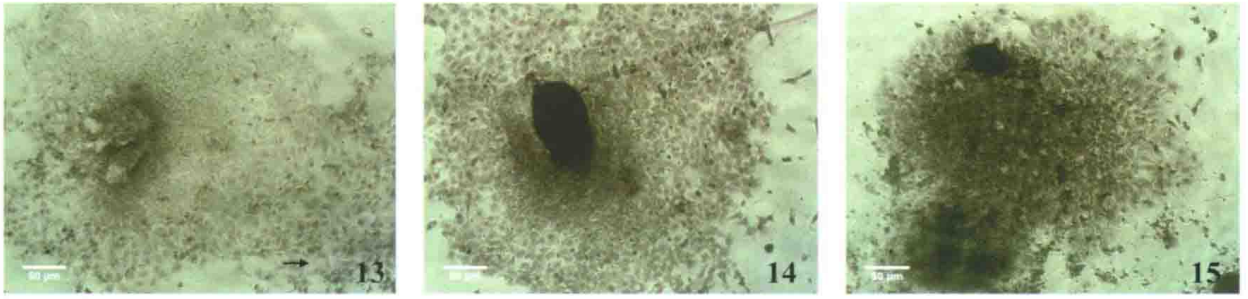




图版5-III (1~4为荧光倒置显微镜观察, 5~15为Giemsa染色观察)

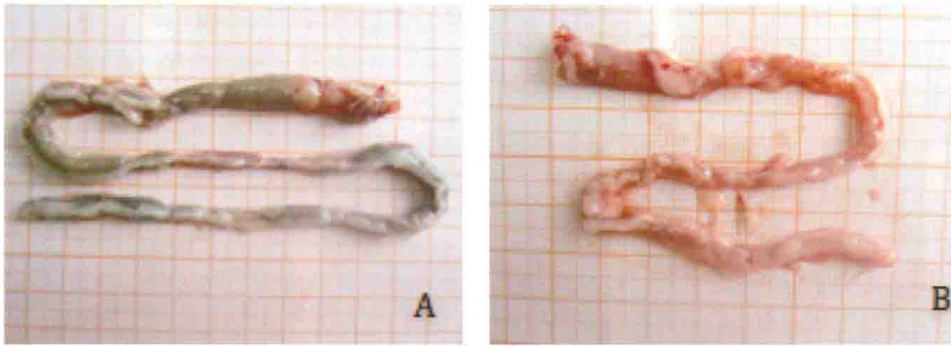
1: 丙二醛1-3组, 6h, $\times 200$; 2: 丙二醛1-3组, 9h, $\times 200$; 3: 丙二醛-酵母培养物水溶物处理3-1组, 6h, $\times 200$; 4: 丙二醛-酵母培养物水溶物处理3-2组, 9h, $\times 200$; 5: 细胞培养48h后Giemsa染色, 细胞核(↑), $\times 200$; 6: 对照组, 3h, 细胞集落(↑), $\times 200$; 7: 对照组, 6h, $\times 200$; 8: 对照组, 9h, $\times 200$; 9: 对照组, 12h, 细胞分化正常(↑), $\times 200$; 10: 氧化豆油水溶物1-3组, 3h, 细胞轮廓不清晰(↑), $\times 200$; 11: 氧化豆油水溶物1-4组, 3h, 细胞轮廓不清晰(↑), $\times 200$; 12: 氧化豆油水溶物1-1组, 6h, $\times 200$; 13: 氧化豆油水溶物1-2组, 3h, $\times 200$; 14: 氧化豆油水溶物1-3组, 6h, $\times 200$; 15: 氧化豆油水溶物1-4组, 6h, $\times 200$



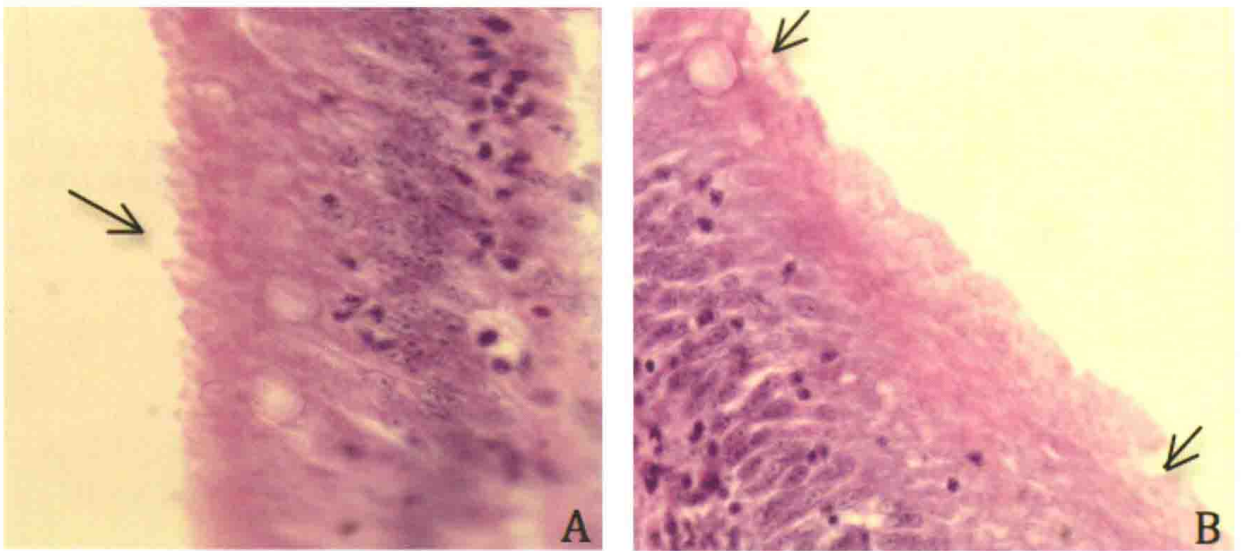


图版5-IV (Giemsa染色观察)

1: 氧化豆油水溶物1-3组, 12h, $\times 200$; 2: 丙二醛1-2组, 3h, 细胞轮廓不清晰(\uparrow), $\times 200$; 3: 丙二醛1-2组, 6h, 部分细胞脱落凋亡(\uparrow), $\times 200$; 4: 丙二醛1-2组, 9h, $\times 200$; 5: 丙二醛1-3组, 6h, 部分细胞脱落凋亡(\uparrow), $\times 200$; 6: 丙二醛1-3组, 9h, 细胞轮廓不清晰(\uparrow), $\times 200$; 7: 丙二醛1-4组, 9h, $\times 200$; 8: 丙二醛1-1组, 12h, 细胞生长较正常, $\times 200$; 9: 酵母培养物水溶物1-3组, 3h, 细胞贴壁较好(\uparrow), $\times 200$; 10: 酵母培养物水溶物1-4组, 3h, 细胞贴壁较好(\uparrow), $\times 200$; 11: 酵母培养物水溶物1-5组, 3h, $\times 200$; 12: 丙二醛-酵母培养物水溶物3-2组, 6h, 受损细胞(\uparrow), $\times 200$; 13: 丙二醛-酵母培养物水溶物3-1组, 9h, 正常贴壁的细胞(\uparrow), $\times 200$; 14: 丙二醛-酵母培养物水溶物3-2组, 9h, $\times 200$; 15: 丙二醛-酵母培养物水溶物3-3组, 9h, $\times 200$



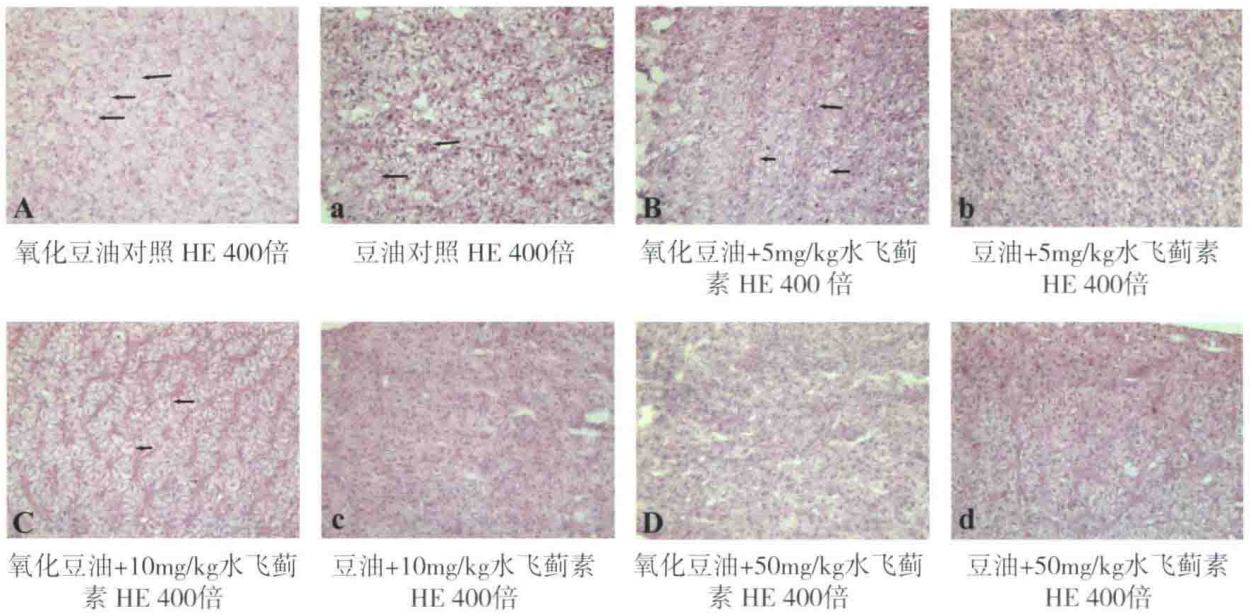
彩图6-5-1 正常和损伤肠道外观形态
Fig. 6-5-1 Normal and damaged intestinal morphology diagram
A.正常肠道; B.损伤肠道



彩图6-5-2 健康与损伤草鱼的肠道组织切片观察 ($\times 1000$)

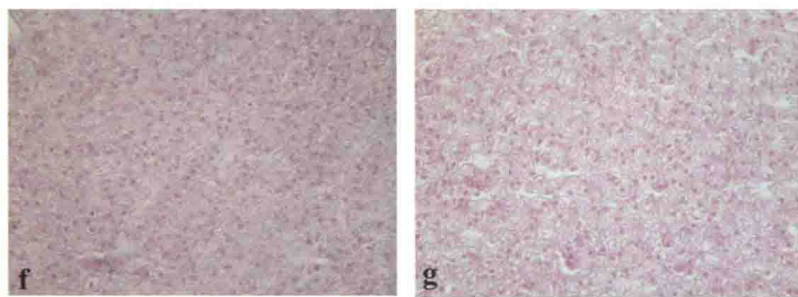
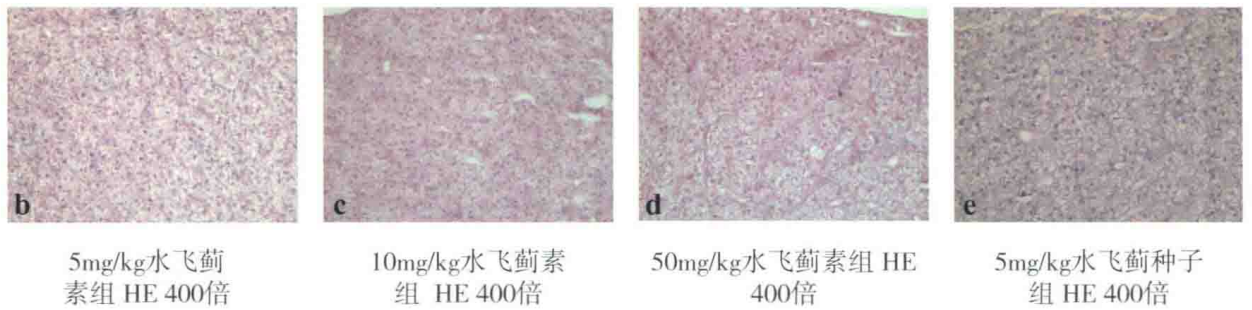
Fig.6-5-2 Healthy and damaged grass carp intestinal tissue observed in sliced figure

A.正常肠道; B.损伤肠道, 箭头示肠微绒毛, 健康草鱼的肠道微绒毛排列整齐、切面完整, 而损伤草鱼的微绒毛疏松, 局部脱落



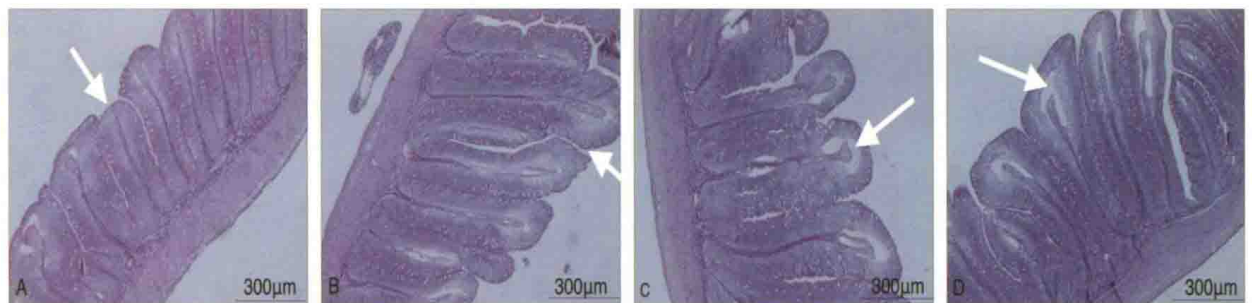
彩图7-2-1 氧化油脂及不同水平水飞蓟素对团头鲂肝脏组织结构的影响

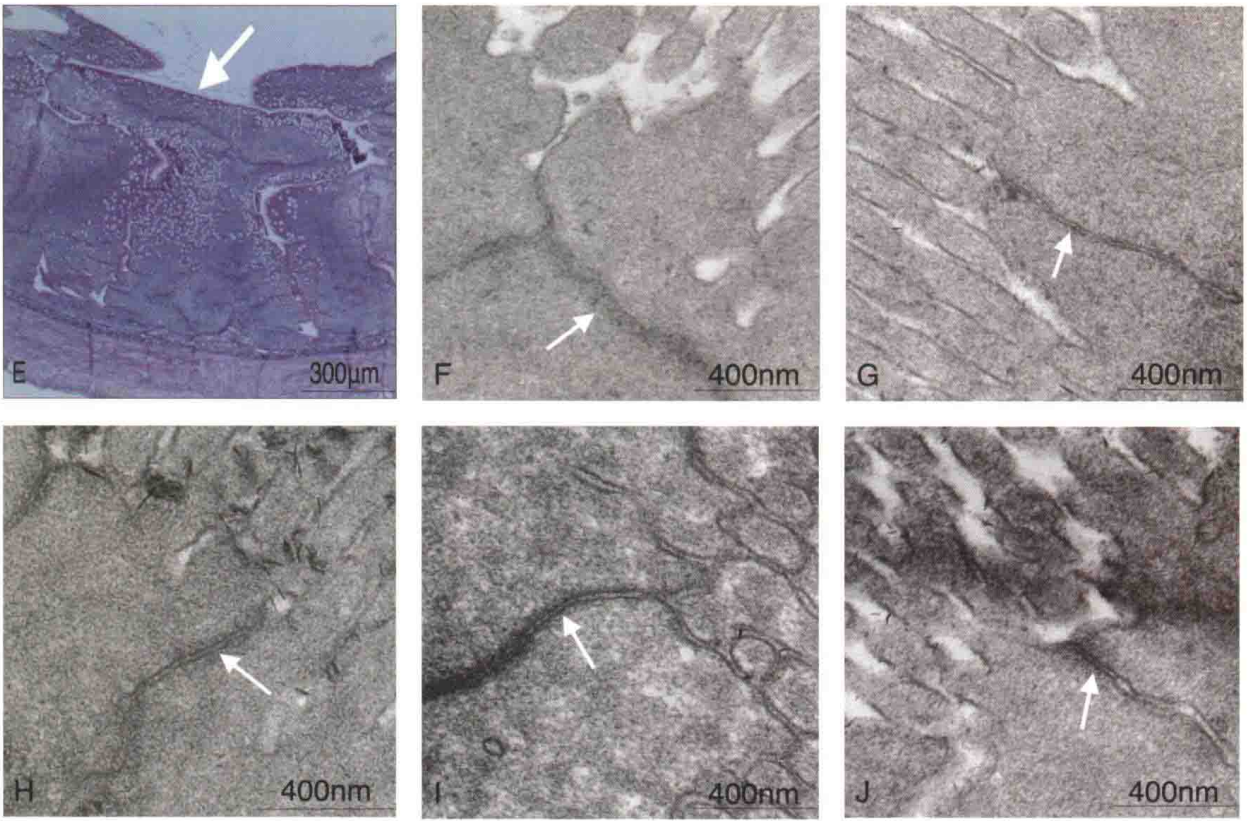
Fig.7-2-1 Effect of oxidized soybean oil and different level of silymarine on hepatopancreas structure of *Megalobrama amblycephala*



彩图7-3-2 添加水飞蓟素和水飞蓟素种子对团头鲂肝脏组织结构的影响

Fig. 7-3-2 Effect of silymarine and silybum marianum seed on the structure of hepatopancreas



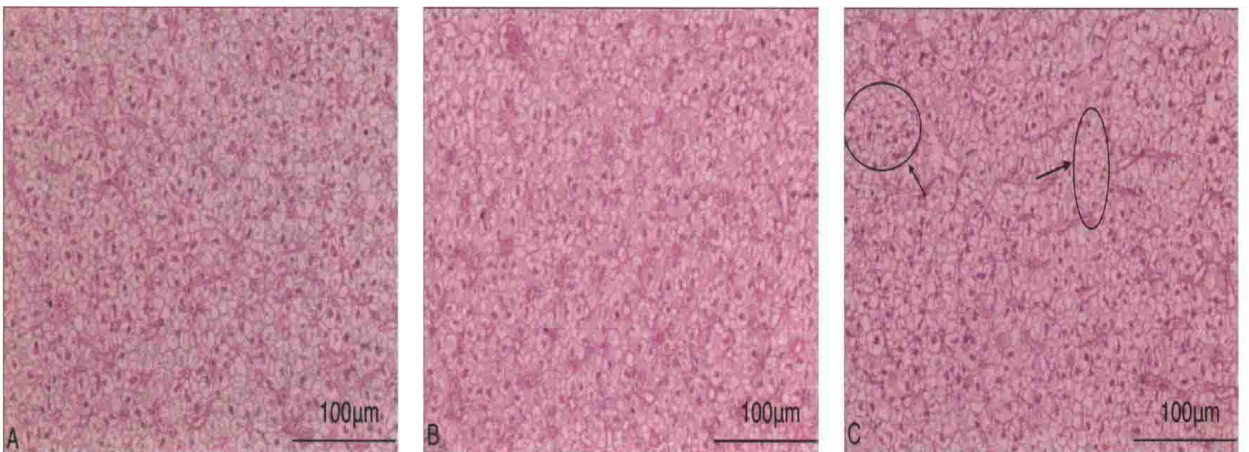


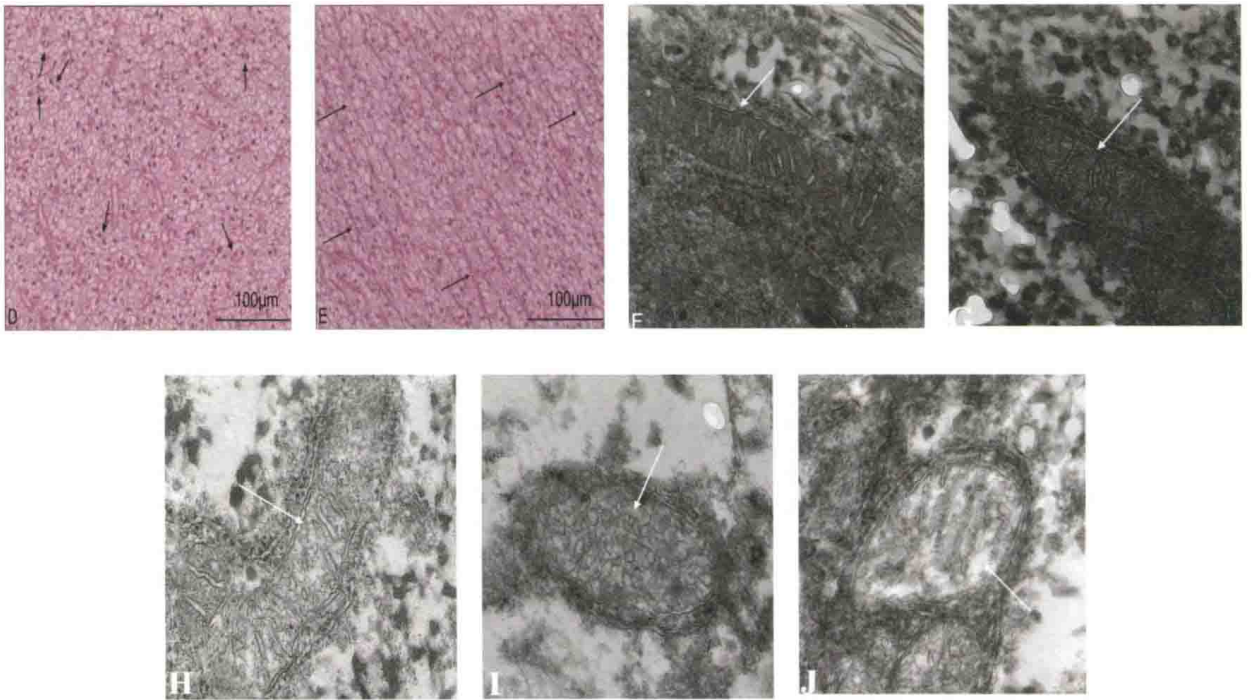
图版 9-3-I 氧化鱼油对草鱼中肠形态、结构的影响

Plate 9-3-I Effect of oxidized fish oil on morphology and structure of Grass carp midgut

A. 6S组, 中肠绒毛排列整齐, 黏膜表面完整(↑); B. 6F组, 绒毛间隙增大(↑); C. 20F组, 中央乳糜管扩大(↑); D. 40F组, 绒毛不规则排列, 中央乳糜管扩大(↑); E. 60F组, 绒毛增生、水肿(↑); F. 6S组, 中肠紧密连接正常(↑); G. 6F组, 紧密连接出现缝隙(↑); H. 20F组, 紧密连接缝隙扩张(↑); I. 40F组, 紧密连接受损, 缝隙明显(↑); J. 60F组, 紧密连接严重受损, 结构完全打开(↑)

A—E: 光学显微镜观察, ×100; F—J: 透射电镜观察, ×12000



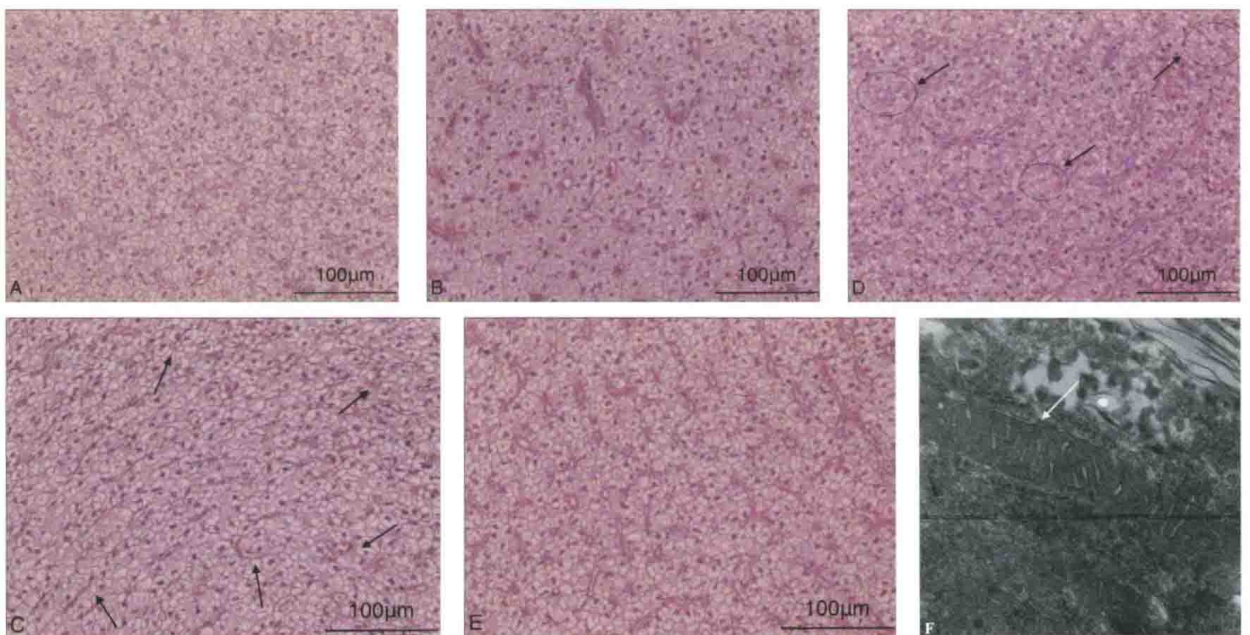


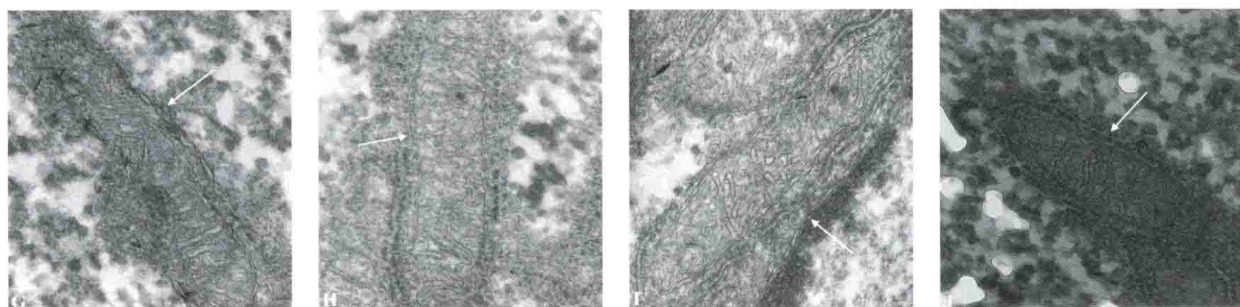
图版9-4- I 氧化鱼油对草鱼肝胰脏形态、结构的影响

Plate9-4- I Effect of oxidized fish oil on morphology and structure of grass carp hepatopancreas

A—B. 6S、6F组，肝胰脏细胞排列整齐，大小均一；C. 20F组，部分肝胰脏细胞受挤压变形(↑)；D. 40F组，部分肝胰脏细胞细胞核由细胞中央转移至细胞边缘(↑)；E. 60F组，肝胰脏细胞变形，有明显纤维化趋势(↑)；F—G. 6S、6F组，肝胰脏细胞线粒体形态正常，内部结构清晰完整(↑)；H. 20F组，线粒体形态正常，内部嵴形态不清晰(↑)；I. 40F组，线粒体形态发生变化，内部结构不清晰(↑)；J. 60F组，线粒体呈圆形，内部嵴消融(↑)

A—E：光学显微镜观察，×400；F—J：透射电镜观察，×20000



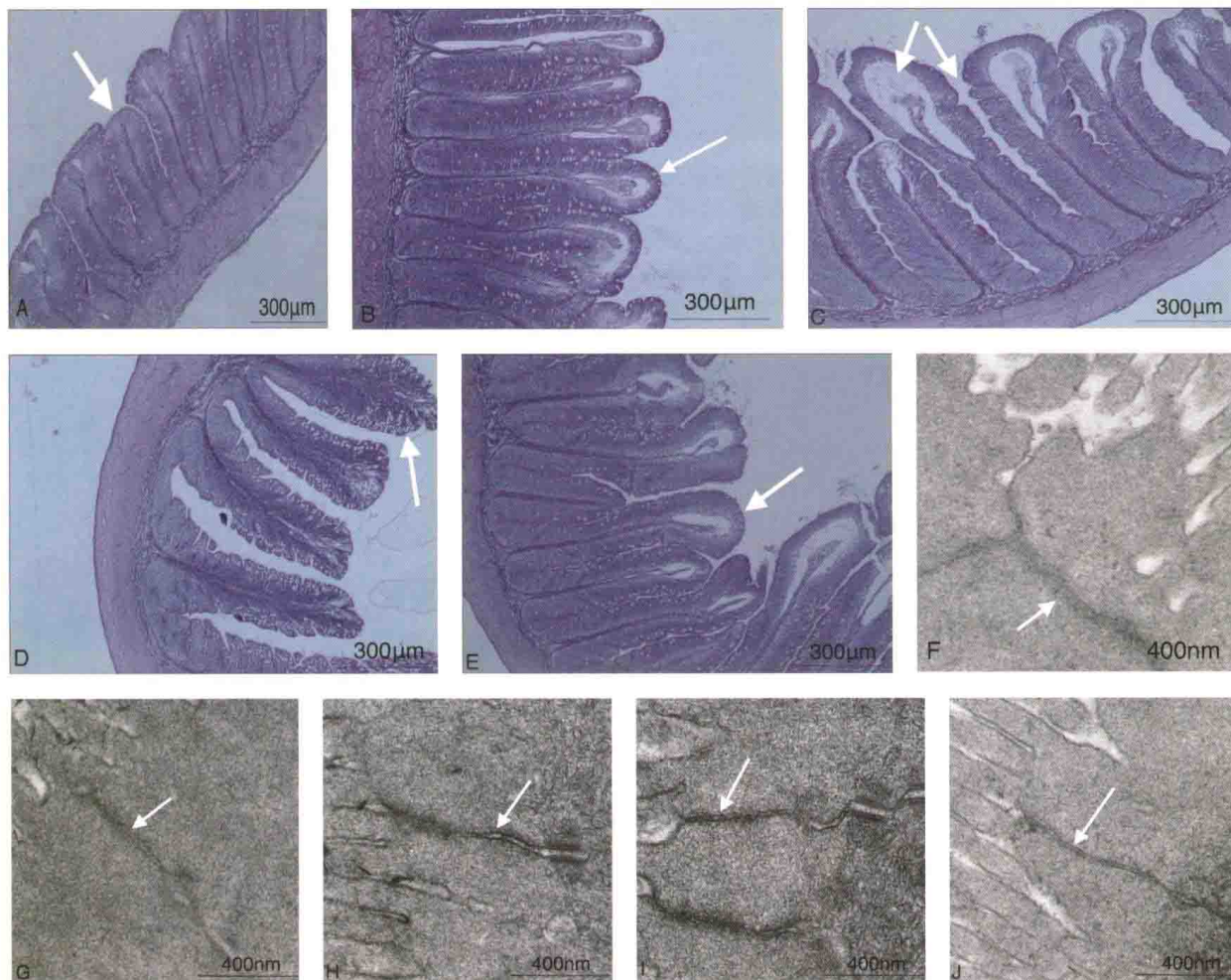


图版9-5-I MDA对草鱼肝胰脏形态、结构的影响

Plate 9-5-I Effect of MDA on morphology and structure of grass carp hepatopancreas

A、B、E. S、M1、F组，肝胰脏细胞排列整齐，大小均一；C. M2组，部分细胞细胞核消失(↑)；D. M3组，肝胰脏细胞形态发生改变，有明显纤维化趋势(↑)；F. S组，肝胰脏线粒体形态正常，内部结构清晰完整(↑)；G. M1组，线粒体形态正常，部分嵴形态发生改变(↑)；H. M2组，线粒体形态正常，嵴形态较为模糊(↑)；I. M3组，线粒体形态正常，内部结构混乱(↑)；J. F组，线粒体形态发生改变，内部结构清晰完整(↑)

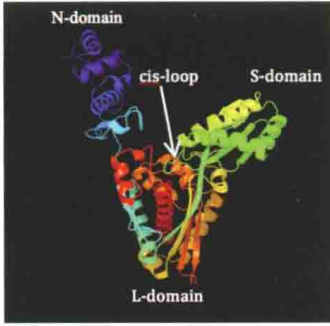
A~E: 光学显微镜观察，×400；F~J: 透射电镜观察，×20000



图版9-6-I 氧化鱼油对草鱼中肠形态、结构的影响

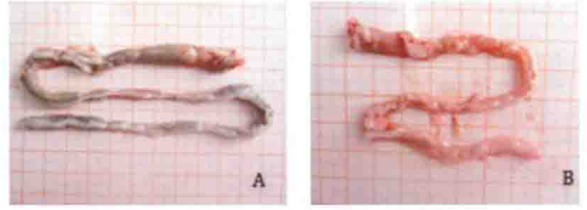
Plate 9-6-I Effect of oxidized fish oil on morphology and structure of Grass carp midgut

A. S组，中肠绒毛排列整齐，黏膜表面完整(↑)；B. M1组，绒毛排列较整齐，中央乳糜管扩大(↑)；C. M2组，绒毛间隙增大，中央乳糜管扩大(↑)；D. M3组，绒毛密度下降，出现假复层柱状上皮细胞(↑)；E. F组绒毛中央乳糜管扩大(↑)；F. S组，中肠紧密连接正常(↑)；G. M1组，紧密连接出现缝隙(↑)；H. M2组，紧密连接扩张(↑)；I. M3组，紧密连接严重受损，结构完全打开(↑)；J. F组，紧密连接结构出现缝隙(↑)



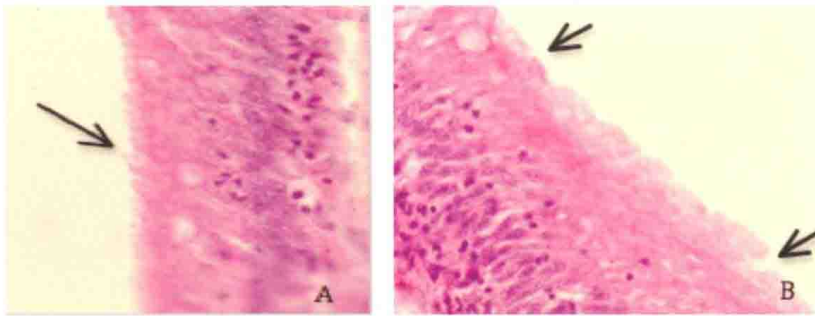
彩图10-5-3 HMGCR蛋白质的空间构象模拟图

Fig.10-5-3 HMGCR protein conformation mimic diagram



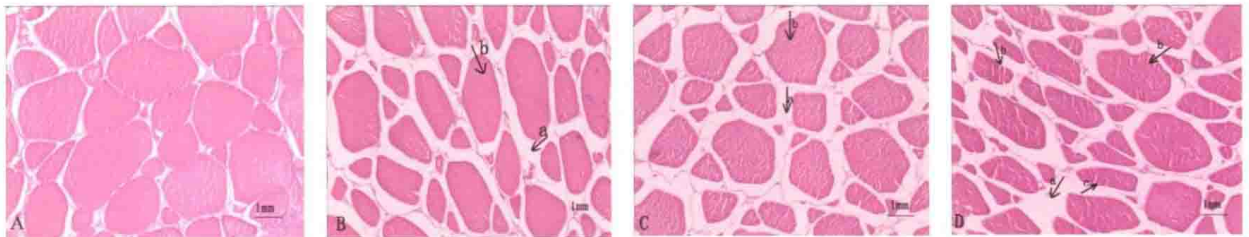
彩图10-6-1正常和损伤肠道外观形态 A.正常肠道; B.损伤肠道

Fig.10-6-1 normal and damaged intestinal morphology diagram A. normal intestine; B. damaged intestine



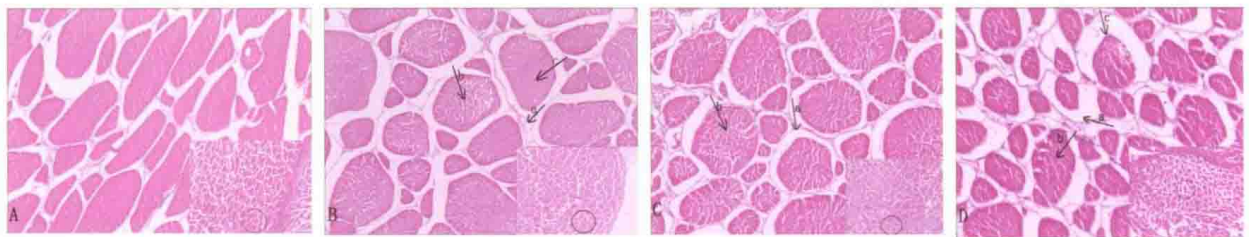
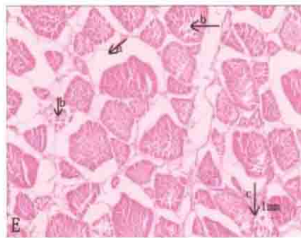
彩图10-6-2 肠道组织形态的影响 (×1000) A.正常肠道; B.损伤肠道, 箭头示肠微绒毛疏松, 局部脱落

Fig.10-6-2 Effects of intestinal tissue morphology A. normal intestine; B. damaged intestine, the arrows indicate the intestinal microvilli loose, partial loss



图版11-7-1 氧化鱼油对草鱼肌肉形态、结构的影响

A. 6S组 肝胰脏细胞排列整齐, 大小均一; B. 6F组, 肌纤维间隙出现增宽的现象(↑a), 但肌纤维内部还保持完整(↑b); C-D. 20F-40F 肌纤维萎缩(↑c), 间隙显著增宽(↑a), 并发生断裂呈竹节状(↑b); E. 60F组肌纤维进一步萎缩(↑b), 间隙进一步增宽(↑a), 有的出现破碎甚至溶解的现象(↑c)



图版11-8-1 丙二醛对肌肉组织结构的影响 (400倍)

Plate11-8-1 Effect of MDA on structure of muscle in grass carp (×400)

A. 6S组 肝胰脏细胞排列整齐, 大小均一; B1组肌纤维间隙显著增宽(↑a), 部分肌纤维内部出现断裂(↑b, ↑c); B2组肌纤维萎缩, 间隙显著增宽(↑a), 大部分肌纤维发生断裂呈竹节状(↑b), B3组肌纤维进一步萎缩, 间隙进一步增宽(↑a), 肌纤维发生断裂(↑b), 肌纤维边缘模糊(↑c)