ANSC (NUTR) 618
LIPIDS & LIPID METABOLISM
Adipose Tissue Differentiation

I. Definitions

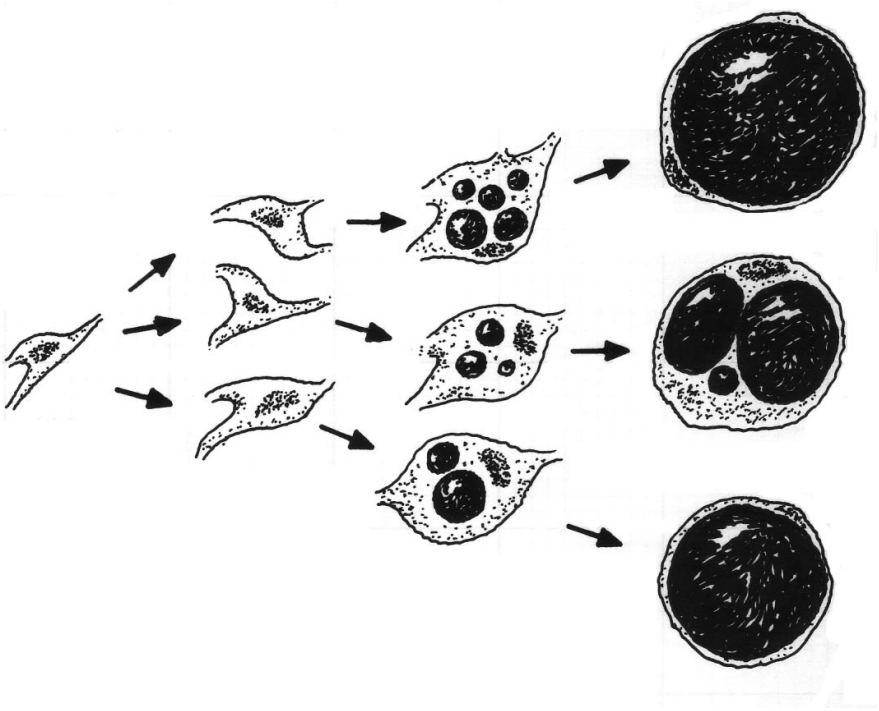
A. Hyperplasia

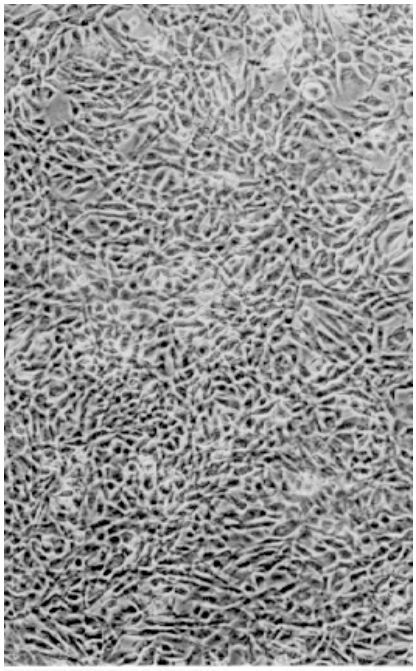
1. Increase in cell number.
2. Presumes divisions of cells (mitotic for most cell types).
3. Prenatal or postnatal.

B. Hypertrophy

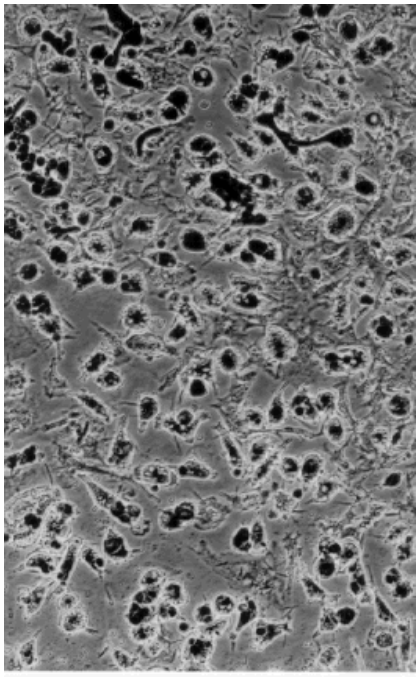
1. Increase in cell size.
2. Biosynthetic processes proceed at faster rate than degradative processes.

3. Primarily postnatal.



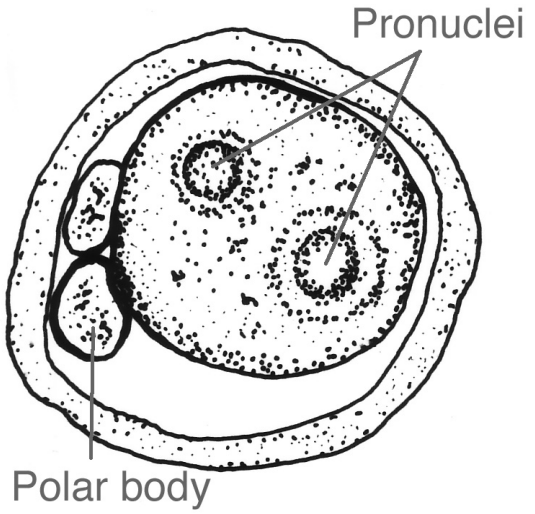


3T3-L1 preadipocytes at confluence. No lipid filling has yet occurred.



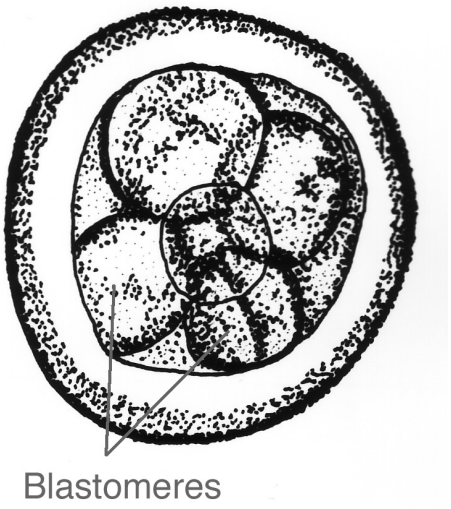
3T3-L1 adipocytes after 6 d of differentiation. Dark spots = lipid droplets.

II. Embryonic development



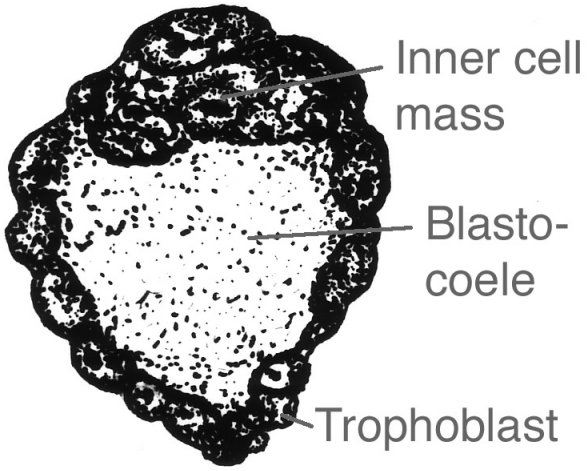
A. Zygote

1. Pronuclei are separate immediately after fertilization.
2. Fuse to form single nucleus.



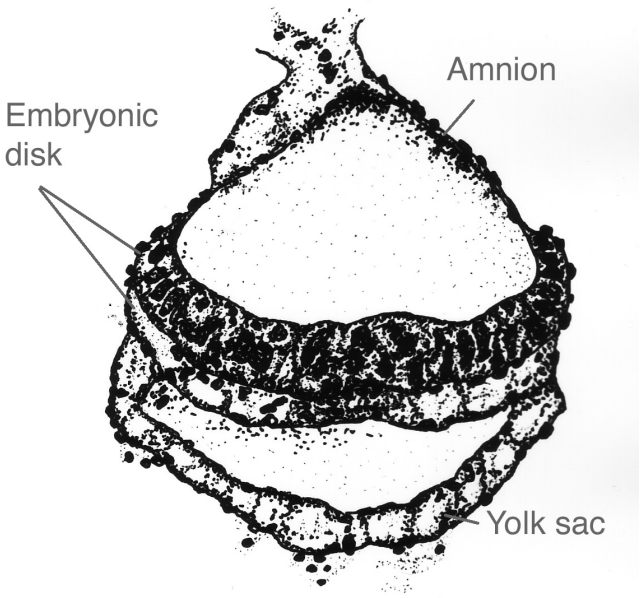
B. Morula

1. Contains blastomeres (divided cells).
2. Blastomeres are totipotential until approximately the 32-cell stage.



C. Blastocyst

1. Hollow sphere (cavity = blastocoele)
2. Trophoblast (outer layer of cells)
3. Inner cell mass (source of germ cell lines)

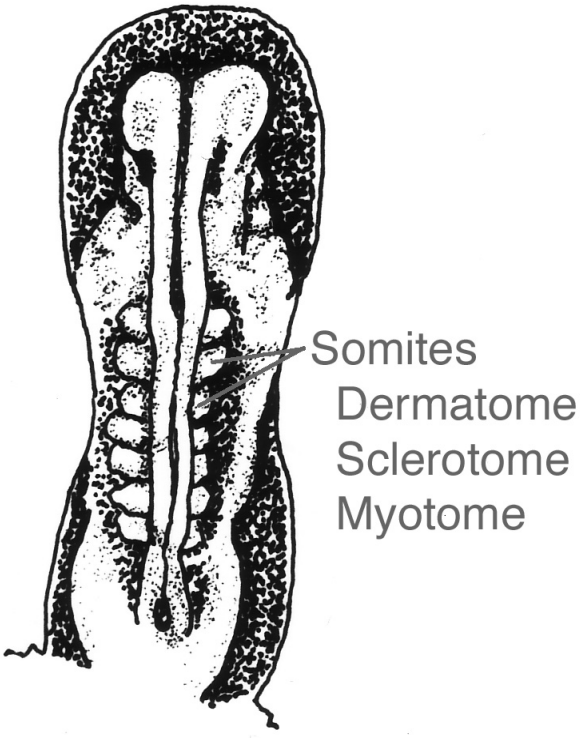


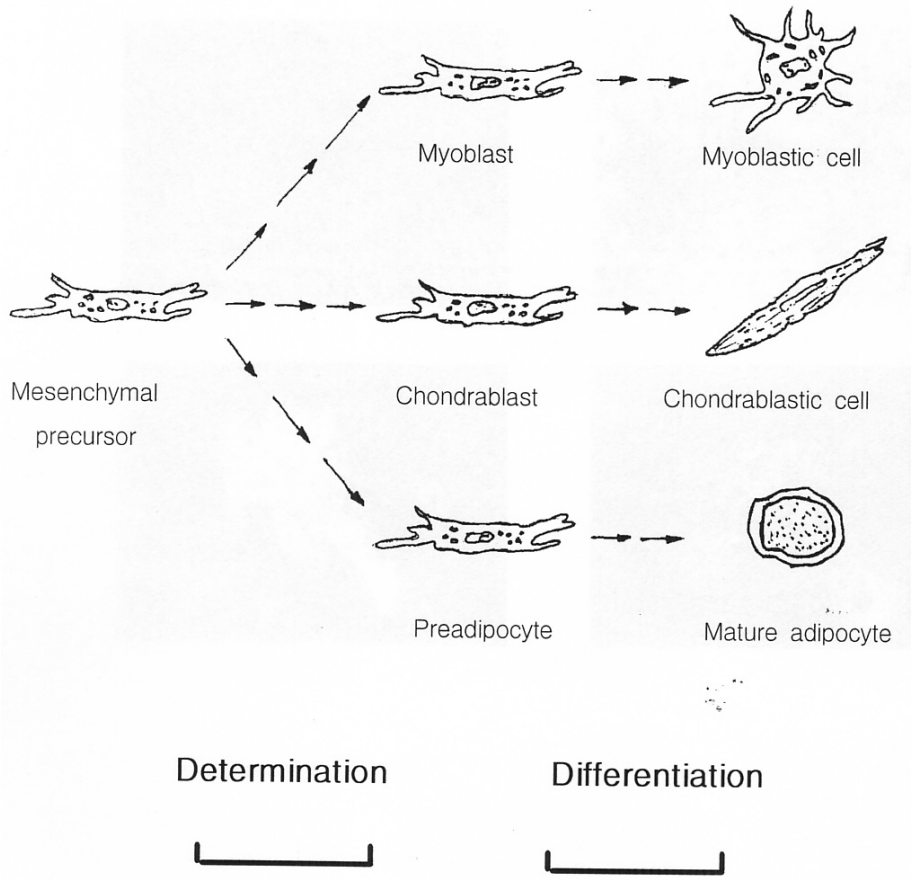
D. Embryo -- early

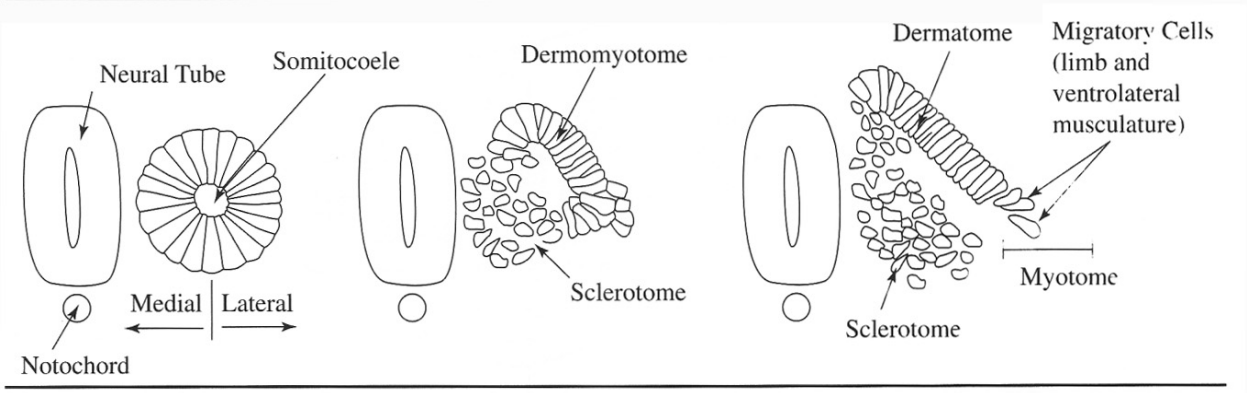
1. Dorsal (ectoderm)
2. Ventral (endoderm)
3. Primitive streak (mesoderm → connective tissues, muscle)

E. Embryo -- late

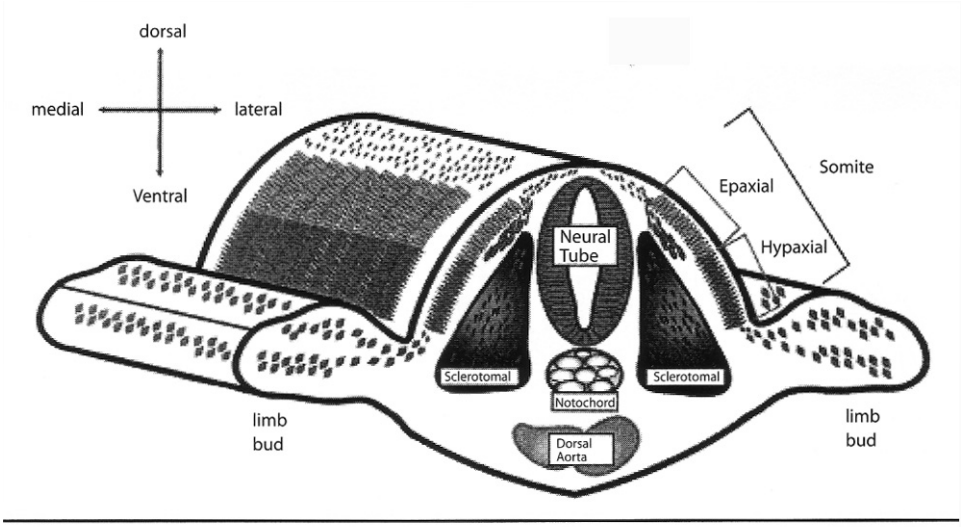
1. Visible notochord
2. Somites (**from the mesoderm**)
   a. Dermatome → mesenchymal cells (connective tissues)
   Collagen-secreting chondroblasts
   Preadipocytes
   Stromal vascular cells
   b. Sclerotome → source of bone
   c. Myotome → muscle







Maturation of a somite into the dermatome, myotome, and sclerotome.



Migration of mesodermal cells and formation of a limb bud.

III. Early postnatal development of adipose tissue

A. Origin of adipocytes

1. Mesoderm
2. Mesenchyme
3. **Some cell types will become brown adipocytes.**

B. Differentiation

1. Fibroblasts
   a. Proliferative
   b. No adipocyte-specific gene expression.
2. Adipoblasts (preadipocytes)

a. Proliferative

b. Distinguished by adipocyte-specific gene expression and some lipid filling.

3. Mature adipocytes

a. Extensive lipid filling.

b. No further division.

IV. Development of adipose tissue in mature animals

A. Hypertrophy

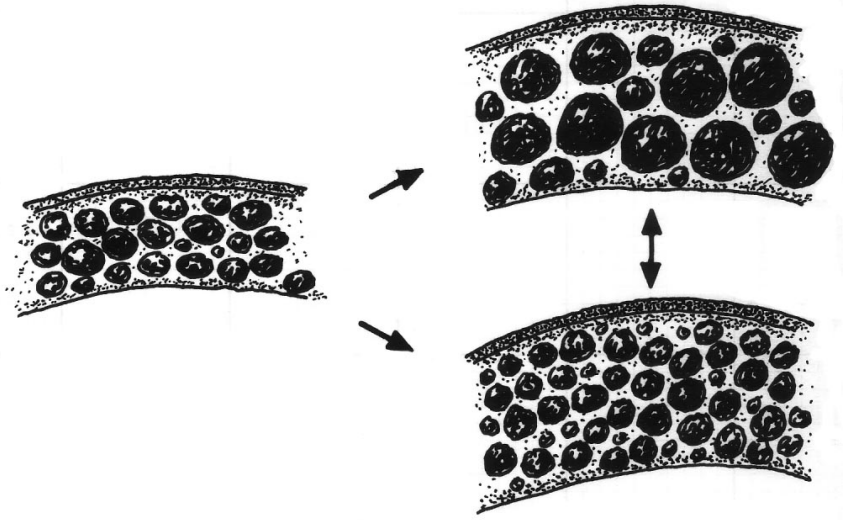
1. Important in young animals.
2. Contributes little to adipose tissue mass in mature animals.

B. Hyperplasia

1. Only in preadipocytes
2. Increases total adipocyte number.

C. Recruitment

1. Differentiation of quiescent adipoblasts
2. "Apparent" increase in adipocyte number



V. Sources of new adipocytes in subcutaneous adipose tissue

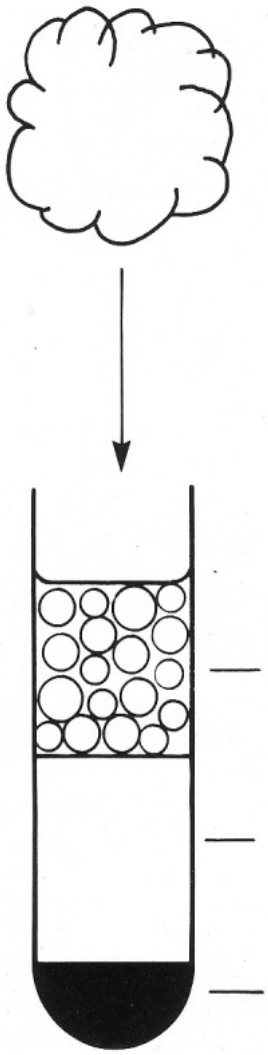
A. Stromal-vascular tissue (mesenchymal tissue)

1. Can be separated from mature adipocytes by collagenase treatment.

a. Mature (lipid-filled) adipocytes are discarded.

b. SV cells (containing preadipocytes) are plated.

2. After plating, SV cells rapidly divide.
3. Upon confluence, SV cells (preadipocytes?) begin to differentiate.
4. Cells convert to multilocular adipocytes under appropriate culture conditions.



Adipose tissue

Collagenase digestion
and centrifugation

Mature fat cell fraction, consisting of adipocytes that float because they are replete with triglyceride. This fraction is cultured and used for studying fat cell dedifferentiation

Infranatant, relatively cell-free depending on the stage of development

SVF (stromal-vascular fraction), consisting of several cell types (see *Table 15.1*) sedimented due to their high density, ultimately yielding homogeneous adipocyte precursor cell strains. This fraction is cultured and used for studying fat cell replication and differentiation

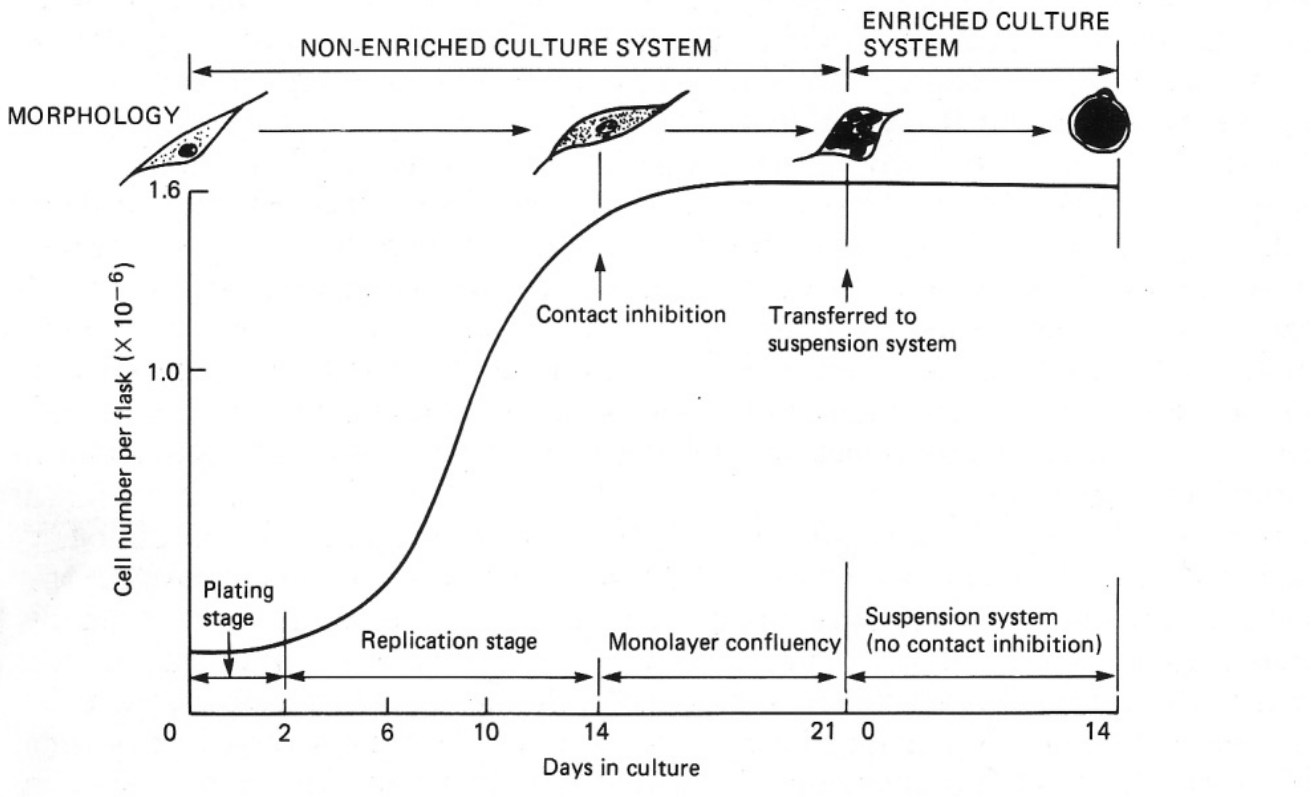
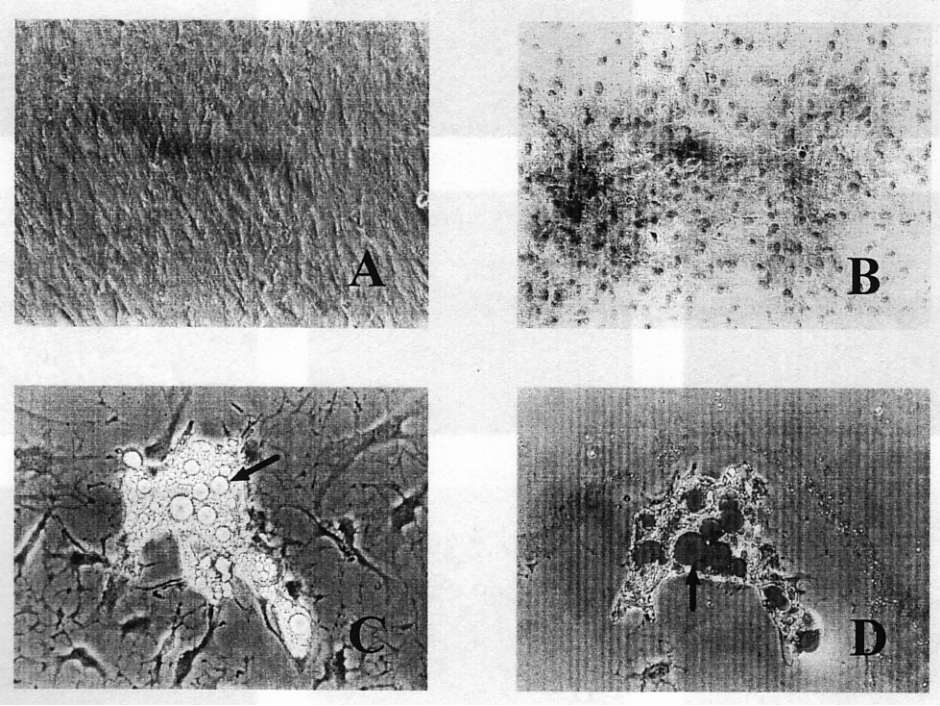


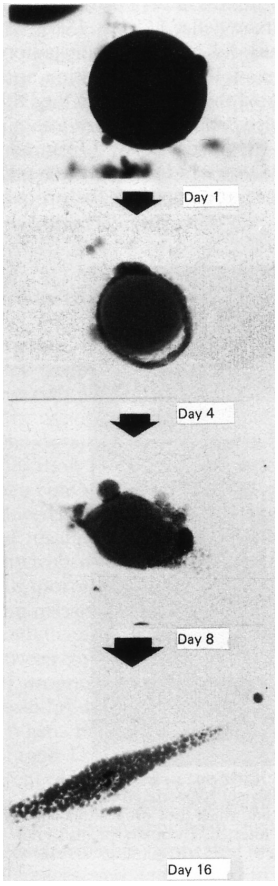
Figure 15.5. A schematic representation of the morphological growth characteristics of both human and rat adipocyte precursor cell strains as a function of culture conditions (*see text*)



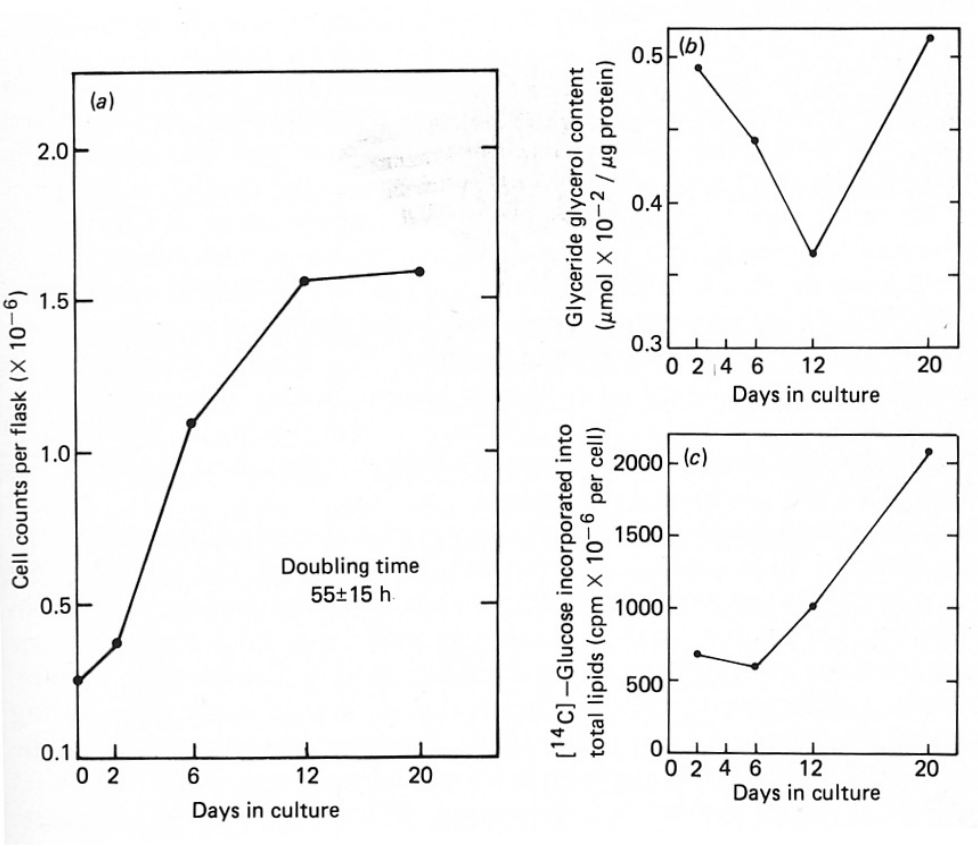
Hanwoo preadipocytes at confluence (A & B) and after 10-20 days in differentiation media (C & D). B & D are oil-red O stained. Chung et al.

B. Delipidation of mature adipocytes

1. During delipidation, no hyperplasia.
2. After extensive delipidation, normal exponential growth.



Deplipidation of human adipocytes in culture.



Time course of proliferation and glucose metabolism in preadipocytes after delipidation.

C. Processes of lipid filling and delipidation

1. Once thought that differentiated cells could not divide.
2. Now known that proliferation can occur after lipid filling begins.

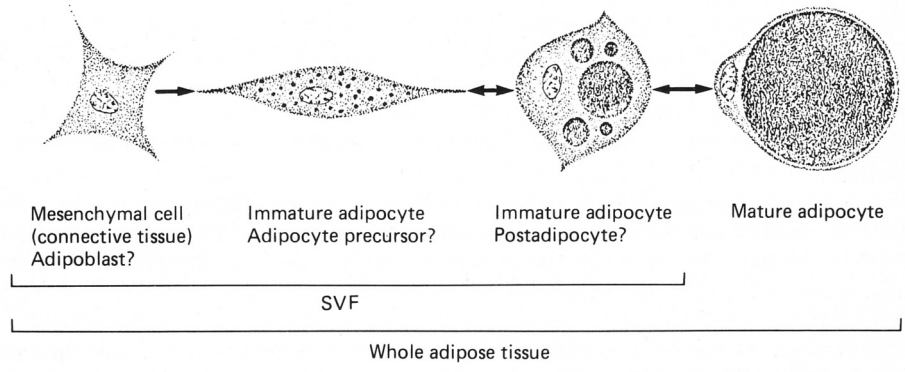


Figure 15.13. Proposed maturation and delipidation of adipocytes