**GLANDS**

*ى*

*A gland is an organ of secretion made of specialised secretory cells derived from surface epithelium on which it opens.*

**GENERAL FEATURES**

* Glands can be present as discrete organs or in the layers of viscera.
* The secretory cells of the glands form functional units called secretory end pieces, which are either ﬂask shaped (acini) or cylindrical in shape (tubules).
* It is epithelial in origin.
* The ﬂuid secreted by the gland contains enzymes, hormones, mucus or fat.
* The rate of secretion is modulated by nervous and hormonal inﬂuences.
* The secretory end pieces of some exocrine glands are surrounded by star-shaped contractile cells that lie between the secretory cells and the basement membrane. They are called myoepithelial cells as they share characteristics of both epithelial and muscle cells.

**DEVELOPMENT**

* Glands arise as invagination of the epithelium into the underlying vascular connective tissue.
* The distal part of the invagination forms the glandular portion or *secretory* end piece, which is functionally an active portion.
* The proximal part forms the *excretory duct* which opens on the surface of the epithelium from which it is developed.
* Some cells get detached from the epithelial surface and form ductless glands or endocrine glands.

**CLASSIFICATION OF GLANDS**

1. **Based on the site of secretion**
   1. **Exocrine gland** – secretes its products onto a surface through ducts, e.g. *salivary glands.*
   2. **Endocrine gland** – secretes its products into the bloodstream, e.g. *thyroid glands.*
2. **Based on the number of cells**
   1. **Unicellular gland** – composed of a single cell, e.g. *goblet cells* in the respiratory and intestinal tracts.
   2. **Multicellular gland** – composed of many cells, e.g. *all glands other than goblet cells*.
3. **Based on the number of ducts and shape of secretory end piece**
   1. **Simple gland –** has one duct.
   2. **Compound gland –** has minor and major ducts.

The types of simple and compound glands are illustrated in Flowchart 3.1.

**37**



Excretory duct

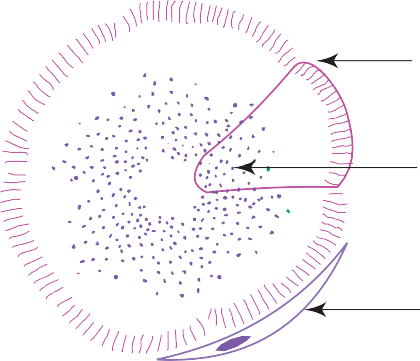
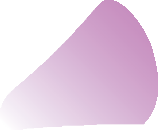
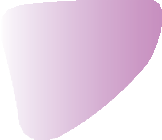
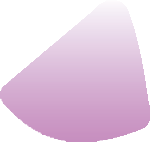
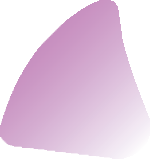
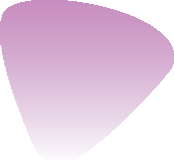
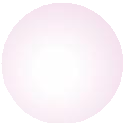
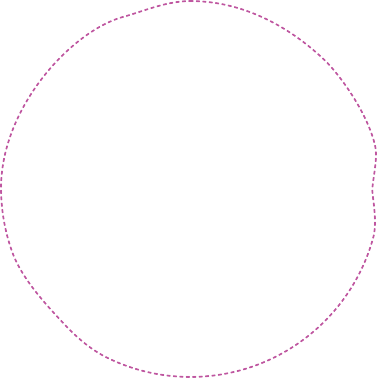


Secretory end piece

**Fig. 3.1** Development of glands.

1. **Based on the mode of secretion**
   1. **Merocrine gland** – secretory cells release their contents by exocytosis **(no loss of cytoplasm)**, e.g. most of the *compound glands*.
   2. **Apocrine gland** – apical part of the cytoplasm of the secretory cells is lost in the process of secretion **(partial loss of cytoplasm)**, e.g. lactating *mammary gland*, *sweat gland* in the axilla and external genitalia.
   3. **Holocrine gland** – secretory cells burst out pouring their contents, resulting in the death of the cells **(complete loss of cytoplasm)**, e.g. *sebaceous gland, tarsal gland*.
   4. **Cytocrine gland** – cells are released as secretion, e.g. *testis (spermatozoa)*.
2. **Based on the nature of secretion**
   1. **Serous gland** – secretes thin watery material rich in enzymes, e.g. *parotid salivary gland* (Fig. 3.2; Box 3.1).

Basal lamina

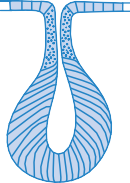
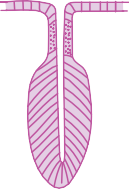
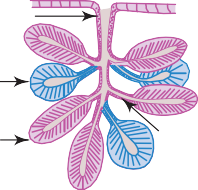
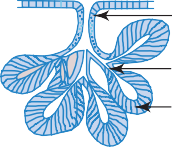
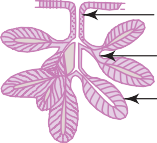
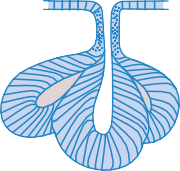
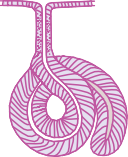


Zymogen granules

Myoepithelial cell

**Fig. 3.2** Serous acinus.

Glands



1. Unbranched, e.g. *urethral gland*
2. Branched, e.g. *sebaceous gland, tarsal gland*

Acinar (alveolar)

1. Straight, e.g. *intestinal crypt*
2. Branched, e.g. *uterine gland fundic and pyloric glands of stomach*
3. Coiled, e.g. *sweat glands*

Tubular

Minor duct

Tubule

Tubuloacinar, e.g. *sublingual and submandibular glands*

Major duct

Acinus

Acinar, e.g. *parotid gland*

Major duct

Minor duct Acinus

Tubular, e.g. *cardiac gland of stomach, Brunner’s*

*gland of duodenum*

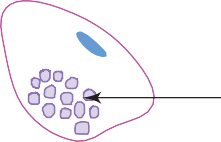
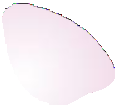
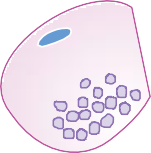
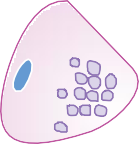
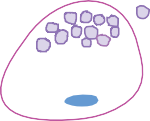
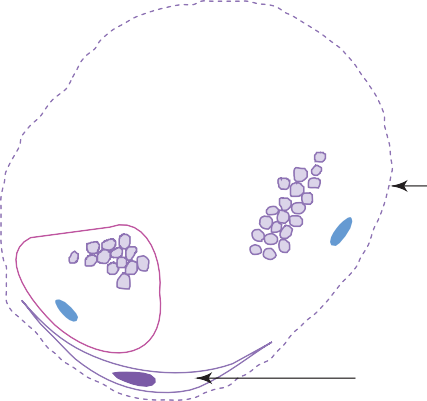
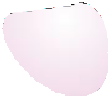
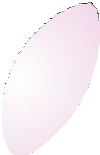
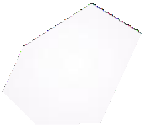
Major duct Minor duct Tubule

Compound

Simple

**Flowchart 3.1** Classiﬁcation of glands, based on the number of ducts and shape of secretory end pieces.

Mucigen droplets



Basal lamina

Myoepithelial cell

**Fig. 3.3** Mucous acinus.

**Box 3.1**

**Serous Gland (Parotid Salivary Gland).**

*Presence of*

Serous Acini

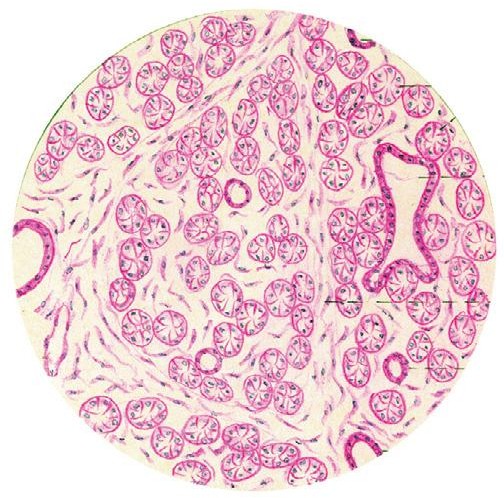
Round Central Nucleus Striated Duct

Interlobular Connective Tissue Septum

Intercalated Duct

Interlobular Duct

**Ugtqwu incpf \*Rctqvif ucnixct{ incpf+**



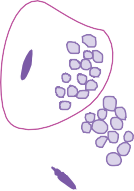
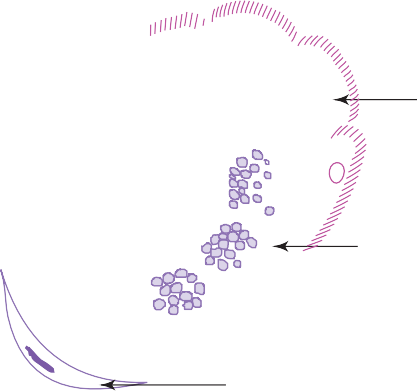
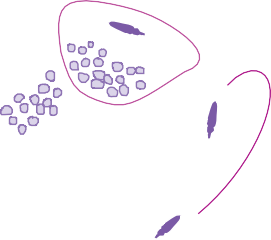
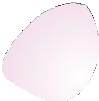
* + 1. darkly stained **serous acini** with

**narrow lumen;**

* + 1. **round, centrally placed nuclei** in the serous cells;
    2. well-developed duct system.
  1. **Mucous gland –** secretes thick viscous material for protection and lubrication, e.g. *sublingual salivary gland* (Fig. 3.3; Box 3.2).
  2. **Mixed gland (seromucous)** – secretes watery and viscous material from both, serous and mucous acini, e.g. submandibular salivary gland (Box 3.3; Fig. 3.4).

The distinguishing features of serous and mucous acini are presented in Table 3.1.

Serous demilune



Mucous acinus

Myoepithelial cell

**Fig. 3.4** Seromucous acinus (mixed).

**Mucous Gland (Sublin-**

Flat Peripheral Nucleus

Mucous Acinus Interlobular Septum

Serous Demilune Interlobular Duct

Serous Acinus

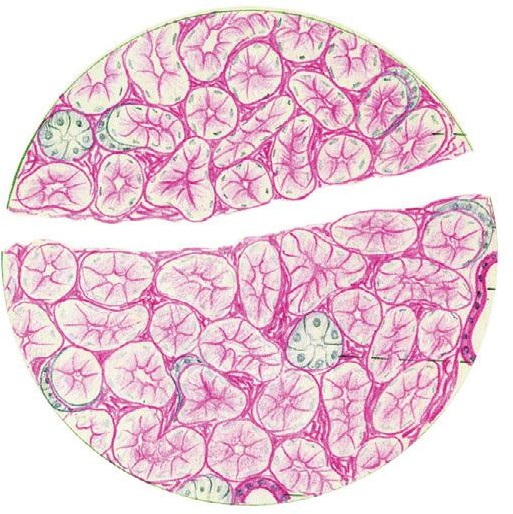
Striated Duct

**Oweqwu incpf \*Uwdnipiwcn ucnixct{ incpf+**

**Box 3.2**

**gual Salivary Gland).**

*Presence of*



* + 1. lightly stained mucous acini/tubules with **large lumen;**
    2. **ﬂat, peripheral nuclei** in the mucous cells;
    3. poorly developed duct system.

**Box 3.3**

*Presence of*

Interlobular Duct Serous Acini

Striated Duct Mucous Duct Serous Demilune Interlobular Duct

**Oizgf incpf \*Uwdocpfidwnct incpf+**



**Mixed Gland (Submandibular Gland).**

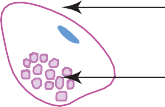
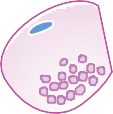
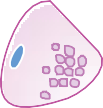
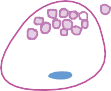
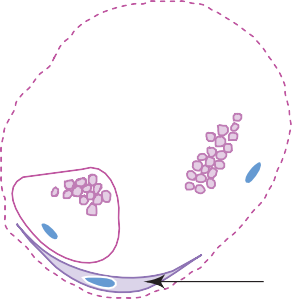
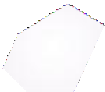
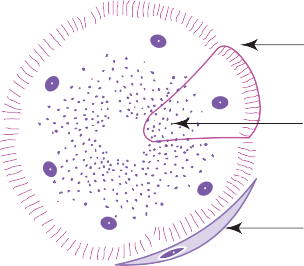
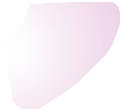
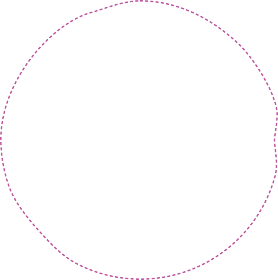
1. both darkly stained **serous** and lightly stained **mucous acinus;**
2. **serous demilune** (crescent-shaped patch of serous cells);
3. moderately developed duct system.

**Table 3.1** Differences between serous and mucous acini

*Diagram*

**Serous acinus Mucous acinus**

Basal lamina



Zymogen granules

Basal lamina Mucigen droplets

Myoepithelial cell

*Consistency for secretion* Thin watery Thick viscous

Myoepithelial cell

*Nature of secretory granules*

*Shape and position of nucleus*

Zymogen granules Mucigen droplets

Round, central Flat, peripheral

*Size of lumen* Small Large

*Appearance of cell boundaries*

*Staining reaction with haematoxylin and eosin*

Indistinct Distinct

Darkly stained Lightly stained

*Functions* Enzyme action Protection and lubrication

*Example* Parotid gland Sublingual gland

**GENERAL ARCHITECTURE OF A COMPOUND GLAND**

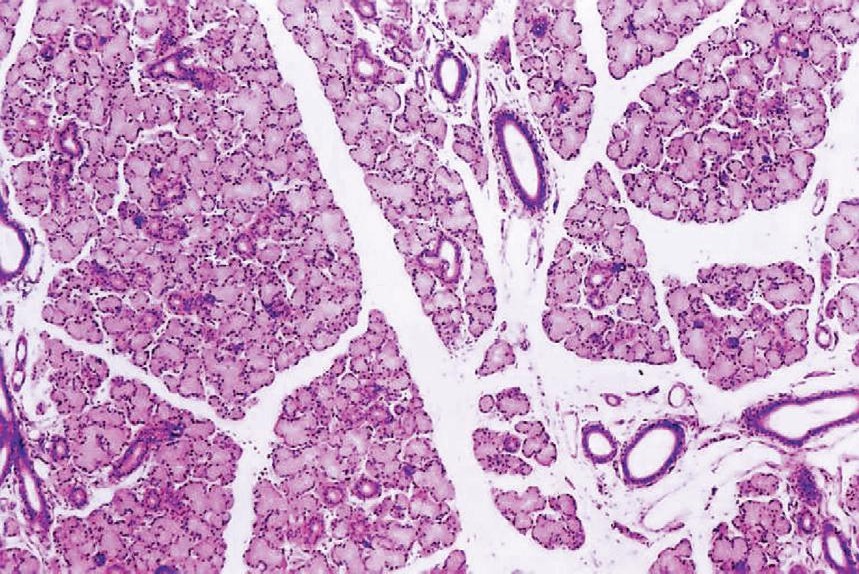
* Most glands are composed of either serous or mucous secretory cells or are of both types. These cells form secretory end pieces which are ﬂask shaped (acini) or cylindrical (tubules) in shape. The end pieces are often associated with contractile *myoepithelial cells*, whose function is to express the secretion.
* The secretory end pieces and their associated ducts of the gland form *parenchyma.*
* The connective tissue framework of the gland which supports the parenchyma forms the *stroma*.
* **Parenchyma** is composed of
  + secretory end pieces (acini/tubules/tubulo-acini)
  + ducts (intralobular, interlobular, main excretory duct).
* **Stroma** is composed of
  + capsule
  + septae (interlobular, interlobar)
  + loose intralobular connective tissue supporting the parenchyma.

Malignant tumours arising from glandular epithelial tissue are called adenocarcinomas.



*Self-assessment Exercise*

**Z62**



**Id**

**Lo**

**Is**

**Lo**

**Id**

**Ma**

**Lo**

**Ma**

**Is**

**Is**

**Id**

**Lo**

**Is**

**Ed**

**Lo**

**Id**

**c**

**Salivary gland.**

Examine a section of salivary gland under scanner (Plate 3:1a) and appreciate the general architecture of the gland.

**Plate 3:1a**

* + Note the ﬁbrous capsule surrounding the gland sending interlobular septae (**Is**) divid- ing it into many lobules (**Lo**).



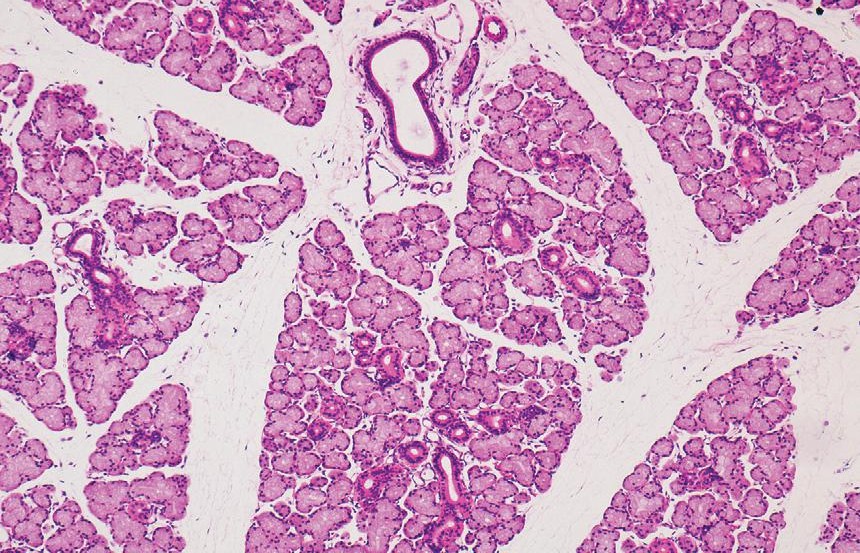
*Practical No. 3*

*Glandular Epithelium: The Salivary Glands*

* + Identify the larger excretory ducts (**Ed**) and medium-sized interlobular ducts (**Id**) in the septum and the small eosinophilic in- tralobular ducts and lightly-stained secretory acini (**Ma**) in the lobule.

**45**

**X100**



**Id**

**Ma**

**In**

**Is**

**Is**

**d**

**Mucous gland (e.g. *sub- lingual salivary gland*).**

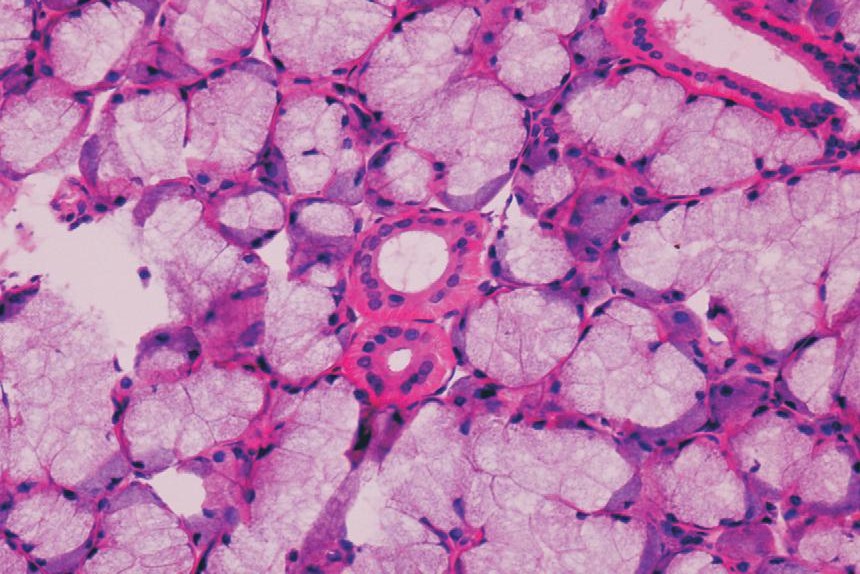
**Plate 3:1 b and c**

At low and high magniﬁcations (Plate 3:1b and c), observe the secretory end piece (mucous acinus) and note its features:

**X400**

* *Lightly-stained* cuboidal mucous cells, form- ing *mucous acinus* (**Ma**).
* *Flat peripherally-placed nucleus* (**N**) in each cell.
* *Large lumen* of the acinus – can be easily identiﬁed.
* Some mucous acini are associated with darkly stained crescentic patch of serous cells called serous demilune (**Sd**).

Among the acini identify the large eosin-stained intralobular ducts (**In**; striated or secretory ducts) lined by simple columnar epithelium and the small intercalated ducts lined by cuboidal epithelium.



**Ma**

**In**

**In**

**Ma**

**Sd**

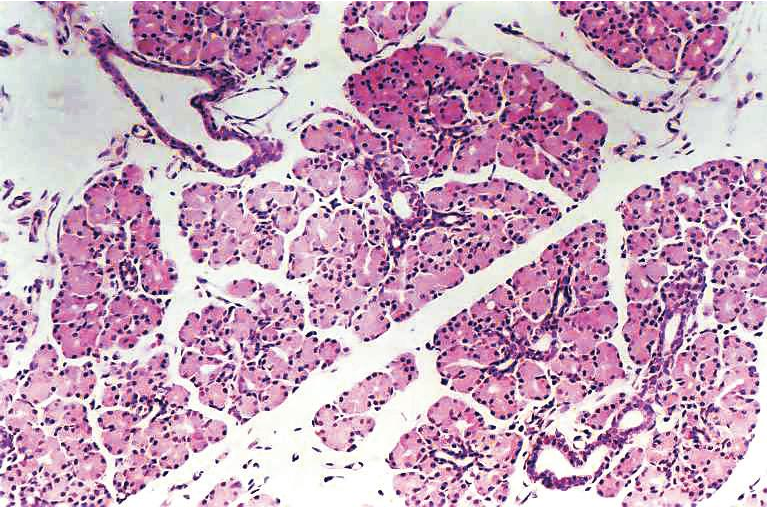
**N**

**e**

The **striated ducts** exhibit basal striations which are due to the basal infoldings of plasma membrane and longitudinal orientation of mitochondria (characteristics of an ion transporting cell). These ducts secrete potassium into primary saliva and absorb sodium making the isotonic primary saliva, hypotonic. They also secrete immunoglobulin A.

**X100**

**Plate 3:2**



**Is**

**Id**

**Sa**

**In**

**Sa**

**Is**

**In**

**Sa**

**In**

**c**

**Serous gland (e.g. *parotid gland)*.**

**a and b**

At low magniﬁcation (Plate 3:2a), observe the architecture of the gland.

Note the intercalated duct **(Ic)**; intralobular duct **(In)**; interlobular duct **(Id)**; interlobular septum **(Is)**.

At high magniﬁcation (Plate 3:2b), observe the secretory end piece (serous acinus) and note the following features:

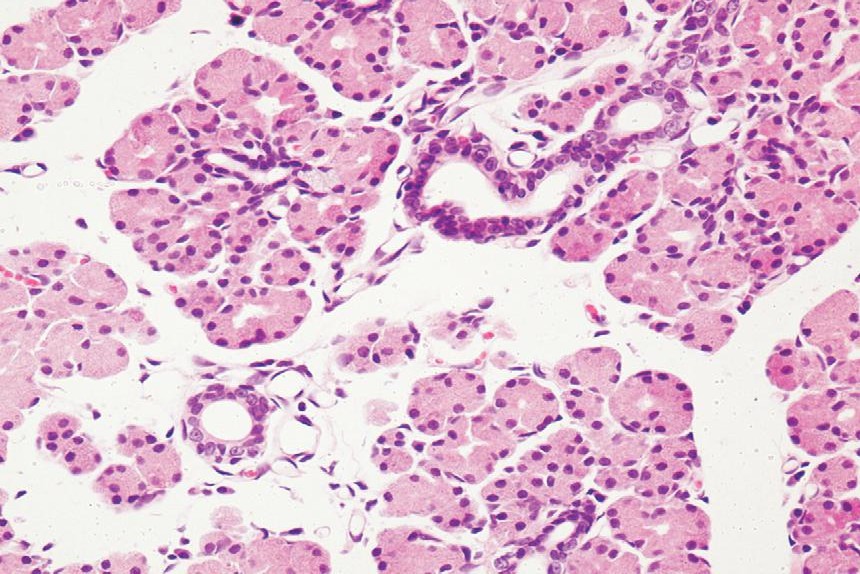
**X400**

* *Darkly-stained pyramidal serous cells* forming

*serous acinus* **(Sa)**.

* *Round centrally-placed nucleus* **(N)** in each cell.
* *Small lumen* of the acinus; lumen is very *small*

and may not be visible.



**Sa**

**In**

**Ic**

**N**

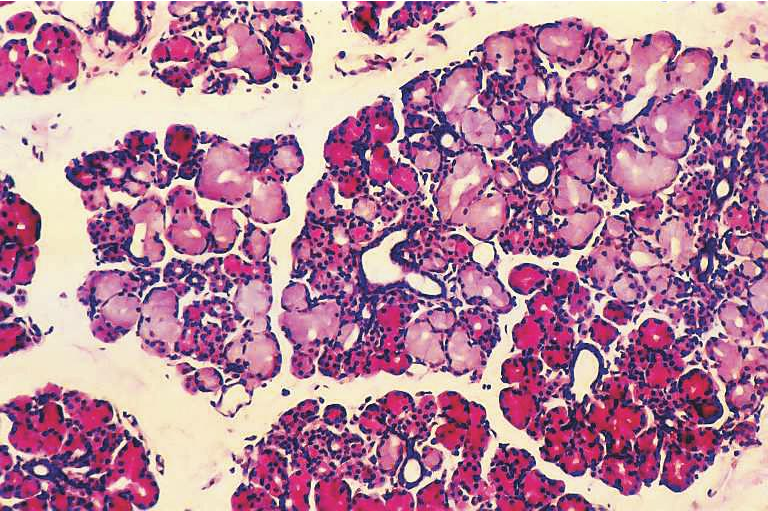
**Sa**

**d**

Note the small intercalated duct (**Ic**) arising from the acinus. These ducts end in striated duct (**In**).

Compare this slide with the previous one and note the differences between serous and mucous acini (refer to text).

**X100**



**In**

**Ma**

**Ma**

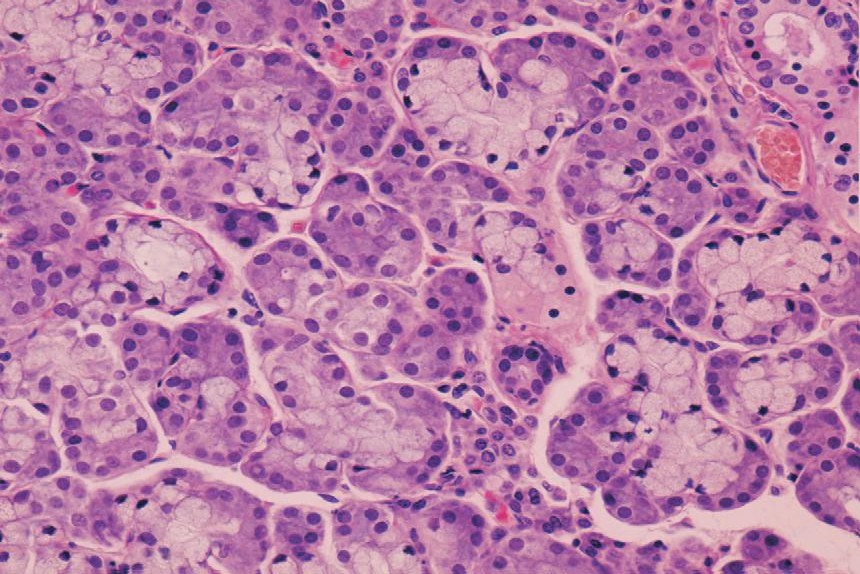
**In**

**Sa**

**Sa**

**c**

**X400**



**In**

**Sa**

**Ma**

**Ma**

**Sa**

**Sd**

**Sd**

**d**

**Plate 3:3**

**a and b**

**Mixed gland (e.g. *sub- mandibular salivary gland*).**

At low magniﬁcation (Plate 3:3a) appreciate the architecture as well as mixed nature of the gland.

It shows darkly-stained areas made up of serous acini (**Sa**) and lightly-stained areas made up of mucous acini (**Ma**). (Do not confuse adipose tissue for mucous acini.) Intralobular ducts (**In**) are seen among acini.

At high magniﬁcation (Plate 3:3b), observe the secretory end pieces (serous acini, mucous acini, serous demilunes) and note their features:

* The serous (**Sa**) and mucous acini (**Ma**) can be identiﬁed by their staining reaction, size of lumen, and shape and position of nuclei as stated in the text.
* The mucous acini are often associated with darkly-stained, crescentic patch of serous cells called *serous demilune* (**Sd**) of Giannuzzi. Identify this semilunar serous demilune ad- herent to a mucous acinus.

***Exercise***

Compare the slides of salivary glands (Plates 3:1 to 3:3) and enumerate their salient features.

Characteristics of salivary glands: sublingual, parotid and submandibular

**Sublingual Parotid Submandibular**

Mixed gland but predominantly made of mucous acini

Purely serous gland Mixed gland but predominantly made of serous acini

Compound tubuloacinar gland Compound acinar gland Compound tubuloacinar gland

Poorly developed duct system Well-developed duct system

(mainly striated ducts)

Moderately developed duct system

Very few adipose cells More inﬁltration of adipose cells Moderate number of adipose cells

Thick viscous secretion protective and lubricative in function

Constitutes 5% of volume of saliva

Secretes thin watery secretion rich in enzymes and antibodies (IgA)

Secretion constitutes 25% of volume of saliva

Intermediate in consistency

Constitutes 70% of volume of saliva