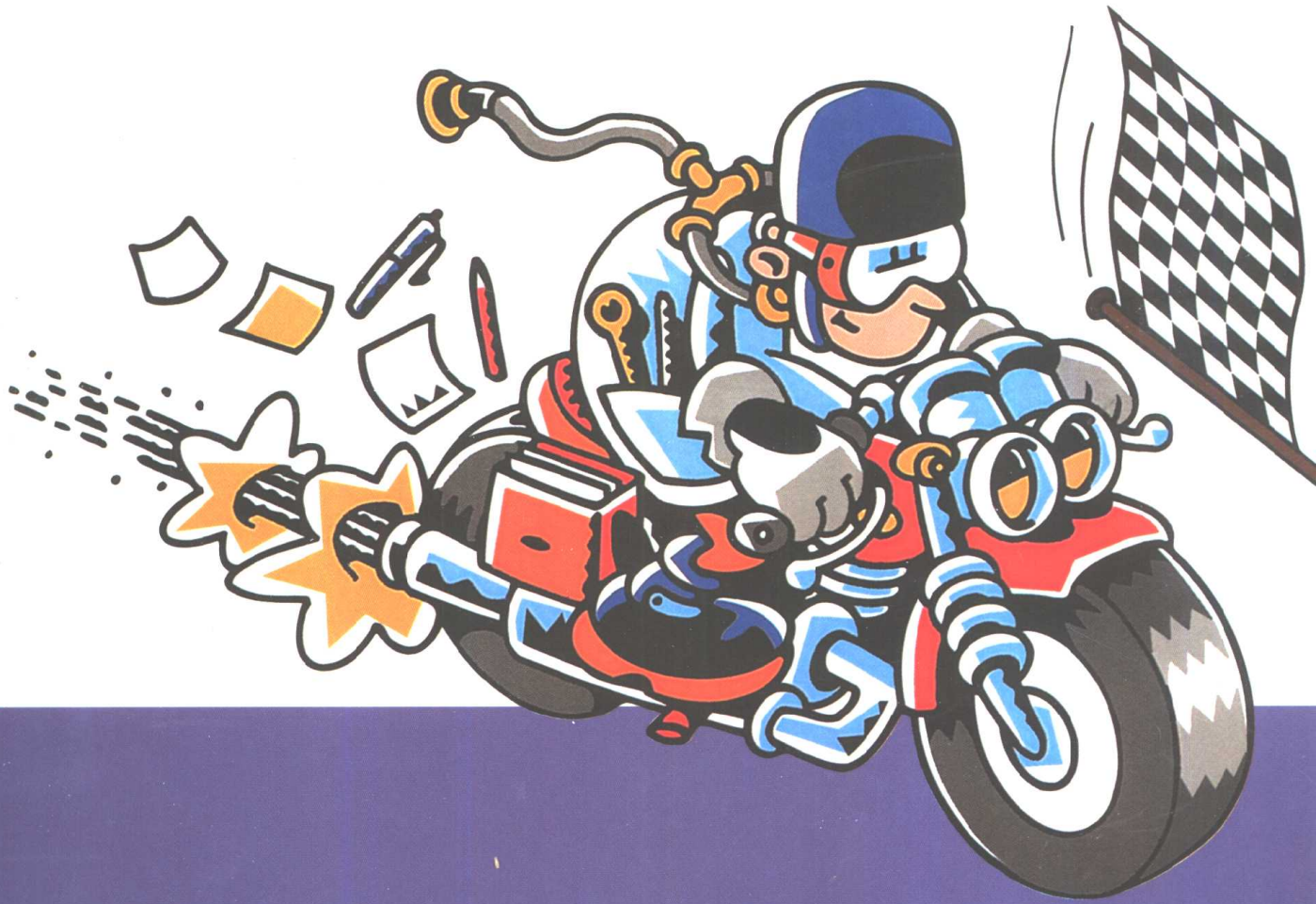
风暴式医学教程 MOSBY'S CRASH COURSE (原版英文医学教程)

呼吸系统
ResPiratory System

Angus Jefferies ⊙ Andrew Turley
with Daniel Horton-Szar as Series Editor



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（原版英文医学教程）

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Harcourt Asia
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2002

Reprint ISBN 981-4095-33-8

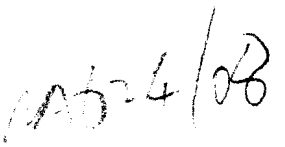
北京市版权局版权登记号：01-2001-3859

图书在版编目(CIP)数据

呼吸系统/(英)杰弗里斯(Jefferies, A.)编. -影印版. -北京：科学出版社，2002.2
风暴式医学教程
ISBN 7-03-009696-7

Ⅰ. 呼… Ⅱ. 杰… Ⅲ. 呼吸系统-教材-英文 Ⅳ. R322.3

中国版本图书馆 CIP 数据核字(2001)第 063343 号



科学出版社 出版
北京东黄城根北街16号
邮政编码：100717
http://www.sciencep.com
新蕾印刷厂 印刷
科学出版社发行 各地新华书店经销
*
2002年2月第 一 版 开本：787×1092 1/16
2002年2月第一次印刷 印张：16
印数：1—5 000 字数：359 000
定价：39.00元
(如有印装质量问题，我社负责调换〈新欣〉)

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Respiratory System

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Science Press
Harcourt Asia
Mosby

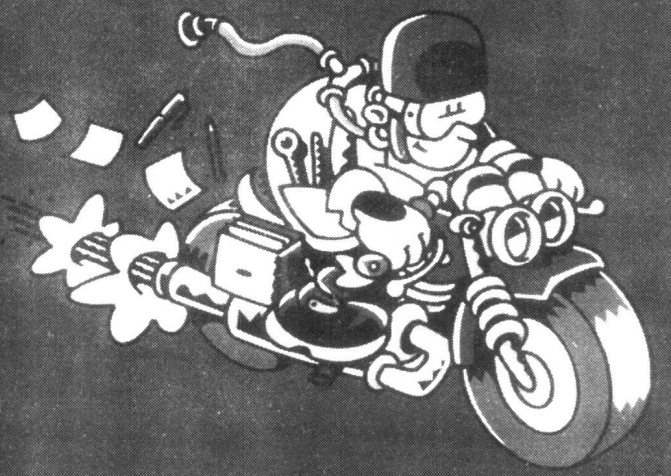
SCIENCE PRESS
A division of China Science Publishing Group
16 Donghuangchenggen North Street,
Beijing 100717
China

HARCOURT ASIA PTE. LTD
A Harcourt Publishers International Company
583 Orchard Road #09-01 Forum
Singapore 238884

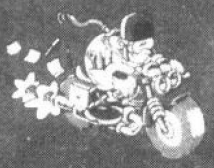
Distribute in the Mainland China by Science Press,
16 Donghuangchenggen North Street, Beijing 100717, China.

This Edition First Printed in China in 2002.
ISBN 7-03-009696-7/R • 765
Reprint ISBN 981-4095-33-8

Printed in China



Respiratory System



Preface

Whether you aspire to be a hospital-based physician, a surgeon or a general practitioner, respiratory medicine will play a pivotal part in your daily workload. However, first things first and to pass the medical finals, which is every student's immediate aim, you are going to need to have a good grasp of respiratory medicine both factually and clinically.

As students, we are partly assessed on how much factual information we can remember from a wide diversity of specialities. Bearing this in mind, we have written *Crash Course: Respiratory Medicine* with the aim of combining the core information of basic clinical skills with the preclinical factual base, providing a fully integrated basic review. Numerous illustrations, hints and tips boxes, and comprehension check boxes at the end of each section, will hopefully make things a little easier around exam time.

We hope that *Crash Course: Respiratory Medicine* proves to be most useful in the pre-exam cramming period!

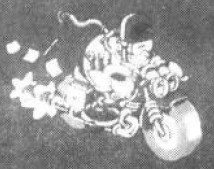
Angus Jefferies
Andrew Turley

Physiology and pathology of the respiratory system enter into all aspects of medicine. Lung disease accounts for a large proportion of morbidity and mortality - asthma, emphysema, chronic bronchitis and lung cancer all being common diseases. A patient cannot be safely anaesthetised or ventilated without a good working knowledge of respiratory physiology, and this knowledge can also be applied in other areas including sports medicine.

Crash Course: Respiratory System offers a succinct, yet comprehensive, coverage of respiratory physiology and pathophysiology that is essential information for all medical students. It contains many useful distillations of knowledge in the form of clinical algorithms, tables and hints and tips boxes. There are also multiple-choice, short-answer and essay questions for you to test your knowledge.

Diligent study of *Crash Course: Respiratory Medicine* will provide a core knowledge of respiratory medicine that will be useful for a professional lifetime as well as ensuring success in relevant examinations.

Simon Cross
Jacqueline Hardcastle
Faculty Advisors



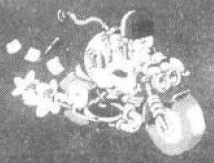
Preface

OK, no-one ever said medicine was going to be easy, but the thing is, there are very few parts of this enormous subject that are actually difficult to understand. The problem for most of us is the sheer volume of information that must be absorbed before each round of exams. It's not fun when time is getting short and you realize that: a) you really should have done a bit more work by now; and b) there are large gaps in your lecture notes that you meant to copy up but never quite got round to.

This series has been designed and written by senior medical students and doctors with recent experience of basic medical science exams. We've brought together all the information you need into compact, manageable volumes that integrate basic science with clinical skills. There is a consistent structure and layout across the series, and every title is checked for accuracy by senior faculty members from medical schools across the UK.

I hope this book makes things a little easier!

Danny Horton-Szar
Series Editor (Basic Medical Sciences)



Acknowledgements

Andrew Turley would like to gratefully acknowledge the help, advice, criticism and encouragement of Professor Alyn H. Morice who has nurtured his interest in respiratory medicine from an early stage in his medical career.

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Figures 9.13, 9.14, 9.16, 9.23, 9.24, 11.1 and 11.34 are taken from *A Concise Textbook of Clinical Imaging 2e*, David Sutton and Jeremy W R Young, Mosby, 1995.
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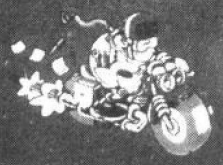

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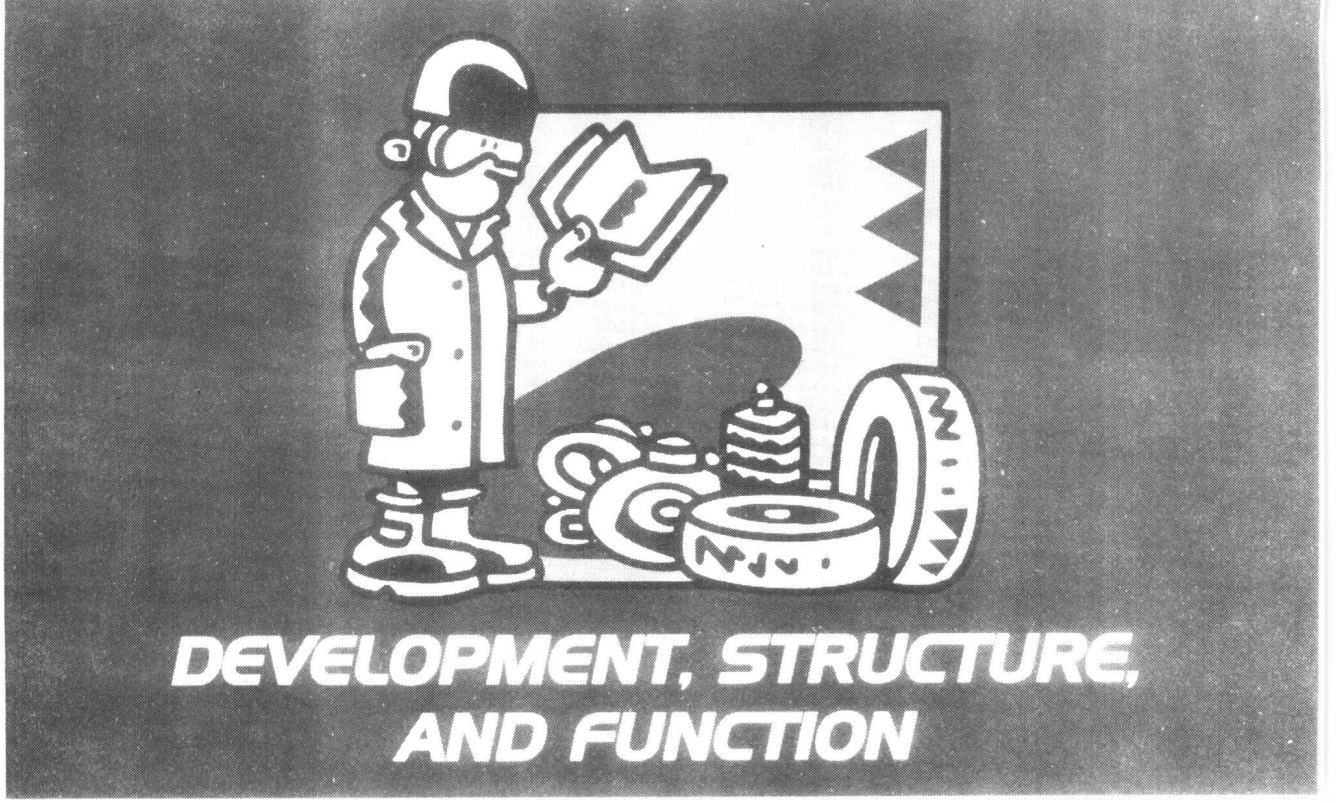

DEVELOPMENT, STRUCTURE, AND FUNCTION

1. Overview of the Respiratory System

OVERALL STRUCTURE AND FUNCTION

Respiration

Respiration is considered to be the processes involved in oxygen transport from the atmosphere to the body tissues and the release and transportation of carbon dioxide produced in the tissues to the atmosphere.

This book will not discuss the oxygen-requiring biochemical reactions of tissue respiration, so for further information see *Crash Course, Metabolism and Nutrition*.

In addition, respiration is also concerned with:

- Regulation of the pH of body fluids.
- Regulation of body temperature.

Microorganisms rely on diffusion to and from their environment for the supply of oxygen and removal of carbon dioxide. Humans, however, are unable to rely on diffusion because:

- Their surface area : volume ratio is too small.
- The diffusion distance from the surface of the body to the cells is too large and the process would be far too slow to be compatible with life.

Remember that diffusion time increases with the square of the distance and as a result, the human body has had to develop a specialized respiratory system to overcome these problems. This system has two components:

- A gas-exchange system that provides a large surface area for the uptake of oxygen from, and the release of carbon dioxide to, the environment. This function is performed by the lungs.
- A transport system that delivers oxygen to the tissues from the lungs and carbon dioxide to the lungs from the tissues. This function is carried out by the cardiovascular system.

Structure

The respiratory system can be neatly divided into upper respiratory tract (nasal and oral cavities, pharynx, larynx, and trachea) and lower respiratory tract (main bronchi and lungs) (Fig. 1.1).

Upper respiratory tract

The upper respiratory tract has a large surface area, a rich blood supply, and its epithelium (respiratory epithelium) is covered by a mucous secretion. Within the nose, hairs are present, which act as a filter. The function of the upper respiratory tract is to warm, moisten, and filter the air so that it is in a suitable condition for gaseous exchange in the distal part of the lower respiratory tract.

Lower respiratory tract

The lower respiratory tract consists of the lower part of the trachea, the two primary bronchi, and the lungs. These structures are contained within the thoracic cavity.

Lungs

The lungs are the organs of gas exchange and act as both a conduit for air flow (the airway) and a surface for movement of oxygen into the blood and carbon dioxide out of the blood (the alveola capillary membrane).

The lungs consist of airways, blood vessels, nerves, and lymphatics, supported by parenchymal tissue. Inside the lungs, the two main bronchi divide into smaller and smaller airways until the end respiratory unit (acinus) is reached (Fig. 1.2).

Acinus

The acinus is that part of the airway that is involved in gaseous exchange (i.e. the passage of oxygen from the lungs to the blood and carbon dioxide from the blood to the lungs). The structure of the acinus is considered in detail in Chapter 2.

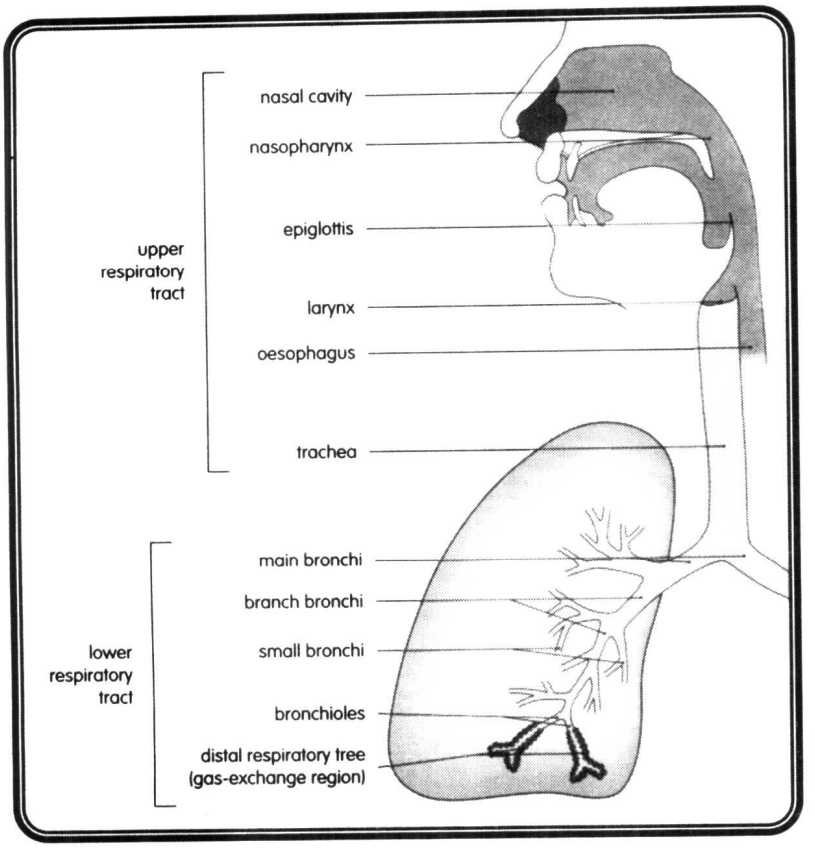

Fig. 1.1 A schematic diagram of the respiratory tract.

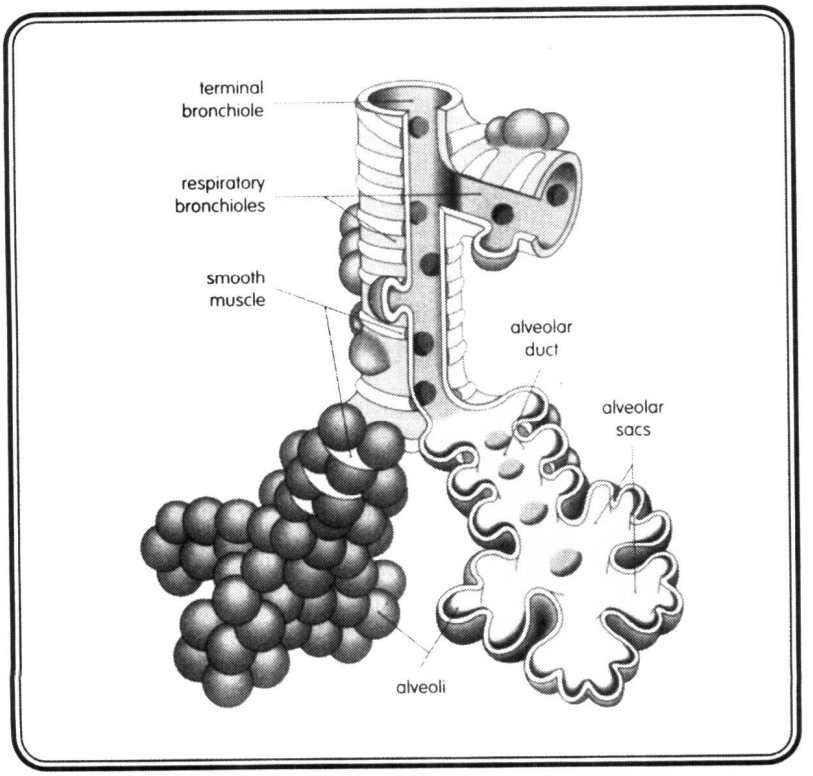

Fig. 1.2 The acinus, or respiratory unit. This part of the airway is involved in gas exchange.

Pleurae

The lung, chest wall, and mediastinum are covered by two continous layers of epithelium known as the pleurae. The inner pleura covering the lung is the visceral pleura and the outer pleura covering the chest wall and mediastinum is the parietal pleura. These two pleurae are closely opposed and are separated by only a thin layer of liquid. The liquid acts as a lubricant and allows the two surface to slip over each other during breathing.

THE DYNAMICS OF BREATHING

The aim of breathing is to increase air flow into the lungs so that gaseous exchange can occur between the alveoli and the blood.

Air flows from a high-pressure area to a low-pressure area. We cannot change the local atmospheric pressure around us to a level higher than that inside our lungs; the only obvious alternative is to lower the pressure within the lungs. We achieve this pressure reduction by expanding the size of the chest.

The main muscle of respiration is the diaphragm, upon which the two lungs sit. The diaphragm is dome shaped; contraction flattens the dome, increasing intrathoracic volume. This is aided by the external intercostal muscles, which raise the rib cage; this results in a lowered pressure within the thoracic cavity and hence the lungs, supplying the driving force for air flow into the lungs.

Expiration is largely a result of elastic recoil of the lung tissue. However, in forced expiration (e.g. during coughing), the abdominal muscles increase intra-abdominal pressure, forcing the contents of the abdomen against the diaphragm. In addition, the internal intercostal muscles lower the rib cage. These actions greatly increase intrathoracic pressure and enhance expiration.

CONTROL OF BREATHING

Respiration must respond to the metabolic demands of the body. This is achieved by a control system within the brainstem (the respiratory centres—see Chapter 5, pp 83) which receives information from various sources in the body where sensors monitor:

- Partial pressures of oxygen and carbon dioxide (PO_2 and PCO_2) in the blood.
- pH of the extracellular fluid within the brain.
- Mechanical changes in the chest wall

On the basis of information they receive, the respiratory centres modify ventilation to ensure that oxygen supply and carbon dioxide removal from the tissues matches their metabolic requirements. The actual mechanical change to ventilation is carried out by the respiratory muscles: these are known as the effectors of the control system.

Respiration can also be modified by higher centres (e.g. during speech, anxiety, emotion, etc.).

SUMMARY OF RESPIRATORY FUNCTIONS

The functions of the respiratory system can be summarized as air flow, gaseous exchange, transport of oxygen and carbon dioxide, control of breathing, acid–base regulation, body temperature regulation, metabolism, excretion, and hormonal activity.

Air flow

Air flow causes ventilation of the lungs.

Gaseous exchange

Gaseous exchange of oxygen and carbon dioxide occurs between the alveolar gas and pulmonary capillary blood.

Transport of oxygen and carbon dioxide

Oxygen and carbon dioxide are carried within the blood stream to the tissues.

Control of breathing

Breathing is controlled to match pertusion and ventilation with the body's biochemical and behavioural requirements.

Acid–base regulation

By controlling the partial pressure of carbon dioxide, pH may be altered (see Chapter 4).

Body temperature regulation

Body temperature is achieved mainly by insensible heat loss. Thus, by altering ventilation, body temperature may be regulated.

Metabolism

The lungs have a huge vascular supply and thus a large number of endothelial cells. Hormones such as noradrenaline, prostaglandins, and 5-hydroxytryptamine are taken up by these cells and destroyed. Some exogenous compounds are also taken up by the lungs and destroyed (e.g. amphetamine and imipramine).

Excretion

Carbon dioxide and some drugs (notably those administered through the lungs; e.g. general anaesthetics) are excreted by the lungs.

Hormonal activity

Hormones (e.g. steroids) act on the lungs. Insulin enhances glucose utilization and protein synthesis. Angiotensin II is formed in the lungs from angiotensin I (by angiotensin-converting enzyme). Damage to the lung tissue causes the release of prostacyclin PG I_2, which prevents platelet aggregation.

- **Why have humans developed a respiratory system?**
- **Describe how breathing is brought about.**
- **List the main functions of the respiratory system.**

2. Organization of the Respiratory System

UPPER RESPIRATORY TRACT

Macroscopic structure of the upper respiratory tract

Nasal cavities

The nose consists of an external part (the external nose) and an internal part (the nasal cavities). The nose is used for smelling and breathing. This book will be concerned only with the internal nose (Figs 2.1 and 2.2) and its function in breathing.

Blood and nerve supply, and lymphatic drainage

The nose is richly supplied with blood and nerve fibres. Lymphatic vessels drain into the submandibular node, then drain into deep cervical nodes.

Pharynx

The tube of the respiratory tract becomes common with the alimentary tract in the middle part of the pharynx. The pharynx lies anteriorly to the cervical vertebra and is described as being divided into three parts: the nasopharynx, oropharynx, and the laryngopharynx, which open anteriorly into the nose, the mouth, and the larynx, respectively (Fig. 2.3).

- Superiorly, the pharynx is attached to the base of the skull, but opens anteriorly into the nasal cavities at the choanae (posterior nares).
- Inferiorly, the pharynx is continuous with the oesophagus at the level of the cricoid cartilage. At this level, the pharynx also opens anteriorly into the larynx below the epiglottis, which covers the opening to the larynx during swallowing.

Important openings into the nasal cavity (from top to bottom) are:

- **In the sphenoethmoidal recess—opening of the sphenoid sinus.**
- **In the superior meatus openings of the posterior ethmoidal air sinuses.**
- **In the middle meatus openings (anteriorly to posteriorly) of the frontal nasal duct, maxillary sinus, and anterior and middle ethmoid air sinus through the hiatus semilunaris.**
- **In the inferior meatus—the nasolacrimal duct, draining the conjunctival sac.**

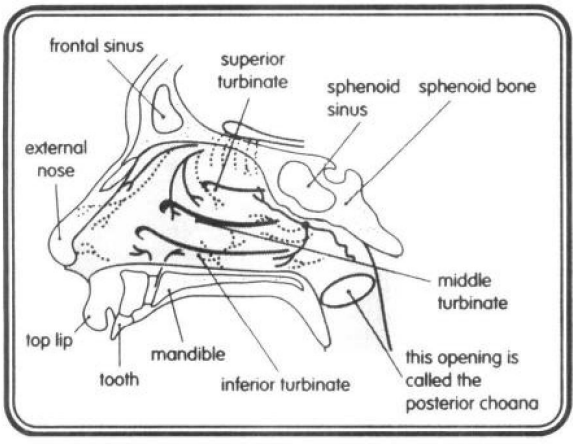

Fig. 2.1 Lateral view of the nasal cavity showing the rich blood and nerve supply

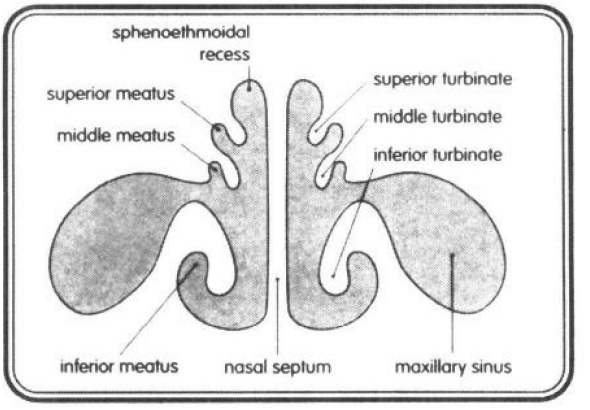

Fig. 2.2 Frontal view of the nasal cavity showing the superior, middle and inferior turbinates and the air spaces created by these: the superior, middle and inferior meatus.