

STEAMSHIPS

DURING the nineteenth century, large sailing ships almost completely disappeared as steam power took over. The first successful steam-powered vessel was a river steamer built in the USA by Robert Fulton in 1808. On early steamships the steam engine turned paddle wheels that moved the ship along, but by the 1850s most ships were using propellers instead. Ocean-going steamships kept sails, too, because they could not carry enough coal or water for long-distance voyages, and their engines were not very reliable.



Fifteen hundred people lost their lives when the liner *Titanic* (above) sank after hitting an iceberg on its maiden voyage in 1912. Following the disaster, new safety regulations for ships were introduced.

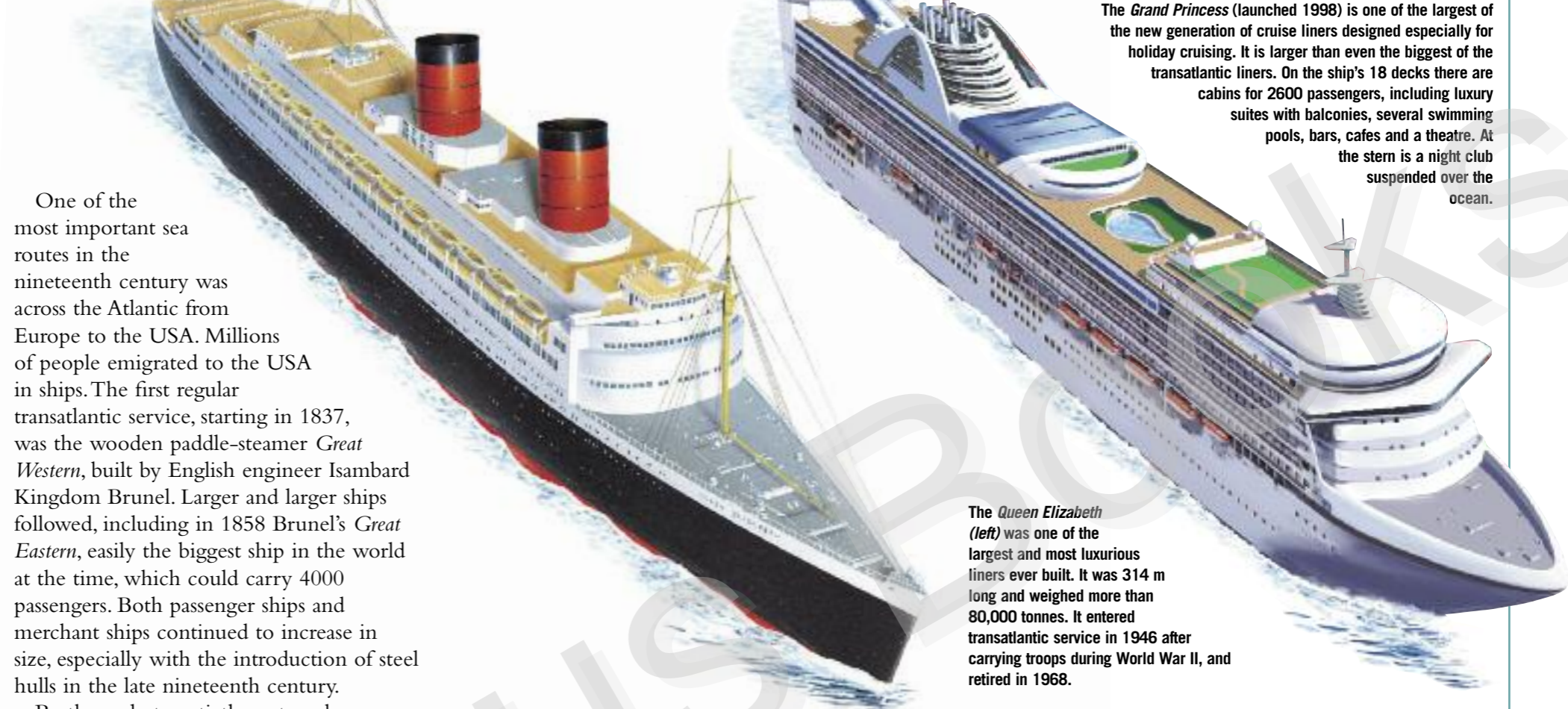
One of the most important sea routes in the nineteenth century was across the Atlantic from Europe to the USA. Millions of people emigrated to the USA in ships. The first regular transatlantic service, starting in 1837, was the wooden paddle-steamer *Great Western*, built by English engineer Isambard Kingdom Brunel. Larger and larger ships followed, including in 1858 Brunel's *Great Eastern*, easily the biggest ship in the world at the time, which could carry 4000 passengers. Both passenger ships and merchant ships continued to increase in size, especially with the introduction of steel hulls in the late nineteenth century.

By the early twentieth century, huge luxury liners were crossing the Atlantic, and steam-powered merchant ships were carrying most of the world's cargo. The fastest liners used the new steam turbine engine, in which the steam turned a fan-like turbine, which turned the propellers at high speed.

The largest modern oil tankers (1), up to 450 m long, and known as ultra-large crude carriers (ULCCs), dwarf a 16th-century Spanish galleon (2).

The French liner *Normandie* (3), launched in 1935, was nearly 300 m long, accommodated 1975 passengers and needed 1345 crew. It was the first of what were called the "1000-foot" liners.

HMS Dreadnought (4), launched in 1906, was the first battleship driven by steam turbines.

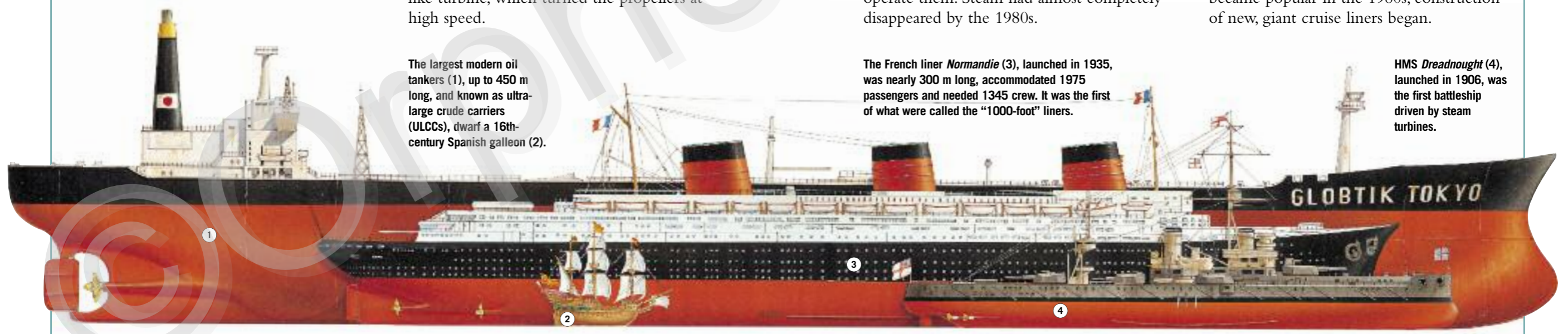


The *Grand Princess* (launched 1998) is one of the largest of the new generation of cruise liners designed especially for holiday cruising. It is larger than even the biggest of the transatlantic liners. On the ship's 18 decks there are cabins for 2600 passengers, including luxury suites with balconies, several swimming pools, bars, cafes and a theatre. At the stern is a night club suspended over the ocean.

The *Queen Elizabeth* (left) was one of the largest and most luxurious liners ever built. It was 314 m long and weighed more than 80,000 tonnes. It entered transatlantic service in 1946 after carrying troops during World War II, and retired in 1968.

In the middle of the twentieth century, steam power began to give way to diesel power. Diesel engines are smaller, cleaner, far more efficient, and need fewer crew to operate them. Steam had almost completely disappeared by the 1980s.

As air travel became convenient and cheap in the 1960s, passengers stopped travelling by sea and the age of the liner came to an end. But as cruise holidays became popular in the 1980s, construction of new, giant cruise liners began.



MICROSCOPES

A **MICROSCOPE** is an instrument that magnifies very small objects, allowing the viewer to see detail in the object that is invisible to the naked eye. Microscopes are used mostly, but not only, in biology and medical research.

There are two main types of microscope—optical microscopes and electron microscopes. In an optical microscope, the image of the object is created by light. The simplest optical microscope is a magnifying glass, which contains a single lens. The lens gathers and bends light coming from the object, making the object look larger than it really is. Compound microscopes have more than one lens. A standard compound microscope has two groups of lenses. The first group, called the objective, gathers light from the object and focuses it to create a magnified image of the object. The second group, called the eyepiece, magnifies this image.



French microbiologist Louis Pasteur (above) studies bacteria under a microscope.

The first compound microscope was probably built by Dutch spectacle-maker Zacharias Janssen in about 1590. Early microscopes had poor-quality lenses and gave blurred images. In the 1670s another Dutchman, Anton van Leeuwenhoek, began making simple, single-lens microscopes. He was the first person to see microorganisms, such as bacteria and amoebae.



KEY

- 1 Eyepiece lenses
- 2 Adjustment controls
- 3 Objective lenses
- 4 Multiple nosepiece
- 5 Specimen on slide
- 6 Stage
- 7 Condenser (focuses light beam)
- 8 Condenser control
- 9 Light beam
- 10 Mirror

A typical compound optical microscope with three interchangeable objective lenses, providing magnifications from about 50 times to about 200 times.

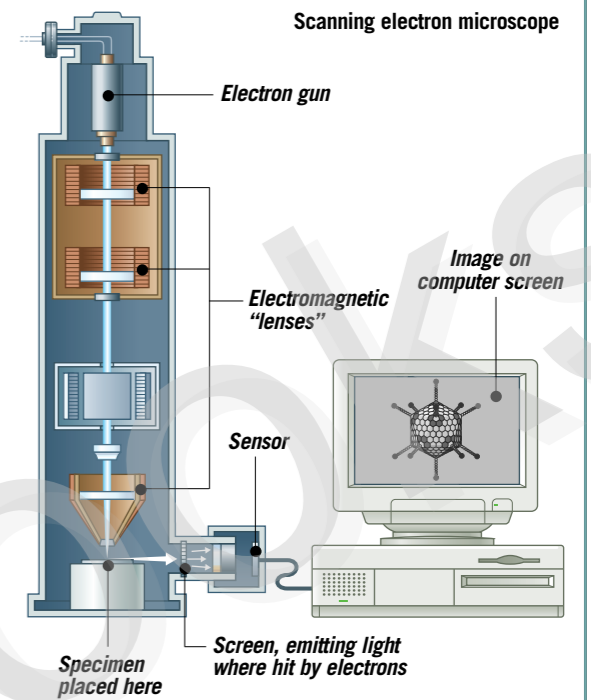
ELECTRON MICROSCOPES

Optical microscopes can only magnify objects up to 2000 times. Greater magnifications do not reveal any more detail. Electron microscopes can magnify objects more than a million times. In an electron microscope, a beam of tiny particles called electrons does the same job as light in an optical microscope. It is fired at the object and then focused by electromagnetic “lenses” on to a screen that emits light where the electrons hit it.



This SEM image of the head of a fruit fly, enlarged about 135 times, has been coloured so that its features can be seen clearly.

There are two main types of electron microscope. In a transmitting electron microscope (TEM), the beam of electrons is fired through an extremely thin slice of the specimen under investigation. In a scanning electron microscope (SEM), a very narrow beam of electrons is fired at the surface of the specimen. The beam scans across the surface of the specimen and a sensor detects the electrons bouncing off. In this way, a three-dimensional image of the specimen is gradually built up.



The images created by electron microscopes are called electron photomicrographs. An example of one is shown here (left). They may be viewed on television screens using video cameras, or digitized and viewed on computer screens.

The first electron microscope, which could magnify objects up to 400 times, was built in 1932 by German engineers Ernst Ruska and Max Knoll. The newest type of electron microscope is the scanning tunnelling electron microscope (STM). It can magnify up to 100 million times, which is enough to see individual atoms.



A microscopic animal called a water bear, magnified about 150 times with an scanning electron microscope.