EVOLUTION OF HORSE

The family Equidae provides about the most common record of evolution in animal series, leading to the existing horses, asses, Onagers and Zebra of the world. There are some sources of horse evolution. The efforts of Prof. Marsh of Yale University who collected fossil horses. The American Museum of Natural History under Osborn's direction has since assembled an immence amount of material which gives a very clear view of the evolution of the group.

The history of evolution of horse dates back to the begining of Eocene period of Coenozoic era and covers a period of about sixty million years.

The first known ancestors of horse were fox like animals living on moist ground and browsing soft leafy vegetation. With the change in climatic and physical conditions and the nature of food, various body changes leads to different evolutionary phases. Theses are —

(1) EOCENE:

The Eocene was a time of warm moist climate, during which N. America was clothed with luxuriant vegetation, forest in which grew both evergreen and deciduous tree as well as numerous streams and lakes, and grassy plains.

Several generic names have been applied to the Eocene horse

i) Eohippus: The dawn Horse which comes from the lower Eocene.

ii) Orohippus: The mountain horse, which comes from middle Eocene Bridger beds.

iii) Both are from Wyoming and New Mexico

(1) EOhippus:

Eohippus represents the first recorded stage in equine evolution characterised by —

(1) It was small and graceful creature, averaging

about 12 inches in hight. i.e. the size of a cat or fox with arched and flexible back.

ii) Short head and neck

iii) Limbs of moderate length

IV) The forelimbs had four complete toes with rudiment of the first digit as vestigeal structure.

V) The hind feet had three toes.

Vi) The skull was comparatively smaller.

Vii) The dentition was brachiodont and the teeth were covered by rounded knobs of enamel like those of the pig.

viii) They were omnivorous animals.

ix) The premolars were relatively simple.

② HYRACOTHERIUM:

It was contemporary of the eohippus and were found in the Europe. The premolar were more simpler than Eohippus. They were regarded as primitive than Eohippus. But hyracotherium is not direct line of evolution.

The Eohippus gave rise to the next genus in the middle Eocene that is called Orohippus.

③ OROHIPPUS:

It was also structurally similar to the eohippus except in the following points in which it was slightly advanced than the eohippus.

(i) The size was like that of dog.

(ii) The splints of the I[st] & 5[th] digit of the hind limbs have 4 and 3 functional digit as in the eohippus

iii) The crusts on the molar teeth were little.

iv) The last premolar has become a true molar and the next premolar is partially molary form.

(v) The orohippus lives in the open forests and gave rise to the epihippus in the late eocene

④ EPIHIPPUS :

The crest of the molar teeth are completely converted into cresents.

The second premolar is completely modified into molar. The fore and hindlimbs still had 4 and 3 digits but the central toes (3rd) in each foot is enlarged.

The epihippus gave rise in the oligocene to the next genus Mesohippus & Miohippus

⑤ MESOHIPPUS & MIOHIPPUS :

These oligocene horses were a little bit bigger than the eocene horses and measured about 18 to 24 inches in height. They had three functional digits in each foot. i.e. the 5th digit in the fore limb have reduced and is present as splint bone. The teeth are still branchiodont, but the 3 premolar have become converted into molar.

These oligocene horses lived on the soft vegetation in the forest.

The oligocene horses in the Miocene gave rise to two genus in two different lines —
a) Anchitherium and ⓑ Hypohippus.

Anchitherium descended from miohippus in the miocene which in the pliocene gave rise to hypohippus and which become extinct.

Thus these two genus are in the indirect line of evolution of the horses.

⑥ PARAHIPPUS :

Miohippus gave rise in the miocene to parahippus which is direct line of evolution of the horses. This genus represent the transitional stage between the forest dwellers ancestors and the plaindweller of the modern horses.

The parahippus have still low crown teeth. The teeth are more advanced. The middle (3rd) in each limb become more elongated. So that the side toes (2nd and 4th) donot touch ground. The 5th digit in the forelimb is still represented by a small nodule.

The parahippus gave rise in the middle miocene to the Merychippus.

7) MERYCHIPPUS:

The merychippus is more like the modern horse. They had high crowned teeth and a a large amount of cement filling the crest of the molar.

The middle toes become still elongated and the side toes no longer touches the ground.

They were much larger and measured about 40 inches in height.

The merychippus in the pliocene gave rise to descendants into the three different lines

a) PROTOHIPPUS: It arose in the early pliocene and which become extinct in the some period.

b) Hiparion: It arose in the middle pliocene which flourished up to the middle plestocene and then become extinct.

c) Pliohippus: It is in the direct line of the evolution of the horses. It arose in the lower pliocene and continued till the late pliocene and gave riseto the Equus - the modern horse.

The pliohippus measured about 40" in height. It had a long muzzle with elongated jaw.

There is a long diastema between the incisors and premolar. The molar and premolar were highly crowned like the modern horse.

The legs were more elongated and had only functional toes ie. the middle (3rd).

(**Hint.** For resolving power of TEM see Q.1.2.)

2. Scanning Electron Microscope (SEM)

The electron gun and lens system of SEM is like TEM but its operation is different.

The specimen to be examined is fixed and dried (by the technique of **critical point drying; Karp** 1996) and then coated with a layer of carbon and heavy metal such as gold or gold-palladium—a process called **shadowing.** This step makes specimen suitable as a target for an electron beam. SEM is used to examine the surface of specimen, *i.e.*, outer cell surface and various processes, extensions and extra–cellular materials. SEM provides a three-dimensional image of a specimen.

In SEM, an extremely fine beam of electrons (5 to 20 nm in diameter) is made at 3–30 kV for scanning a selected area of specimen. In SEM, the electron beam does not pass through the specimen. The condenser lens focusses a fine electron beam on the surface of the specimen. The beam is moved rapidly back and forth by **beam deflectors** to scan the specimen surface. As the electron beam hits the surface of specimen it excites the specimen

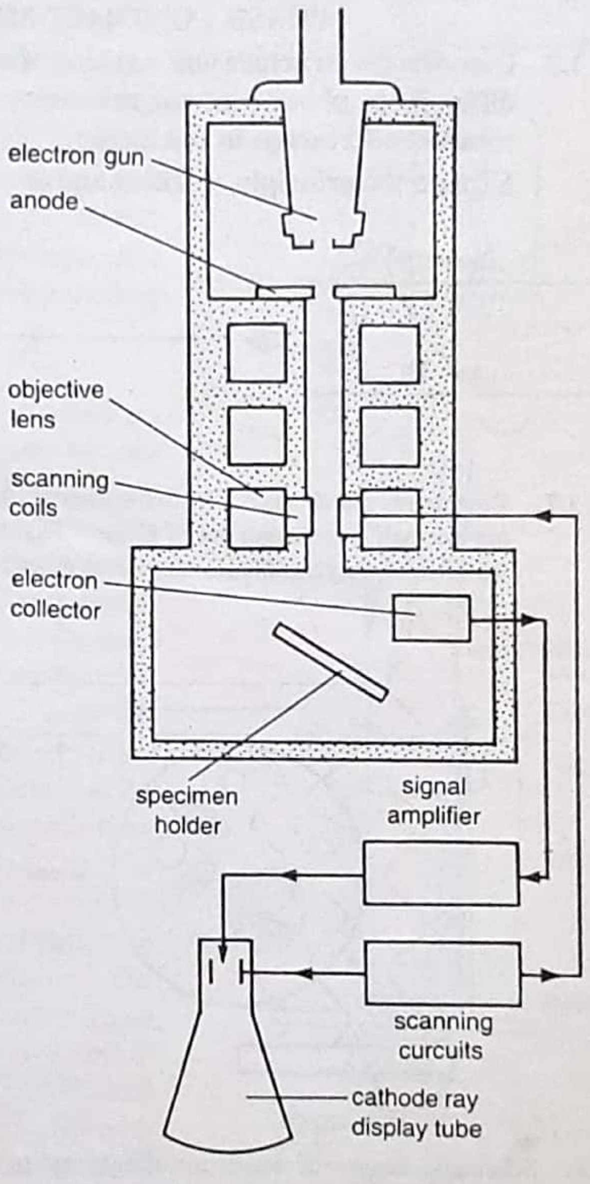

Fig. 1.6 A scanning electron microscope.

molecules to high energy levels. Due to the this, **secondary electrons** are emitted from the metallic surface. These secondary electrons are collected by the positively charged grid. The **collector** gives rise to a flash of light in a solid scintillator. The light output is amplified in a **photo-multiplier** or **video amplifier.** The signal from the grid is transferred to a television tube which scans and forms the image on the screen. Thus image formation in the SEM is indirect compared to that in the TEM.

The amount of secondary electrons produced depends on the angle of specimen points with the scanning beam. Surface perpendicular to the beam produces maximum electrons while surfaces at greater angles release less electrons. Thus, the number of electrons produced depends on the three-dimensional shape of the specimen surface (or surface topology, *i.e.*, the crevices, hills and pits of the specimen). Accordingly the image contains bright (which correspond the elevations or ridges in specimen surface) and darker regions (which correspond to the valleys). These shadows give the image a three-dimensional appearance.

The resolving power of SEM is comparatively less than that of transmission electron microscope. It has an effective magnification upto 20,000 times.