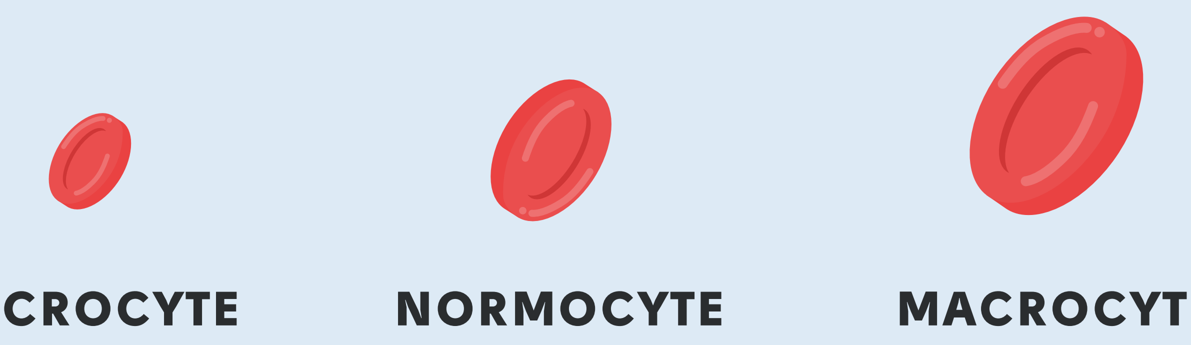
MICROCYTOSIS

TERM DEFINITION

Microcytosis refers to red blood cells (RBCs) that are smaller than normal.



<90 **MEAN CELL VOLUME (MCV) IN fL UNITS** >90

CAUSES

COMMON CAUSES

- Iron deficiency anemia (IDA)
- Thalassemia
- Anemia of inflammation

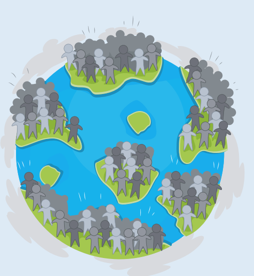
RARE CAUSES

- Hyperthyroidism
- Lead poisoning
- Sideroblastic anemia
- Fragmentation syndrome
- HbAC, CC
- HbSC
- HbAE, EE
- Iron-resistant iron deficiency anemia (IRIDA)

FACTOIDS

7-10%

of patients with microcytosis have unexplained causes



2.5-5%

prevalence of microcytosis in the general adult population

~10%

of cases of anemia of inflammation are microcytic

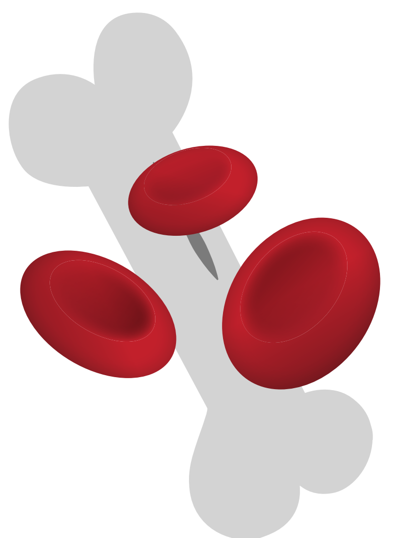
For a given MCV, RBC count is higher in thalassemia compared with iron deficiency anemia

MENTZER INDEX (MCV/RBC)

>13	<13
in favor of iron deficiency anemia	in favor of thalassemia trait

RBC volume

varies between different species. The smallest known RBC is found in the **mouse deer**, measuring just **10 fL** in volume.



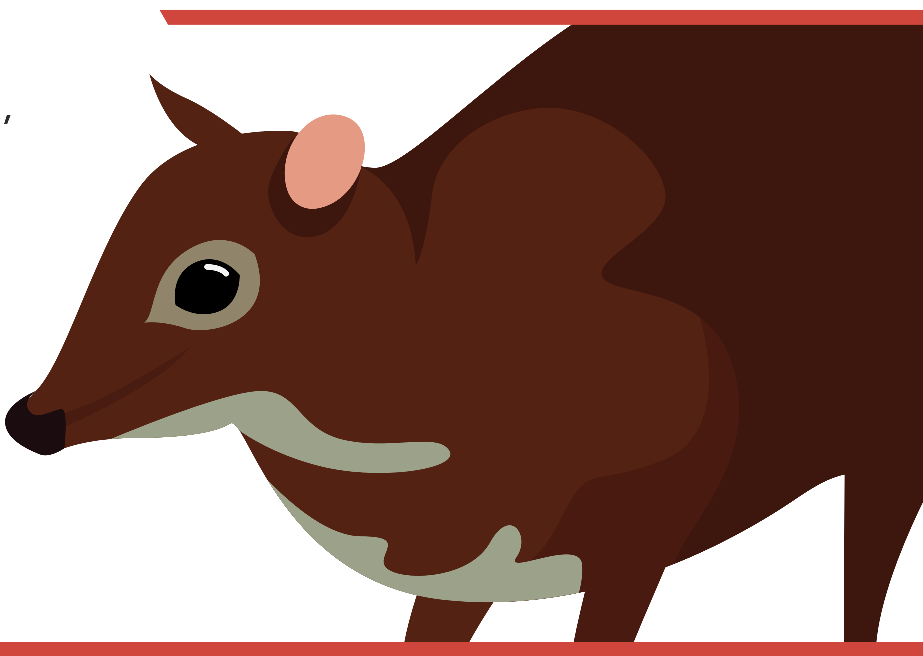
To compensate for the small size and achieve an optimal Hct, the bone marrow of the deer mouse produces vast numbers of red cells.

Hct = RBC count x MCV

50×10^{12}

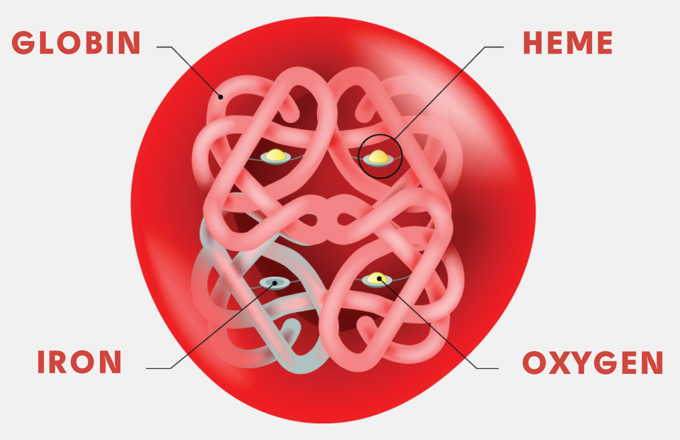
circulating cells/L

COMPARATIVE PHYSIOLOGY



PROXIMATE MECHANISMS

Most causes of microcytosis interfere with Hb synthesis at the level of **heme synthesis** or **globin production.**



Reduced Hb production

↓

Additional cell division of red cell precursor

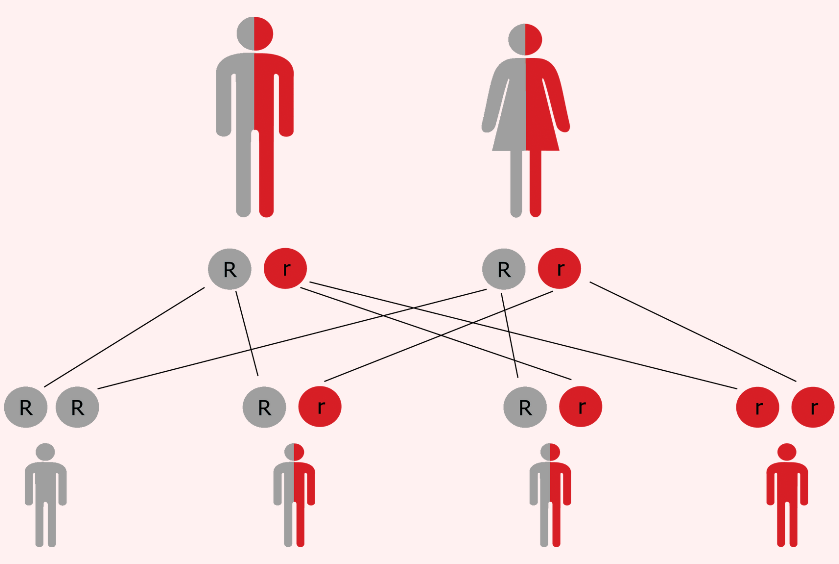
↓

Reduction in cell size

Iron deficiency anemia (IDA), but not **thalassemia**, is associated with impaired RBC production in the bone marrow. That is why patients with IDA tend to have low RBC counts and anemia, whereas those with thalassemia compensate for small cell size by increasing RBC production to maintain Hct, just like the mouse deer.

EVOLUTIONARY MECHANISMS

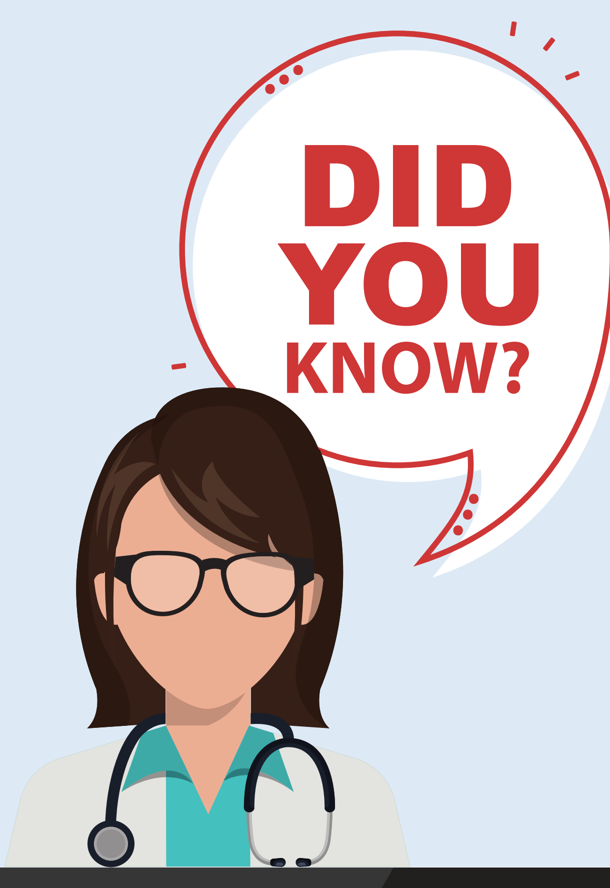
In **thalassemia**, inheritance of one gene *(thalassemia-minor)* was selected for thousands of years ago and is associated with protection against serious malaria infection.



Virtually all vertebrates have red cells.* Red cells are anucleate in mammals, and nucleated in other vertebrate classes. Red cell size does not correlate with body size of the species.

However, there is a trend towards reduced size during evolution, with the smallest red cells found in mammals. A potential advantage for reducing red cell size is to increase the surface area and reduce the path length for oxygen diffusion, thereby increasing the efficiency of oxygen loading and unloading.

** The one fascinating exception is the Antarctic ice fish, which has no circulating RBCs*



HISTORY OF MEDICINE

Patients with presumed anemia and small RBCs on peripheral smear were first noted in the mid-late 1800s. Typically, these patients were labeled with the diagnosis of chlorosis, and while they often received treatment with iron, they were not considered to have iron deficiency.

Beta thalassemia major was first described in the medical literature in 1925 by an American physician Thomas Cooley. Beta thalassemia major is also known as Cooley's anemia.

NOTES

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The Blood Project
ENCYCLOPEDIA OF BLOOD