Plasma carries carbon in solution

Plasma is the liquid component of blood. It is mostly water and carries dissolved substances between organs. Most transported carbon dioxide is carried in a chemically changed form: hydrogencarbonate.

1. TWO IMPORTANT FORMS IN PLASMA

HCO_3^-

HYDROGENCARBONATE

The main form. These soluble ions contain carbon originally released by respiring cells.

CO_2

DISSOLVED CARBON DIOXIDE

A smaller amount remains as carbon dioxide molecules dissolved in the plasma water.

Both are in solution; only one is unchanged dissolved CO_2.

2. NAME THE CHEMICAL FORM PRECISELY

Hydrogencarbonate is also called bicarbonate. It is not carbonic acid: HCO_3^- is an ion, whereas H_2CO_3 is carbonic acid. Saying only "carbon dioxide dissolves in plasma" misses the main form of transport.

3. DO NOT PUT HAEMOGLOBIN IN PLASMA

Some carbon dioxide binds to haemoglobin as carbaminohaemoglobin. In normal blood, haemoglobin is contained inside red cells, so this is not the main plasma route. Keep the transport medium, the chemical form and the binding protein distinct.

The diagrams compare forms, not measured proportions. Use "mainly hydrogencarbonate" and "a smaller amount dissolved as CO_2"; exact percentages vary with conditions and how transport is measured.

Transport forms and compartments: OpenStax Anatomy & Physiology 2e, section 22.5.
Whole-blood routes: Doyle & Cooper, Carbon Dioxide Transport, NCBI Bookshelf.

Scope: Cambridge Biology 9700 syllabus, section 8.2, outcome 3, p. 28.

Load plasma at respiring tissues

Carbon dioxide diffuses from cells through tissue fluid into blood. A small amount stays dissolved in plasma, while much of it enters red cells for rapid conversion.

1. RED CELLS PROCESS; PLASMA CARRIES

Tissue	Red cell	Plasma
CO_2	HCO_3^-	HCO_3^-
Source of carbon	Rapid formation	Carriage in solution

Follow the carbon from left to right. Boxes show locations or transport stages, not the shapes of cells, vessels or organs.

2. REACTION INSIDE RED CELLS

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

3. EXPORT IONS INTO PLASMA

Carbonic anhydrase catalyses the carbon dioxide / carbonic acid step. Haemoglobin buffers many of the hydrogen ions. Hydrogencarbonate then leaves the red cell in exchange for chloride, allowing the plasma water to carry it through the circulation.

Formation site is not the same as carriage site. Rapid production of hydrogencarbonate occurs mainly in red cells, but much of it is transported in plasma. The chloride shift connects these compartments; it does not turn chloride into a carbon-containing ion.

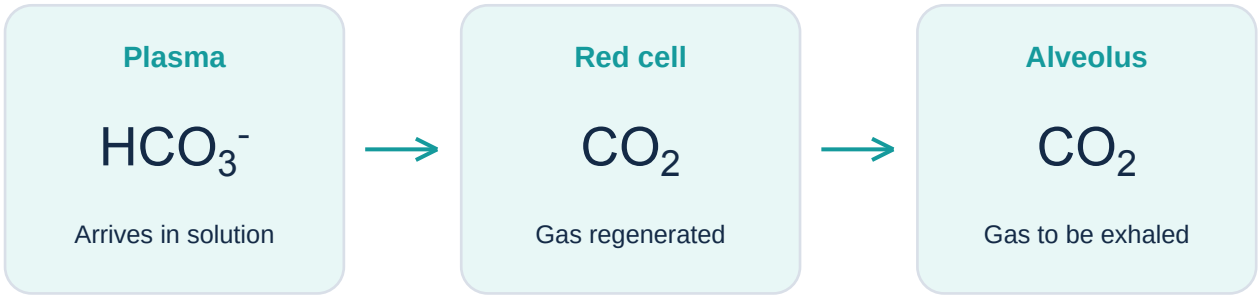
Tissue uptake and conversion: OpenStax Biology 2e, section 39.4.
Use of plasma transport capacity: Chloride-bicarbonate exchange in red blood cells (1983).

Scope: Cambridge Biology 9700 syllabus, section 8.2, outcome 3, p. 28.

Unload carbon dioxide at the lungs

Plasma delivers hydrogencarbonate to lung capillaries. To cross into alveolar air, its carbon must return to carbon dioxide molecules; hydrogencarbonate ions are not breathed out directly.

1. REGENERATE GAS BEFORE EXHALATION



Follow the carbon from left to right. Boxes show locations or transport stages, not the shapes of cells, vessels or organs.

2. REVERSE THE RED-CELL REACTIONS

Hydrogencarbonate returns to red cells as chloride leaves. It combines with hydrogen ions to form carbonic acid. Carbonic anhydrase catalyses conversion to CO_2 and water. CO_2 then diffuses through plasma and the respiratory barrier into the alveoli.

3. CONNECT SOLVENT, BLOOD FLOW AND DIFFUSION

Water keeps hydrogencarbonate ions and some CO_2 in solution. Heart-driven blood flow carries these substances over long distances. At tissues and lungs, CO_2 crosses exchange surfaces by diffusion down its partial-pressure gradient. Plasma is a medium, not a pump.

A complete description links form and route: carbon from respiring tissues is carried mainly as hydrogencarbonate in plasma, returned to red cells at the lungs, and released as CO_2. The smaller dissolved-CO_2 fraction can also diffuse into the alveoli.

Regeneration and exhalation: Doyle & Cooper, Carbon Dioxide Transport, NCBI Bookshelf.
Dissolved gas and lung exchange: OpenStax Anatomy & Physiology 2e, section 22.5.

Scope: Cambridge Biology 9700 syllabus, section 8.2, outcome 3, p. 28.