How iron is absorbed

This is my research notes for this section which I’ve left in incase they’re useful. References are at the end.

1.1. Dissolution in the stomach

(Zariwala 2013)
"During the digestion of food in the stomach, bound iron is liberated from its matrix via a combination of factors that include gastric acidity, enzymatic action, and the churning action of the stomach muscles established by the specialised oblique muscle layer, which is unique to the stomach [3]. The released iron is then available for absorption, which occurs predominantly in the duodenal segment of the small intestine [4]."

http://sickle.bwh.harvard.edu/iron_absorption.html
"At physiological pH, ferrous iron (Fe2+) is rapidly oxidized to the insoluble ferric (Fe3+) form. Gastric acid lowers the pH in the proximal duodenum, enhancing the solubility and uptake of ferric iron (Table 1). When gastric acid production is impaired (for instance by acid pump inhibitors such as the drug, prilosec), iron absorption is reduced substantially."

1.2. Inside the upper intestines (duodenum)

(Zariwala 2013)
"Most dietary non-haem iron is in the insoluble ferric form which is first reduced to ferrous iron by the ferric reductase DcytB (duodenal cytochrome b) located on the brush border surface of duodenal enterocytes [5]."

(Hurrell 1997)
"Fe is absorbed by an active, saturable process, primarily in the duodenum (Charlton and Bothwell, 1983), and is moved across the mucosal cell and serosal membrane into the blood where it is transported by transferrin to the cells or to the bone marrow for erythropoiesis."

(Lynch 1997)
"As previously discussed, the most important interaction between ascorbic acid and iron from the point of view of nutritional anemia is its effect on bioavailability. This appears to be a direct interaction between ascorbic acid and nonheme iron in the lumen of the upper small bowel, which is not related to the individual’s ascorbic acid status."

(Edison, Bajel, and Chandy 2008)
"Iron absorption occurs predominantly in the apical surface of the duodenum and upper jejunum. The two forms of dietary iron namely heme and non-heme iron are absorbed by the enterocyte non-competitively."

(Lönnerdal 2010)
"The comparatively low pH of the proximal duodenum in combination with the acidic microenvironment at the brush border membrane stabilizes iron in the divalent form and
provides protons essential for driving iron uptake across the apical membrane of the mucosa [3,6]."

1.3. The enterocyte cell

(Theil 2011)
Currently, the iron absorbed from the intestine can be divided into 3 categories: heme, nonheme small iron salts or complexes, and nonheme iron minerals (FTN). (FTN = Nonheme food ferritin)

"Iron from the absorbed exogenous FTN enters the cellular iron pool and the protein cage is degraded (10). Neither FeSO4 nor hemoglobin compete with absorption of ferritin iron in humans and iron from exogenous ferritin is transported across rat intestine ex vivo (E.C. Theil, H. Chen, M.T. Nunez, F. Pizarro, and K. Schumann, unpublished data). FTN iron or iron ions, found in many supplements and absorbed by DMT-1, are clearly 2 distinct chemical species of nutritional nonheme iron that are recognized and absorbed differently by the apical surface of the intestine."

(Edison, Bajel, and Chandy 2008)
"Once heme enters the cell, it is opened up by heme oxygenase to release Fe2+ and thereafter the fate of both heme and non-heme iron are the same."

"The non-heme iron mainly exists in the Fe3+ state. The ferric iron is reduced to ferrous iron before it is transported across the intestinal epithelium. This is accomplished by dietary components and duodenal cytochrome b reductase (Dcytb) which is highly expressed in the brush border of enterocytes (3)"

"The Fe2+ inside the cell can undergo two fates – either it can be stored as ferritin or transported across the basolateral surface into the blood stream. The mechanism by which Fe2+ reaches the basolateral membrane is poorly understood."

http://courses.washington.edu/conj/bess/iron/iron.htm
"For the most part, iron bound to ferritin in the enterocyte will remain there. This iron will be lost from the body when the enterocyte dies and is sloughed off from the tip of the villus."

1.4. Through IV
(Lyseng-Williamson and Keating 2009)
(Cançado and Muñoz 2011)
My summary of these
The dose bypasses the gastrointestinal tract, and goes straight into the blood. A small part of it is taken up directly by transferrin in the blood plasma, but most of it is taken up by white blood cells in the liver, spleen and bone marrow where the carbohydrate shell is broken down and the iron is released. The iron is then either stored as ferritin or transported by transferrin to where it’s needed. Some of the iron may get released into the serum which
can cause oxidative stress. Because the IV iron gets released straight into the blood, there is no effect from the usual iron inhibitors and enhancers.

1.5. iron in the body

(Edison, Bajel, and Chandy 2008)
"About 0.1% of total body iron is circulating bound to Tf. Nearly 80% of iron is utilized for hemoglobin synthesis in the bone marrow. Approximately 10–15% is present in muscle fibers (myoglobin) and in other tissues as enzymes and cytochromes (functional iron)."

(Nagababu et al. 2008)
"Approximately 75% of total body iron is associated with hemoglobin, which is responsible for oxygen transport."

(Gkouvatsos, Papanikolaou, and Pantopoulos 2012)
"The adult human body contains approximately 3–5 g of iron (about 55 mg and 44 mg per kilogram of body weight for males and females respectively), with more than two thirds (> 2 g) incorporated in the hemoglobin of developing erythroid precursors and mature red blood cells [9–11]. Most of the remaining body iron is found in a transit pool in reticuloendothelial macrophages (~600 mg) or stored in hepatoctyes (~1000 mg) within ferritin, an iron storage protein. A smaller fraction is present in muscles within myoglobin (~ 300 mg), while only a minuscule amount (~8 mg) is constituent of other cellular iron-containing proteins and enzymes."

"Of the approximately 30 mg of Tf-bound iron circulating every day, more than 80% is delivered to bone marrow erythroblasts [13]"
1.6. References used in this section


