

ALDH9A1, TTR, RLF, IPA1, and PFKFB1 (89). With the prognostic device in hand, the researchers then used it for testing liver samples from 234 other patients with HCC. The result was a success. The device predicted survival, and it predicted recurrence. The researchers concluded that their device can be used to identify patients in need of intensive follow-up after curative surgery.

### III. C-REACTIVE PROTEIN

The protein complex known as *C-reactive protein* (CRP) finds use as a biomarker for diseases having an immune component. While CRP is most associated with atherosclerosis, this chapter describes utility of CRP as a marker in oncology because oncology is the main focus of this textbook. The following summarizes several contexts where CRP has found utility as a biomarker.

- CRP is elevated in patients with chronic, pathological inflammation in the gut, as in Crohn's disease and ulcerative colitis. This inflammation increases the risk for colorectal cancer.
- Elevated CRP occurs in patients with various types of cancer, such as colorectal cancer, non-small cell lung cancer, prostate cancer, and breast cancer. CRP may or may not have prognostic value for these cancers.
- Where CRP levels in the bloodstream are slightly elevated (not markedly elevated) on a chronic basis, CRP serves as a prognostic factor for atherosclerosis.
- Acute changes in plasma CRP may reflect tissue damage resulting from a heart attack. Acute, markedly elevated levels of CRP occur during a heart attack, where the CRP may contribute to the mechanism of tissue damage.

#### a. Biology of C-reactive protein

CRP is a pattern recognition molecule that mediates innate immune response. Because of CRP's role in innate immune response, CRP has a function analogous to other pattern recognition molecules such as the toll-like receptors (TLRs) and NOD proteins (90,91). Specifically, CRP binds to phosphocholine (PC) as a component of microbial capsular polysaccharide and mediates the innate immune response against microorganisms (92). In other words, binding of CRP to the phosphocholine of bacteria promotes

<sup>89</sup> Further information on these genes can be found at a website of the United States government, <[www.ncbi.nlm.nih.gov/pubmed](http://www.ncbi.nlm.nih.gov/pubmed)>.

<sup>90</sup> Lee MS, Kim YJ. Pattern-recognition receptor signaling initiated from extracellular, membrane, and cytoplasmic space. *Mol Cells*. 2007;23:1–10.

<sup>91</sup> Hartvigsen K, Chou MY, Hansen LF, et al. The role of innate immunity in atherogenesis. *J Lipid Res*. 2009; 50(suppl):S388–S393.

<sup>92</sup> Chang MK, Binder CJ, Torzewski M, Witztum JL. C-reactive protein binds to both oxidized LDL and apoptotic cells through recognition of a common ligand: phosphorylcholine of oxidized phospholipids. *Proc Natl Acad Sci USA*. 2002;99:13043–13048.