resistance to carbapenems can be tested by the modified Hodge test (Amjad et al. 2011). This test, which uses a lawn of *Escherichia coli* on a Mueller–Hinton agar plate with an ertapenem or meropenem disk in the center, with the test bacterium and the positive and negative controls streaked from the disk to the outside, takes 16–24 hours to show resistance (Amjad et al. 2011). A modified double-disk synergy test for Gram-negative bacteria producing extended-spectrum β-lactamases, for resistance to penicillin and related antibiotics, uses four disks containing different cephalosporins and one disk containing amoxicillin with clavulanic acid (Kaur et al. 2013). A spectrophotometric method for carbapenemase activity in the *Enterobacteriaceae* requires growth of the cells for 18 hours, centrifugation, sonication, an additional centrifugation, and then measurement of imipenem hydrolysis by monitoring the absorbance at 297 nm (Bernabeu et al. 2012).

In addition to standard methods performed manually, commercial *automated culture systems* are used to detect antimicrobial resistance of bacteria (Pulido et al. 2013). They generally require pure cultures for reliable identification and detection of resistance, although some now allow the direct use of clinical samples in certain cases (Gherardi et al. 2012). Bacterial identification and an antimicrobial susceptibility test (AST) are usually performed together by inoculating the panels provided by the manufacturer with the pure culture. For a typical AST, a panel of reagent wells containing dried antimicrobial agents is inoculated with the bacterial culture and incubated in the instrument (Snyder et al. 2008). The instrument monitors the growth in the presence of each of several antimicrobial agents, using optical density, colorimetric methods, or fluorescent dyes, and compares it with the growth in control wells without antimicrobial agents. The time required for susceptibility results depends on the growth rate of the bacteria; for instance, it has been reported as 4–16 hours for pure cultures (Snyder et al. 2008) and as 6–13 hours for positive blood cultures (Gherardi et al. 2012). The results of automated susceptibility tests generally match the results obtained by conventional sensitivity tests, although confirmation of resistance by another method is recommended in some cases (Snyder et al. 2008).

## 21.3 Rapid Cultural Methods

Because of the importance of timely detection of antimicrobial resistance for successful treatment of bacterial infections, new methods are continually being developed to shorten the time required to detect antimicrobial susceptibility. The following are some of the proposed methods, which generally require pure bacterial cultures for testing and therefore already require several hours to allow growth.