Denitrification processes have been widely recognised as the key processes in biological nitrogen removal from wastewater. In this chapter, the traditional and emerging denitrification processes in wastewater treatment were reviewed in order to illuminate their stoichiometry, microbial community, kinetics, affecting factors, mathematical models and technological applications, including heterotrophic denitrification, anaerobic ammonia oxidation, denitrifying anaerobic methane oxidation, sulphur or hydrogen-based autotrophic denitrification and bioelectrochemical denitrification. Although existing technological denitrification processes still have limitations, their applications will undoubtedly increase in the near future because of increasing attention that is being paid to high-rate, cost-effective nitrogen removal from wastewater.