Phenols represent a group of organic pollutants frequently found in many near-shore marine systems. The microbial degradation of phenols, mainly by bacteria and fungi, has been extensively studied both experimentally and theoretically, but only relatively recently the capabilities of some algae for phenols biodegradation gained interest. The biodegradation of phenols by microalgae occurs only under aerobic conditions. In this paper, a dynamic energy budget model is proposed for describing aerobic biodegradation of phenolic compounds by microalgae and qualitatively validated against experimental data. A microalgal cell has the ability to produce biomass via the autotrophic assimilation (uptake of light and dissolved inorganic carbon), the heterotrophic assimilation (uptake of dissolved organic carbon) and, to a lesser extend, via the biodegradation of phenols. The rules of synthesizing units are used for the uptake and interactions of substrates and for the merging of assimilates. The model is capable of making predictions under oxygen and carbon (inorganic and organic) limiting conditions. Model predictions cover a wide range of experimental evidence, but also give a possible explanation for the inhibition of bioremoval of phenols in the presence of glucose. The dissolved oxygen profiles numerically observed show low oxygen concentration during the intermediate phase of the biodegradation process and a rapid increase after the consumption of the phenolic compound, indicating that lack of oxygen could be a limiting factor for the biodegradation of phenols. The presence of glucose increases the specific growth rate but decreases the specific biodegradation rate of the phenolic compound. Model analysis suggests that this inhibition may be due to the competition for oxygen between glucose and phenol assimilation. In general, the balance between the benefits and costs of the different types of assimilation determines the microalgal growth rates as well as the phenol biodegradation rates. Being based on general assumptions, the model can be applied to the biodegradation of a wide variety of aromatic compounds.