Abstract: We study connectivity in a model of a growing neuronal network in dimensions 2 and 3. Although the axon-to-dendrite proximity is an insufficient condition for establishing a functional synapse, it is still a necessary one. Therefore we study connection probabilities at short distances between the randomly grown axon trees and somas as probabilities of potential connections between the corresponding neurons. Our results show that, contrary to a common belief, these probabilities do not necessarily decay polynomially or exponentially in distance, but there are regimes of parameter values when the probability of proximity is not sensitive to the distance. In particular, in 3 dimensions the Euclidean distance between the neuronal cell body centers of neurons seems to play a very subtle role, as the probabilities of connections are practically constant within a certain finite range of distance. The model has a sufficient number of parameters to assess networks of neurons of different types. Our results give a firm basis for further modelling of the neuronal connectivity taking into account some realistic bouton distributions for establishing synaptic connections.