The reaction of a disinfectant with natural organic matter in the presence of bromides and iodides in raw water intended as a source of drinking water produces brominated (Br-DBPs) and iodinated disinfection by-products (I-DBPs) of water. These tend to be more cytotoxic and genotoxic than their chlorinated analogues. However, little information is available on these products compared to chlorinated ones. Therefore, the aim of this work was to provide an overview of natural and anthropogenic sources of bromine and iodine containing substances, to determine their influence on the formation of brominated and iodinated disinfection by-products, and to compare their cytotoxicity and genotoxicity with chlorinated products. Increasing seawater intrusion into the groundwater drinking water source was found to increase the concentrations of Br-DBPs and I-DBPs by up to thousands of percent. A number of substances can be released from water pipe material depending on the material. These include, for example, tenorite and copper cation released from copper piping, iron cation released from cast iron and steel piping, and bromides and dissolved organic carbon (DOC) released from plastic piping. All of these corrosion products contribute to increasing concentrations of DBPs in the distribution network. Both seawater and water pipes directly affect drinking water. However, there are a number of anthropogenic sources of bromine- and iodine- containing substances that can enter raw water for treatment into drinking water. These anthropogenic precursors then react with natural organic matter and disinfectant to form Br-DBPs and I-DBPs. The following anthropogenic sources were chosen for a more detailed look: produced water from oil and gas extraction, microplastics, brominated flame retardants, iodinated contrast media, iodine disinfectants from dairy industry, and iodine-based water disinfectants. The last part of the paper is devoted to the comparison of brominated, chlorinated and iodinated DBPs within the six groups in terms of cytotoxicity and genotoxicity. The groups compared included trihalomethanes (THMs), haloacetic acids (HAAs), haloacetamides (HAMs), haloacetaldehydes (HALs), haloacetonitriles (HANs) and halonitromethane (HNMs). At the same time, these groups were compared with each other. The order of cytotoxicity was: HAMs > HALs > HNMs > HAAs > HANs > THMs. The order of genotoxicity was then: HAAs > HNMs ≈ HANs ≈ HAMs > HALs. Within THMs, only CDIM shows genotoxicity, so this group was not included in the genotoxicity ranking. In general, the following order of toxicity of Br-DBPs, I-DBPs and chlorinated DBPs (Cl-DBPs) can be determined: I-DBPs > Br-DBPs > Cl-DBPs. Studies on the issue of brominated and iodinated disinfection by-products are currently not that numerous. There are even fewer studies on anthropogenic factors that deserve more attention. Some of them are therefore discussed in more detail in this paper.