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Nucleotides are ubiquitous molecules present in all organisms and fulfilling numerous functions. They are building blocks for the genetic metrial (DNA and RNA) and biomolecules mediating gene expression (e.g. ribozymes). Nucleotides are also an energy source in the cell (usually ATP), and regulators for many processes. Insufficient content or excess of particular nucleotides can be either the cause or a symptom of several diseases. These diseases may result from too low or too high activity of nucleotide-related proteins. Rationally designed modified nucleotides can be useful in understanding of these abnormalities, their diagnostics, and development of novel therapeutic interventions. Appropriately designed (known as ‘labelled’) nucleotides may be used for monitoring of biological processes linked to nucleotides both in vitro and in vivo and to searching of compounds influencing those proceses in a desired ways (screening assays for new drugs). This project is aimed at the synthesis and determining properties of new analogs of selected adenine nucleotides: ATP, PAPS and NAD, which could be useful to study enzymes from kinase, sulfotransferase or pyrophosphatase families. The obtained compounds will be characterized in several biological assays. Compounds with most promising properties may find application in biochemical assays, diagnostics and in the search for new inhibitors with therapeutic potential.