

## Ribosome-Inactivating Proteins

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Fiorenzo Stirpe

### INTRODUCTION

The designation of *ribosome-inactivating proteins* (RIPs; reviews in refs. 1–4) has been applied to plant proteins that enzymatically damage ribosomes in a catalytic manner, thus inhibiting protein synthesis (Table 1). The first identified RIPs were two potent toxins, known for more than a century: ricin, from the seeds of *Ricinus communis*, and abrin, from the seeds of *Abrus precatorius*.

Subsequently, many more RIPs were identified; they can be divided into type 1 RIPs, single-chain proteins of approx 30 kDa, and type 2 RIPs, consisting of two peptide chains, an A chain of about 30 kDa with enzymatic activity, linked to a B chain of about 35 kDa with lectin activity, capable of binding to oligosaccharides containing galactose. A category of type 3 RIPs has been proposed for a maize b-32 RIP, which is synthesized as a proenzyme and is activated after the removal of a short internal peptide segment leaves two segments of 16.5 and 8.5 kDa (5), and for JIP60, an RIP from barley in which a segment similar to type 1 RIP is combined with another segment of similar size but no known function (6). It seems unjustified to define a new class of proteins on the basis of two disparate cases, and for the time being, it seems preferable to consider these two proteins as peculiar type 1 RIPs. A schematic representation of RIP structure is shown in Fig. 1.

Type 2 RIPs can bind to galactose residues on cell membranes, thus agglutinating the cells. Furthermore, this binding leads to entry of the molecule into the cells. Ricin, which contains mannose, also is taken up by Kupffer cells and other macrophages via mannose receptors (7–9). The entry into cells and the intracellular fate of type 2 RIPs and of ricin A chain has been well studied. It has been found that they are transported to the Golgi

**Table 1**  
**Purified Ribosome-Inactivating Proteins**

Family, genus, species, and plant tissues	Name
<b>Type 1 ribosome-inactivating proteins</b>	
Angiospermae	
Aizoaceae	
<i>Mesembryanthemum crystallinum</i>	
cDNA	
Amarantaceae	
<i>Amaranthus viridis</i>	
Leaves	Amaranthin
Asparagaceae	
<i>Asparagus officinalis</i>	
Seeds	Asparins
Basellaceae	
<i>Basella rubra</i>	
Seeds	
Caprifoliaceae	
<i>Sambucus ebulus</i>	
Leaves	Ebulitins
<i>Sambucus nigra</i>	
Bark	Nigritin
Caryophyllaceae	
<i>Agrostemma githago</i>	
Seeds	Agrostins
<i>Dianthus barbatus</i>	
Leaves	Dianthin 29
<i>Dianthus caryophyllus</i>	
Leaves	Dianthins
<i>Dianthus sinensis</i>	
Leaves	
<i>Gypsophila elegans</i>	
Leaves	Gypsophilin
<i>Lychnis chalcedonica</i>	
Seeds	Lychnin
<i>Petrocoptis glaucifolia</i>	
Whole plant	Petroglaucin
<i>Petrocoptis grandiflora</i>	
Whole plant	Petrograndin
<i>Saponaria ocymoides</i>	
Seeds	Ocymoidin

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