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$GABA_A$ receptors in GtoPdb v.2021.3

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Abstract

The $GABA_A$ receptor is a ligand-gated ion channel of the Cys-loop family that includes the nicotinic acetylcholine, 5-HT_3 and strychnine-sensitive glycine receptors. $GABA_A$ receptor-mediated inhibition within the CNS occurs by fast synaptic transmission, sustained tonic inhibition and temporally intermediate events that have been termed '$GABA_A$, slow' [45]. $GABA_A$ receptors exist as pentamers of 4TM subunits that form an intrinsic anion selective channel. Sequences of six α, three β, three γ, one δ, three ρ, one ε, one π and one θ $GABA_A$ receptor subunits have been reported in mammals [278, 235, 236, 283]. The π-subunit is restricted to reproductive tissue. Alternatively spliced versions of many subunits exist (e.g. α4- and α6- (both not functional) α5-, β2-, β3- and γ2), along with RNA editing of the α3 subunit [71]. The three ρ-subunits, (ρ1-3) function as either homo- or hetero-oligomeric assemblies [359, 50]. Receptors formed from ρ-subunits, because of their distinctive pharmacology that includes insensitivity to bicuculline, benzodiazepines and barbiturates, have sometimes been termed $GABA_C$ receptors [359], **but they are classified as $GABA_A$ receptors by NC-IUPHAR on the basis of structural and functional criteria [16, 235, 236]**.

Many $GABA_A$ receptor subtypes contain α-, β- and γ-subunits with the likely stoichiometry 2α.2β.1γ [168, 235]. It is thought that the majority of $GABA_A$ receptors harbour a single type of α- and β -subunit variant. The α1β2γ2 hetero-oligomer constitutes the largest population of $GABA_A$ receptors in the CNS, followed by the α2β3γ2 and α3β3γ2 isoforms. Receptors that incorporate the α4- α5-or α6-subunit, or the β1-, γ1-, γ3-, δ-, ε- and θ-subunits, are less numerous, but they may nonetheless serve important functions. For example, extrasynaptically located receptors that contain α6- and δ-subunits in cerebellar granule cells, or an α4- and δ-subunit in dentate gyrus granule cells and thalamic neurones, mediate a tonic current that is important for neuronal excitability in response to ambient concentrations of GABA [209, 272, 83, 19, 288]. GABA binding occurs at the β+/α- subunit interface and the homologous γ+/α- subunits interface creates the benzodiazepine site. A second site for benzodiazepine binding has recently been postulated to occur at the α+/β- interface ([254]; reviewed by [282]). The particular α-and γ-subunit isoforms exhibit marked effects on recognition and/or efficacy at the benzodiazepine site. Thus, receptors incorporating either α4- or α6-subunits are not recognised by ‘classical’ benzodiazepines, such as flunitrazepam (but see [356]). The trafficking, cell surface expression, internalisation and function of $GABA_A$ receptors and their subunits are discussed in detail in several recent reviews [52, 140, 188, 316] but one point worthy of note is that receptors incorporating the γ2 subunit (except when associated with α5) cluster at the postsynaptic membrane (but may distribute dynamically between synaptic and extrasynaptic locations), whereas as those incorporating the δ subunit appear to be exclusively extrasynaptic.

NC-IUPHAR [16, 235, 3, 2] class the $GABA_A$ receptors according to their subunit structure, pharmacology and receptor function. Currently, eleven native $GABA_A$ receptors are classed as conclusively identified (*i.e.*, α1β2γ2, α1βγ2, α3βγ2, α4βγ2, α4β2δ, α4β3δ, α5βγ2, α6βγ2, α6β2δ, α6β3δ and ρ) with further receptor isoforms occurring with high probability, or only tentatively [235, 236]. It is beyond the scope of this Guide to discuss the pharmacology of individual $GABA_A$ receptor isoforms in detail; such information can be gleaned in the reviews [16, 95, 168, 173, 143, 278, 216,

235, 236] and [9, 10]. Agents that discriminate between α-subunit isoforms are noted in the table and additional agents that demonstrate selectivity between receptor isoforms, for example *via* β-subunit selectivity, are indicated in the text below. The distinctive agonist and antagonist pharmacology of ρ receptors is summarised in the table and additional aspects are reviewed in [359, 50, 145, 223].

Several high-resolution cryo-electron microscopy structures have been described in which the full-length human α1β3γ2L $GABA_A$ receptor in lipid nanodiscs is bound to the channel-blocker picrotoxin, the competitive antagonist bicuculline, the agonist GABA (γ-aminobutyric acid), and the classical benzodiazepines alprazolam and diazepam [198].

Contents

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GABA$_A$ receptor ρ3 subunit

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