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(54) **Titre : DETECTION ET UTILISATION DE MODULATEURS A FAIBLE POIDS MOLECULAIRE DU RECEPTEUR AU FROID ET AU MENTHOL TRPM8**

(54) **Title: DETECTION AND USE OF LOW MOLECULAR-WEIGHT MODULATORS OF THE COLD-MENTHOL RECEPTOR TRPM8**

(57) **Abrégé/Abstract:**

The invention relates to novel modulators of the cold-menthol receptor TRPM8, to a method for modulating the TRPM8 receptor using said modulators; to the use of the modulators for induction of cold sensation; and to the objects and means produced using said modulators.

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(72) **Inventeurs(suite)/Inventors(continued):** WITTENBERG, JENS, DE; KROHN, MICHAEL, DE; ZINKE, HOLGER, DE

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ABSTRACT

The invention relates to novel modulators of the cold-menthol receptor TRPM8, to a method for modulating the TRPM8 receptor using said modulators; to the use of the modulators for induction of cold sensation; and to the objects and means produced using said modulators.

Detection and use of low molecular-weight modulators of the cold-menthol receptor TRPM8.

5 The invention relates to new types of modulators of the cold menthol receptor TRPM8, methods for modulating the TRPM8 receptor using these modulators; the use of the modulators for inducing a sensation of coldness; and also the articles and compositions produced using these modulators.

Background of the invention

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The cold menthol receptor TRPM8 (also referred to as Cold Membrane Receptor (CMR)¹) belongs to the family of the "Transient Receptor Potential Ion Channels", is specifically expressed in a special group of neurons and, in the cell membrane, forms pores (in each case 4 units combine to give a tetramer), which selectively allow Ca²⁺ ions to pass. The protein has 6 transmembrane domains and a cytoplasmatic C and N terminus. Low temperatures (preferably 10-25°C) stimulate this receptor, resulting in a signal transduction which is interpreted by the nervous system as a sensation of coldness. The receptor was described for the first time in 2002 as cold receptor in a number of publications (Peier AM et al, .A TRP channel that senses cold stimuli and menthol.Cell. 2002 Mar 8;108(5):705-15; McKemy DD et al. Identification of a cold receptor reveals a general role for TRP channels in thermosensation. Nature. 2002 Mar 7; 416 (6876): 52-8; Zuker CS. Neurobiology: a cool ion channel. Nature. 2002 Mar 7; 416 (6876): 27-8).

25 Cooling compounds, such as e.g. menthol, have for a long time played an important role in the flavorings and fragrance industry in order to produce an association with freshness and cleanliness. For the compound menthol, it has been shown that it acts as a natural modulator of the receptor TRPM8 (McKemy D.D., *Molecular Pain* 1, 2005, 16; McKemy D.D., *Nature* 416, 2002, 52-58; Peier A.M., *Cell* 108, 2002, 705-715; Dhaka A., *Annu. Rev. Neurosci.* 29, 2006, 135-161). By applying menthol, TRPM8 is activated, which brings about a Ca²⁺ influx into the cold-sensitive neurons. The electrical signal produced as a result is ultimately perceived as a sensation of coldness. Elevated menthol concentrations lead to irritation and an anesthetic effect. Moreover, various publications have described menthol derivatives with a similar effect (British Patent 1971#1315761; Watson H.R., *J. Soc. Cosmet. Chem.* 29, 1978, 185-200; Furrer S.M., *Chem. Percept.* 1, 2008, 119-126). There are also individual compounds, structurally unrelated to menthol, which bring about a significant TRPM8 modulation,

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such as e.g. Icilin (Wei E.T., *J. Pharm. Pharmacol.* 35, 1983, 110-112; WO 2004/026840), WS-23 or compounds listed in the patent application WO 2007/019719.

Further effects of substances which modulate the TRPM8 receptor and/or its insect analogs are a repellent effect on insects (WO 2002/015692; WO 2004/000023, US 2004/0028714), and also activity in antitumor therapy (e.g. an influencing of prostate tumors), activity in the treatment of inflammatory pain / hyperalgesia and an effect as TRPM8 antagonists in the treatment of bladder syndrome or overactive bladder (Beck B. *Cell Calcium*, 41, 2007, 285-294; Levine J.D. *Biochim. Biophys. Acta, Mol. Basis Dis.* 1772, 2007, 989-1003; Mukerji G., *BMC Urology* 6, 2006, 6; US 2003/0207904; US 2005/6893626, Dissertation Behrendt H.J. 2004, Universität Bochum; Lashinger E.S.R. *Am. J. Physiol. Renal Physiol.* Am J Physiol Renal Physiol. 2008 Jun 18. [Epub ahead of print]; PMID: 18562636).

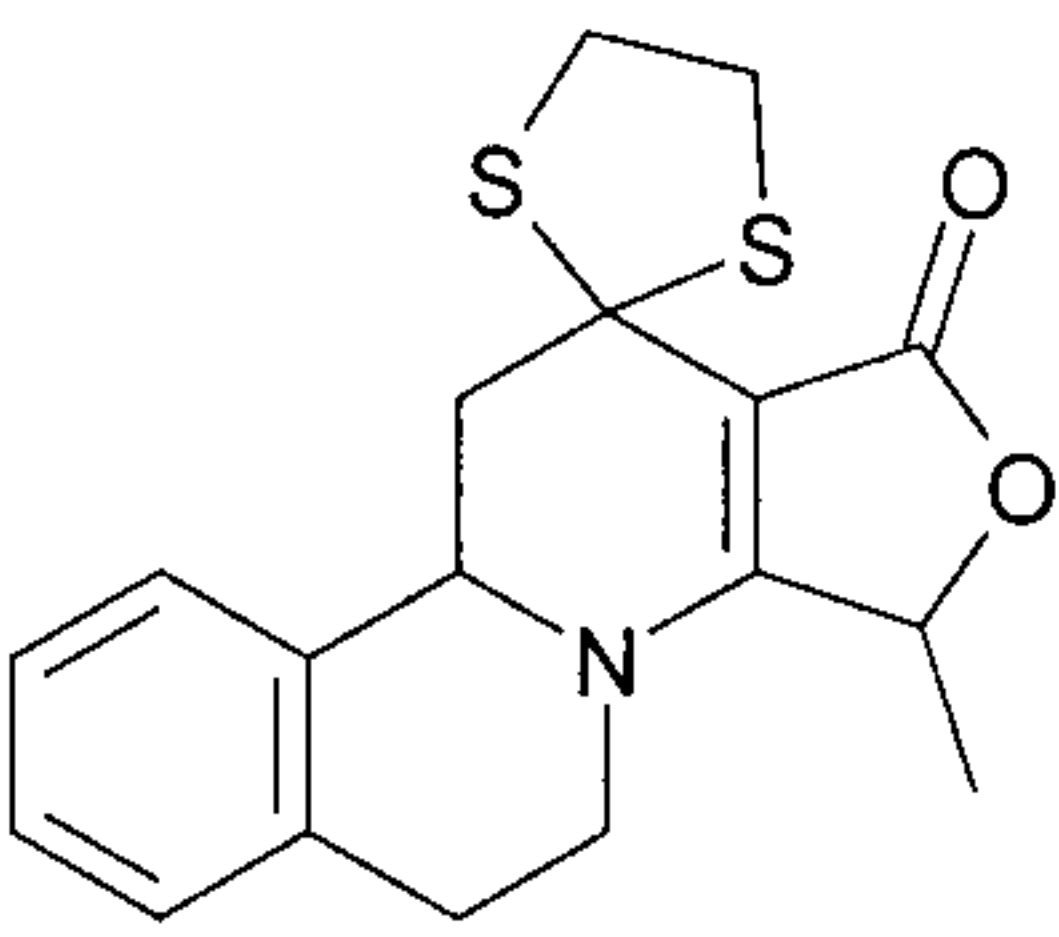
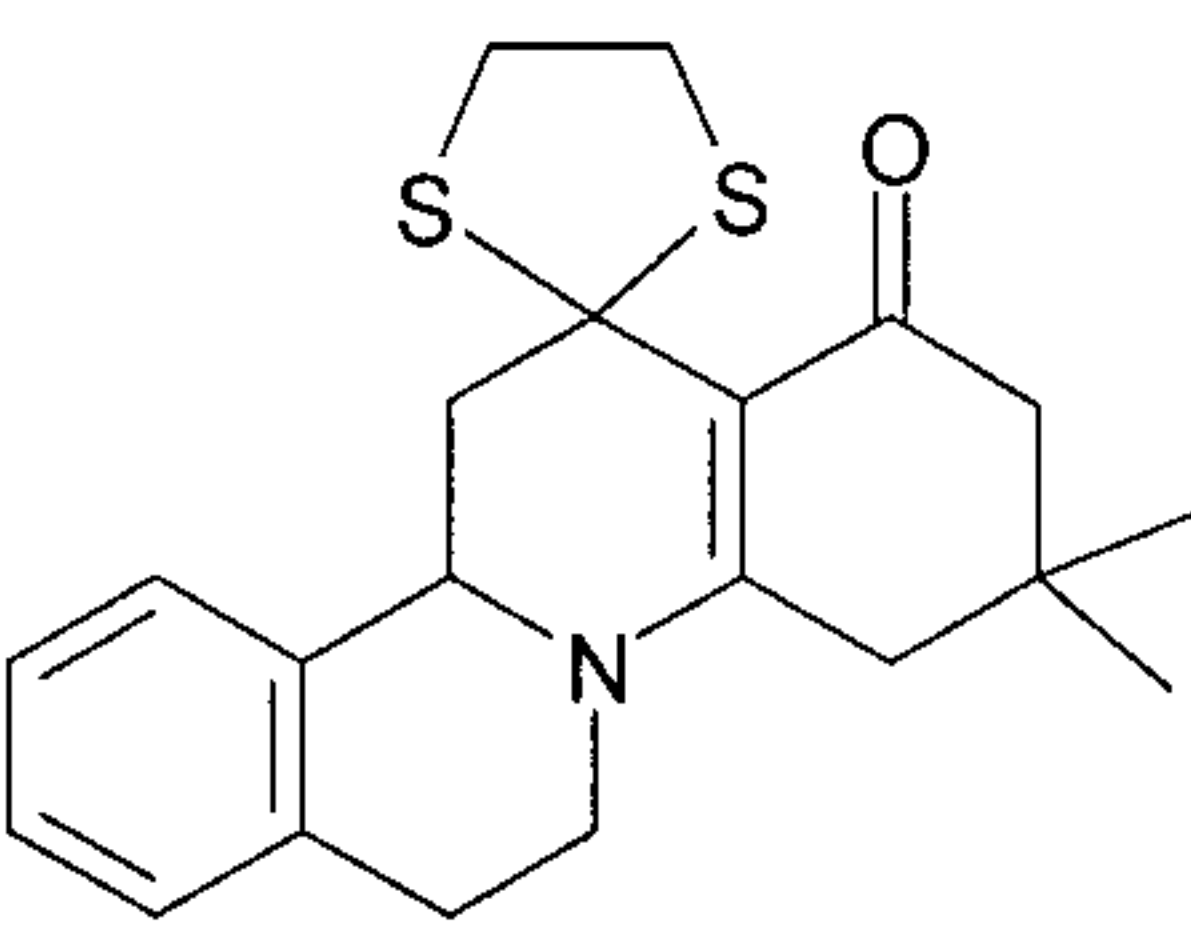
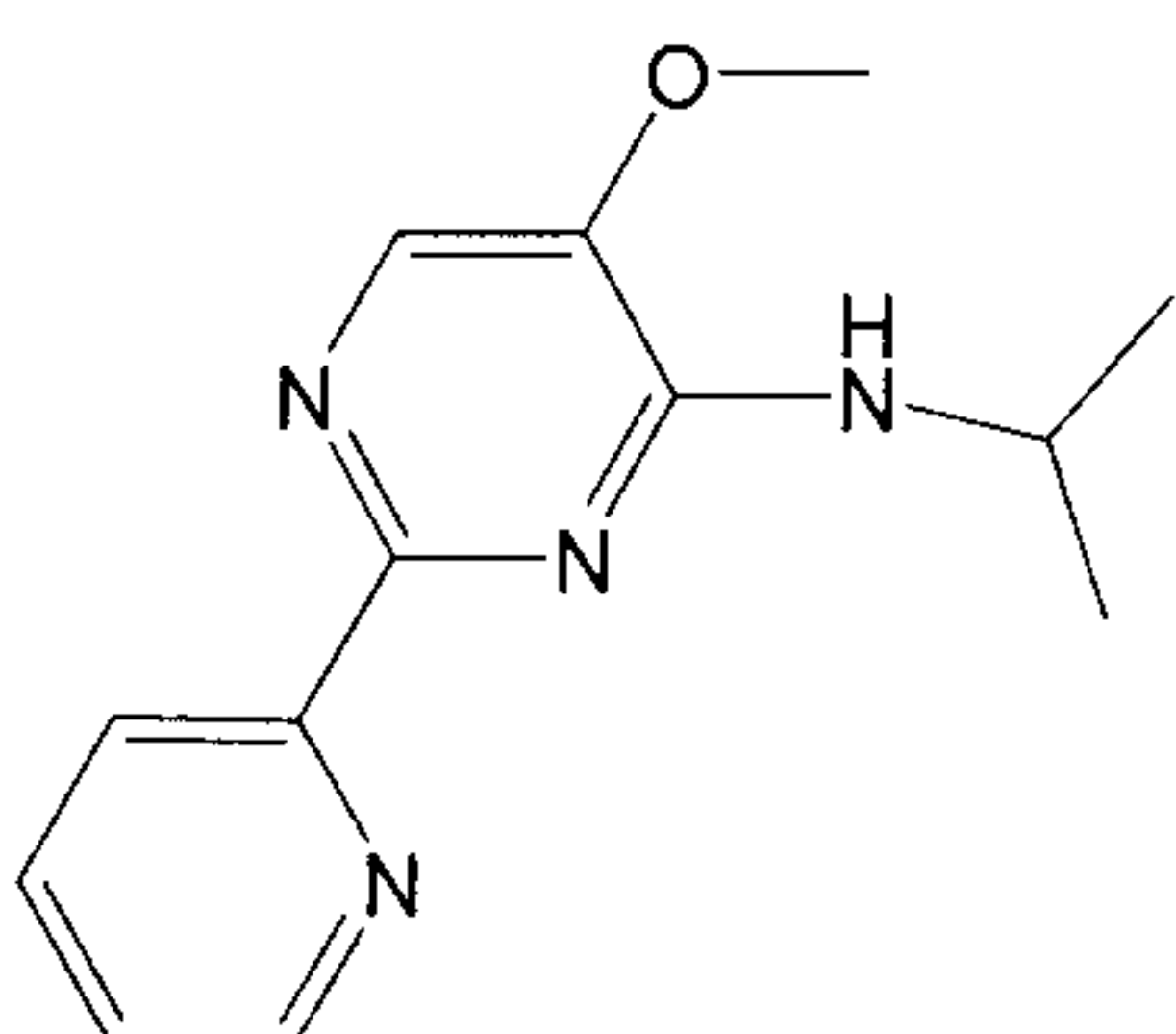
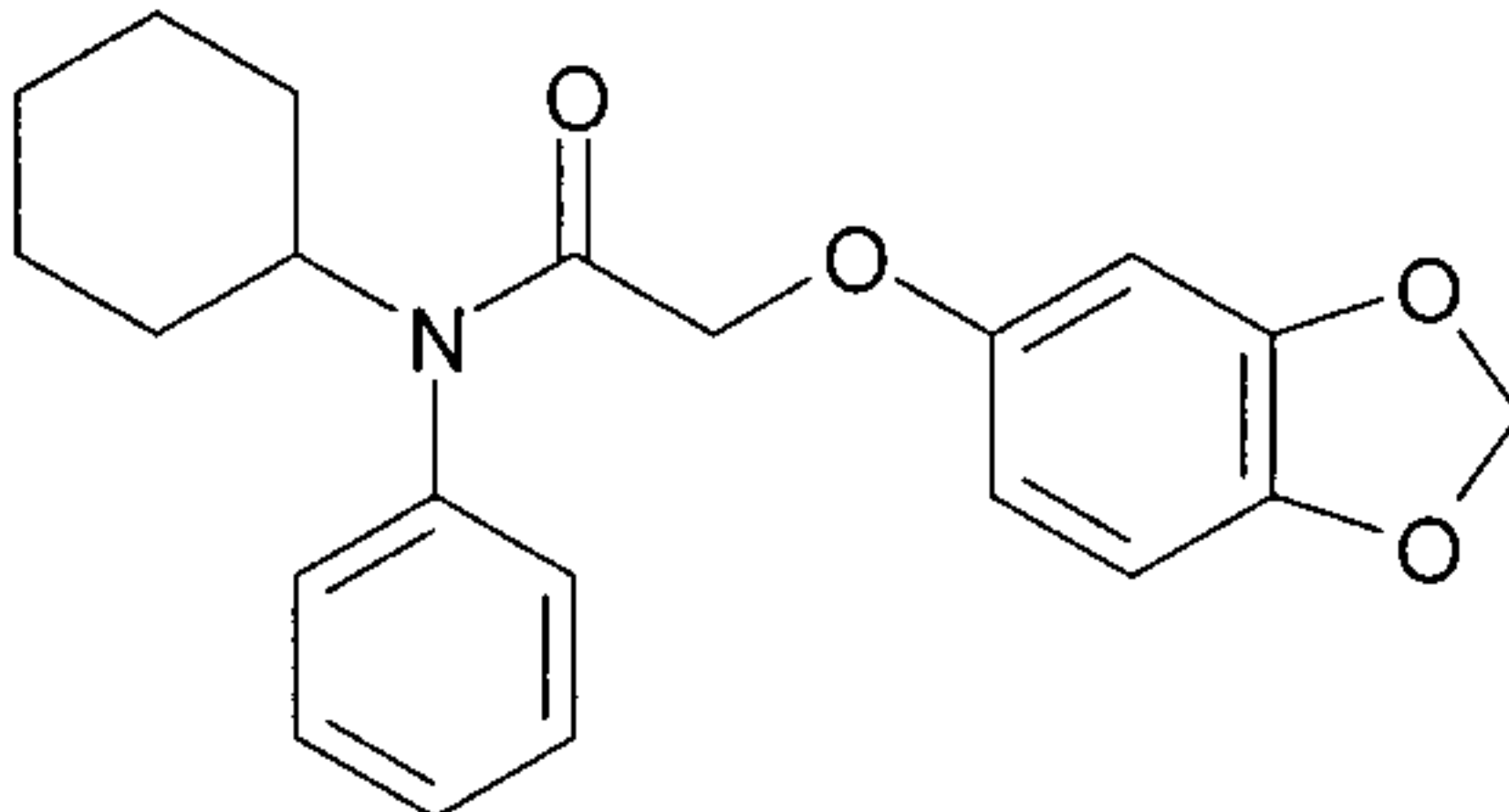
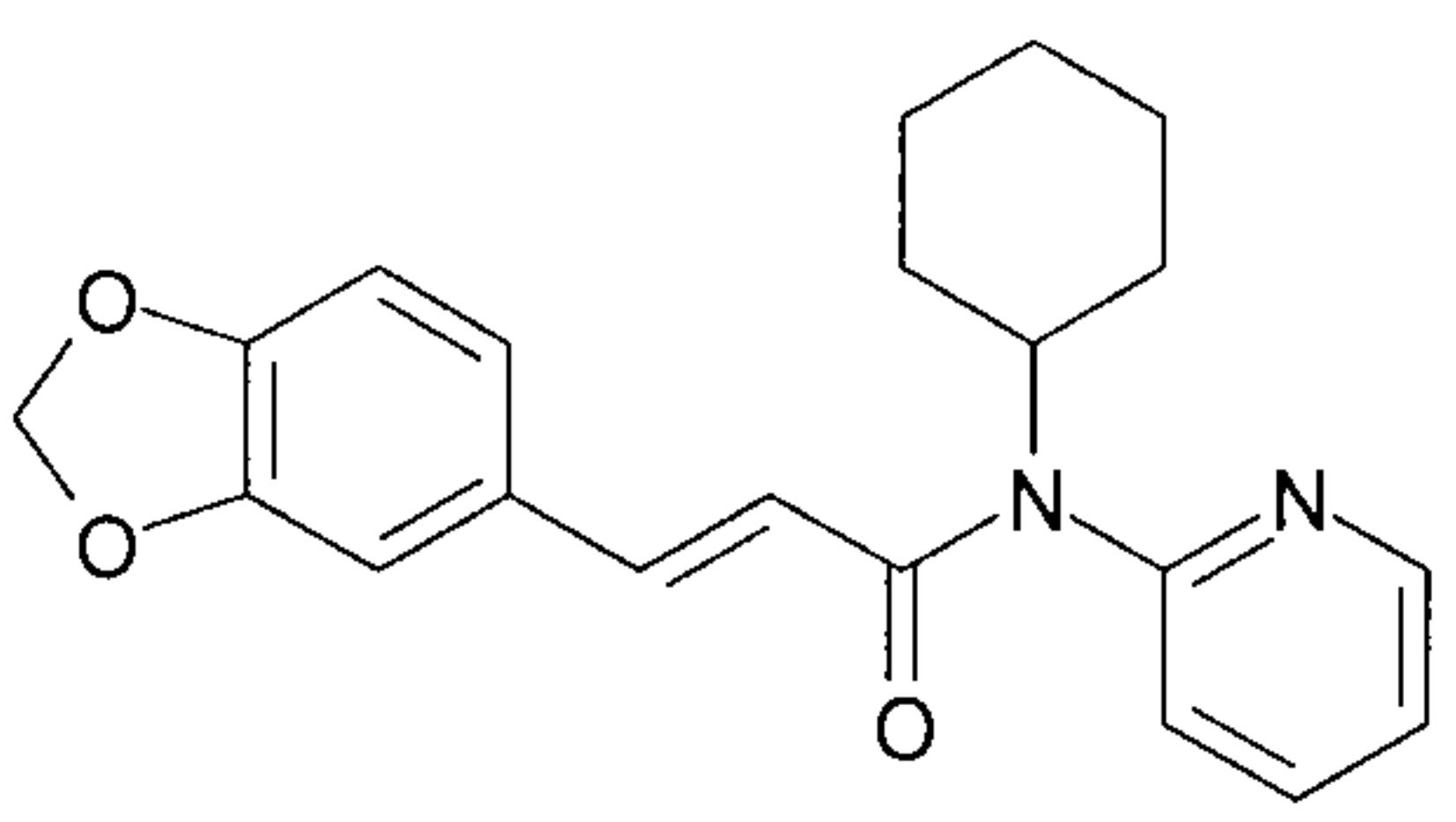
However, many of the TRPM8 modulators found hitherto have deficiencies with regard to strength of effect, duration of effect, skin/mucosa irritation, odor, taste, solubility and/or volatility.

Summary of the invention

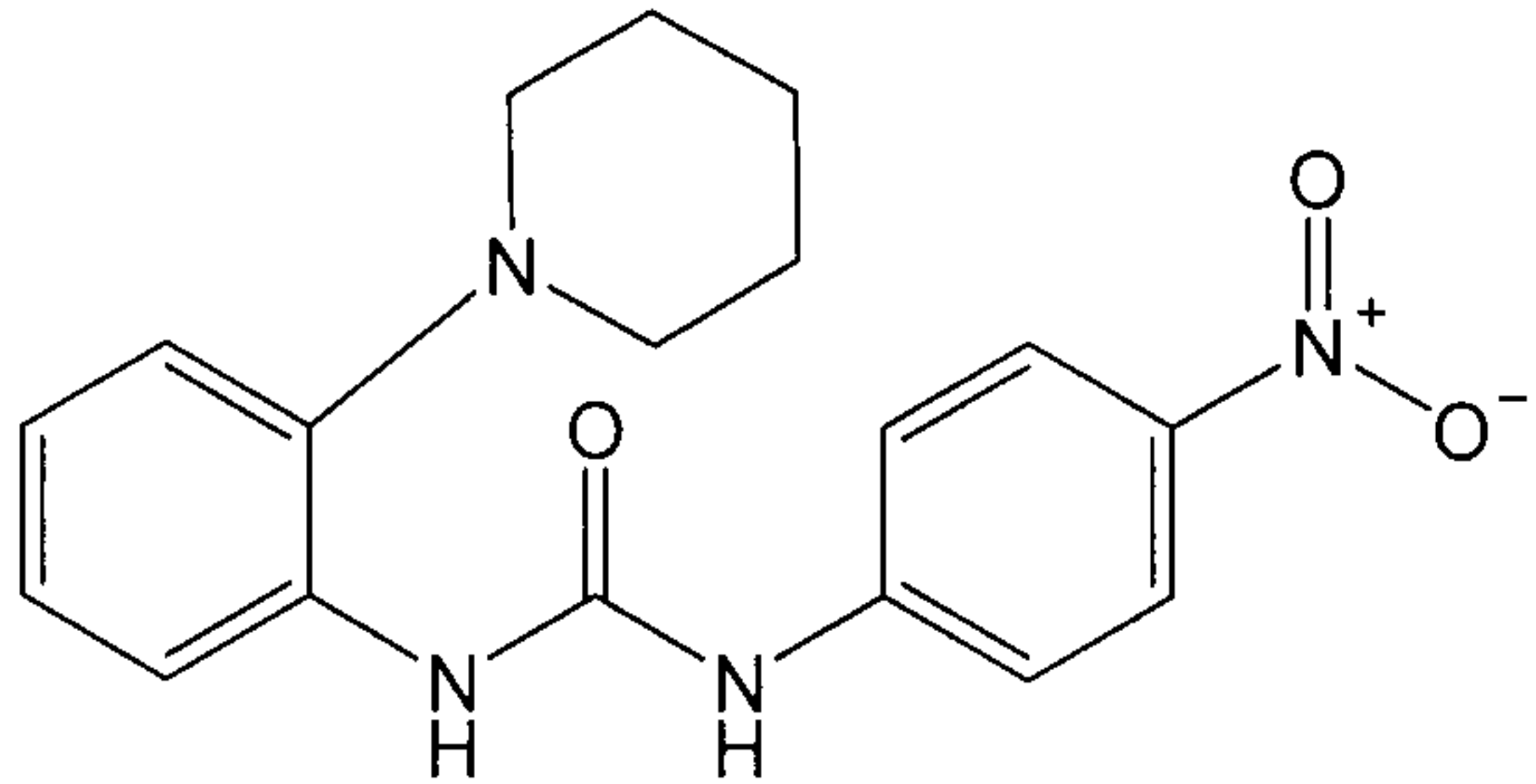
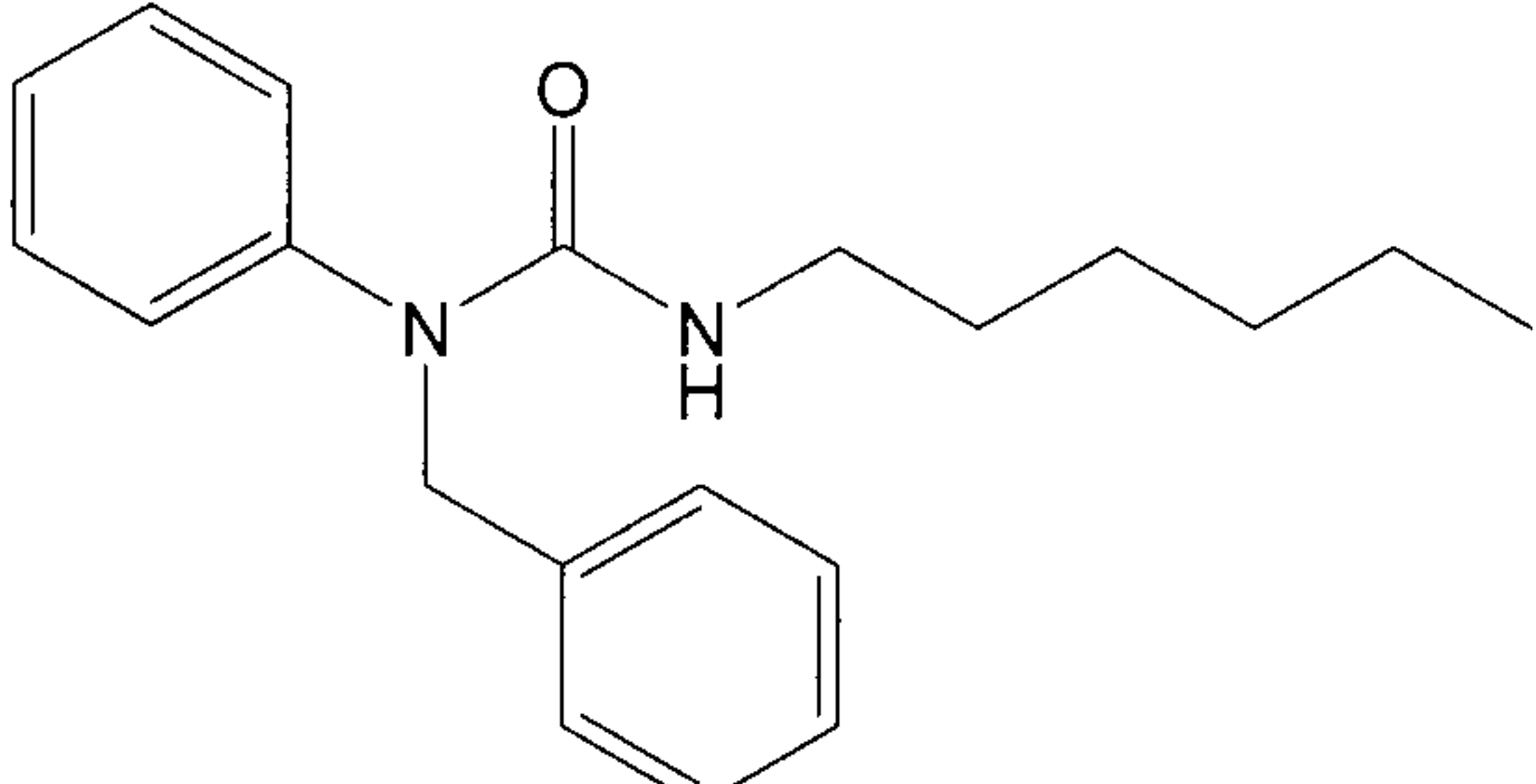
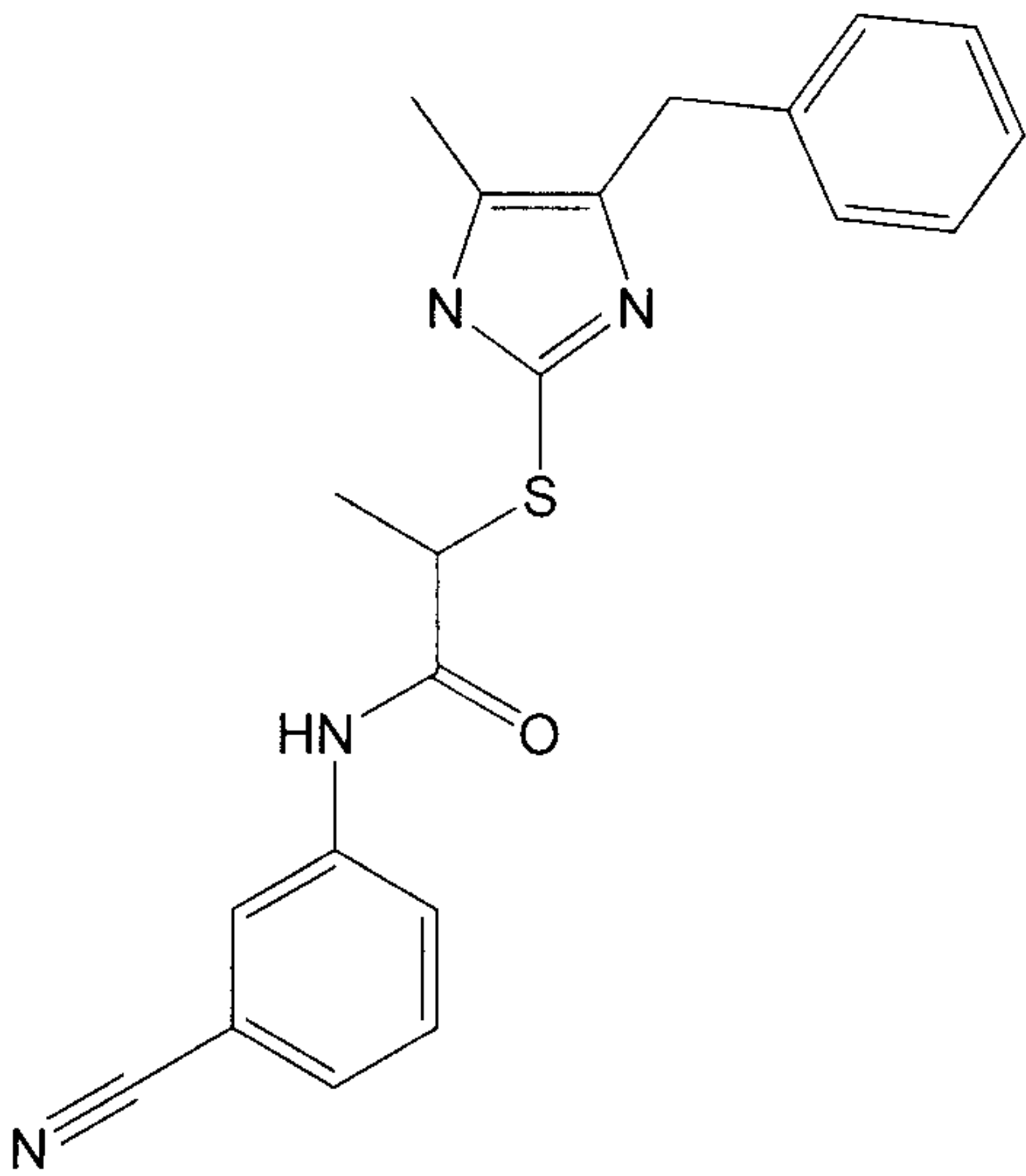
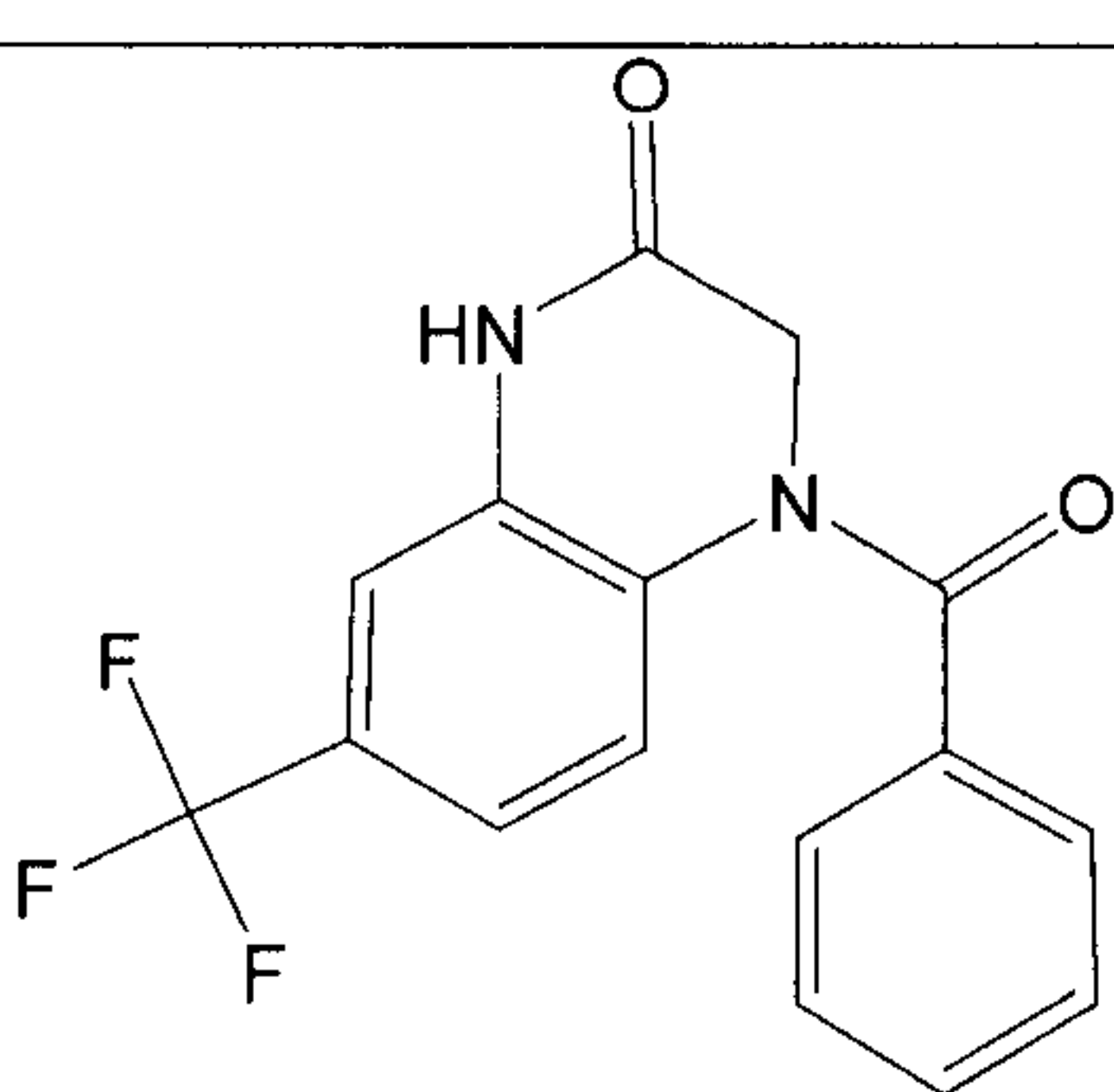
It was therefore an object of the present invention to identify novel substances, which lead to a modulation of the TRPM8 receptor, which can be used as alternatives to the modulators known hitherto. Such compounds should in particular also be suitable for applications in the field of cosmetics (e.g. hair care, skin care, oral care), nutrition (feed/food), textiles, OTC products (e.g. burn ointment), pharmaceuticals (e.g. tumor treatment, bladder weakness), packagings or as insecticide or repellent.

In one aspect, the invention relates to a method for in-vitro modulation of cold menthol receptor TRPM8 comprising contacting the receptor with a polynuclear organic compound, wherein in a cellular activity test, the compound is a modulator of the Ca^{2+} ion permeability of a cell that recombinantly expresses a human TRPM8 receptor, and wherein the modulator is a compound of formulae 1 to 19:

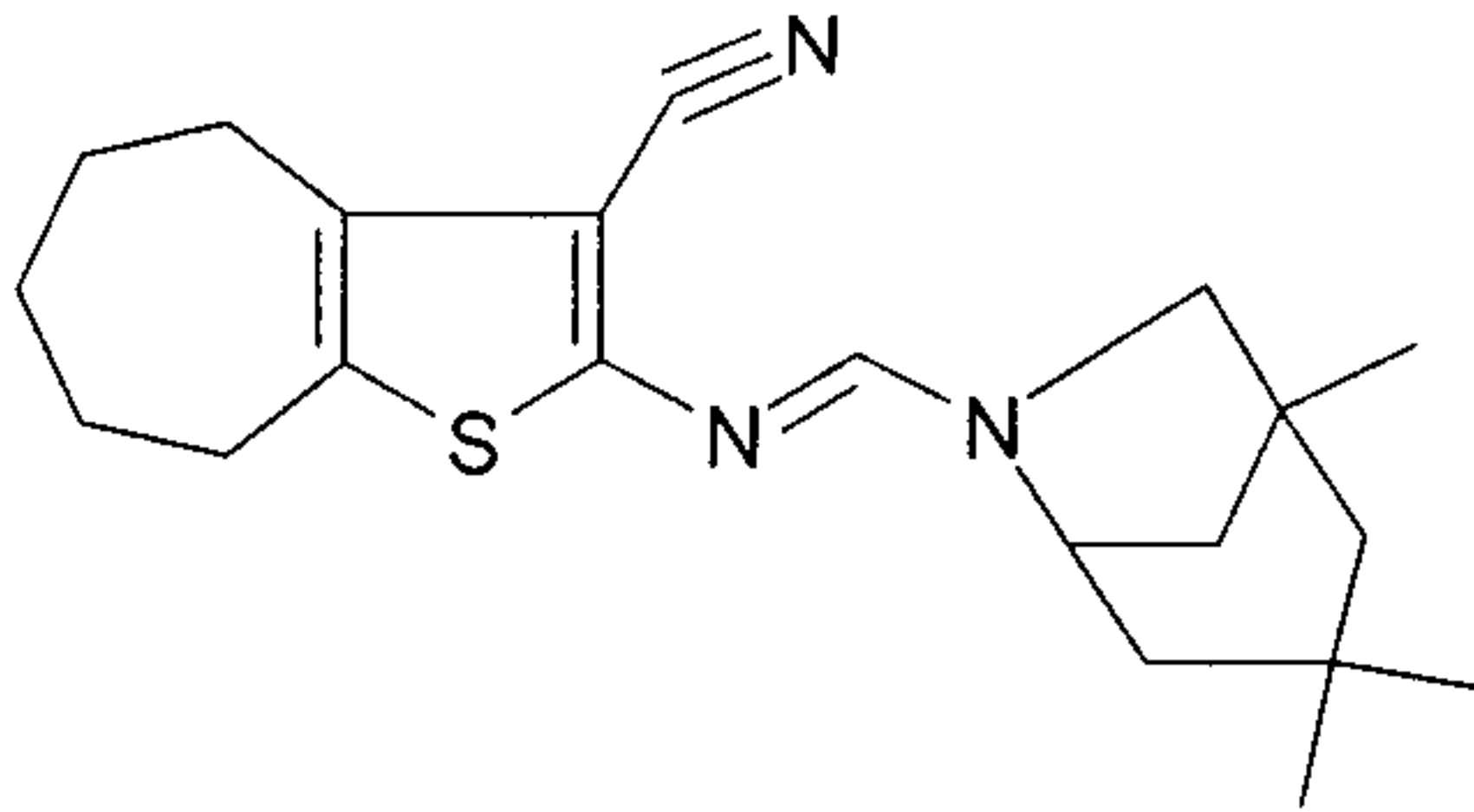
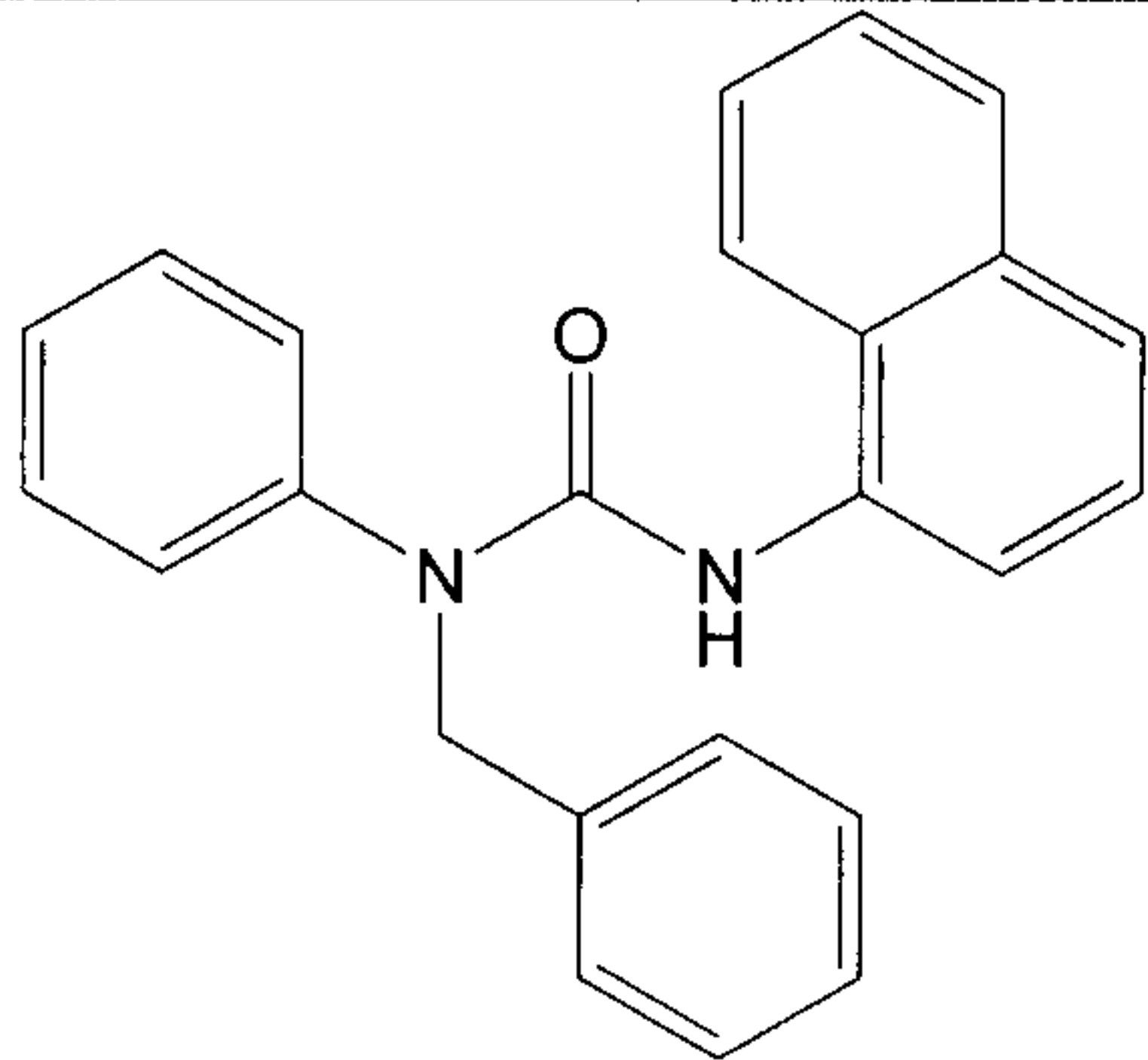
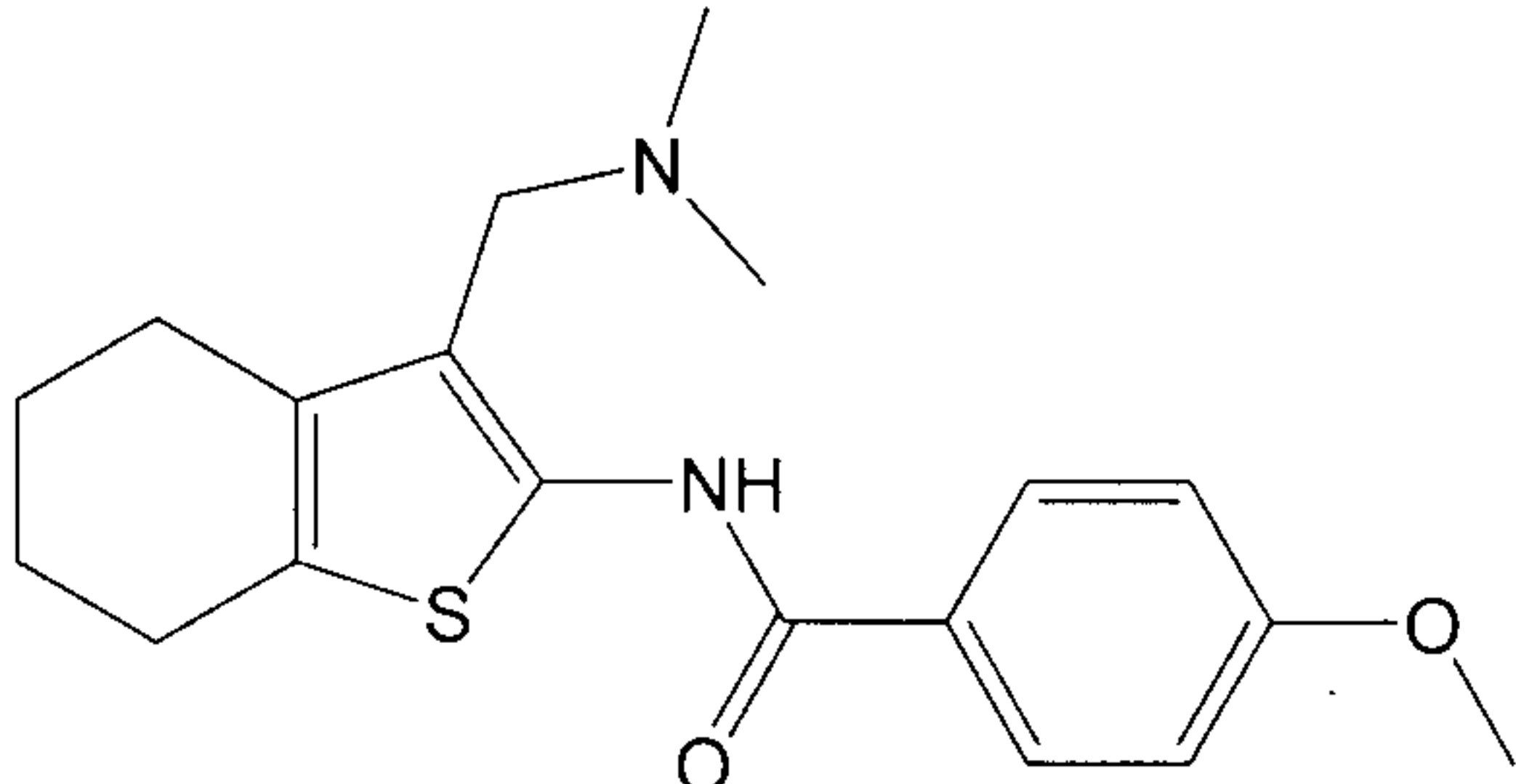
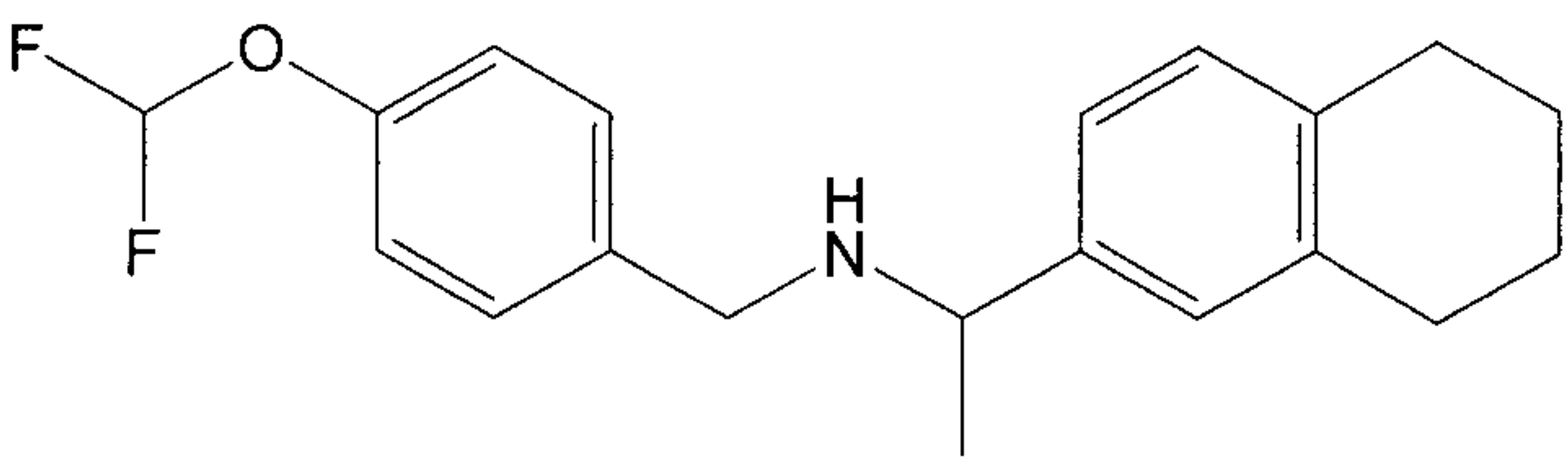
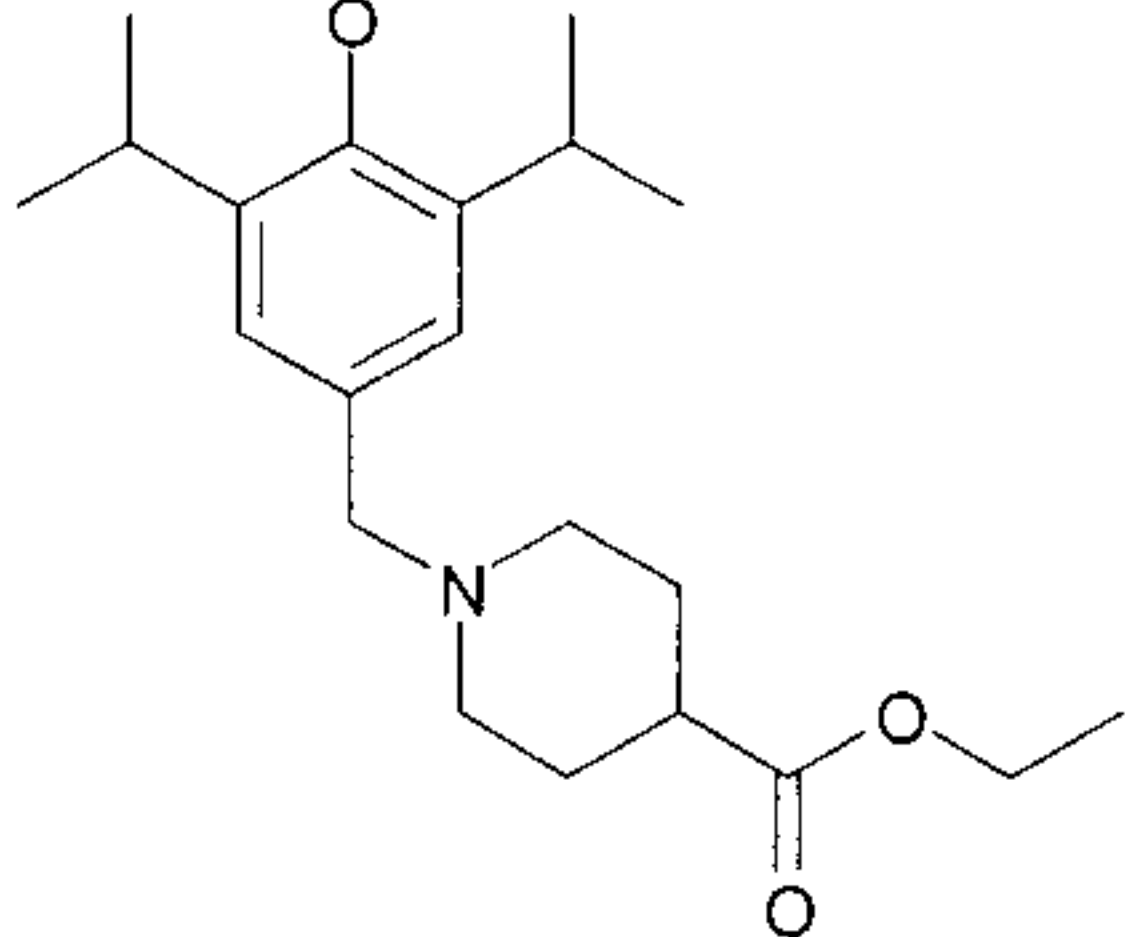
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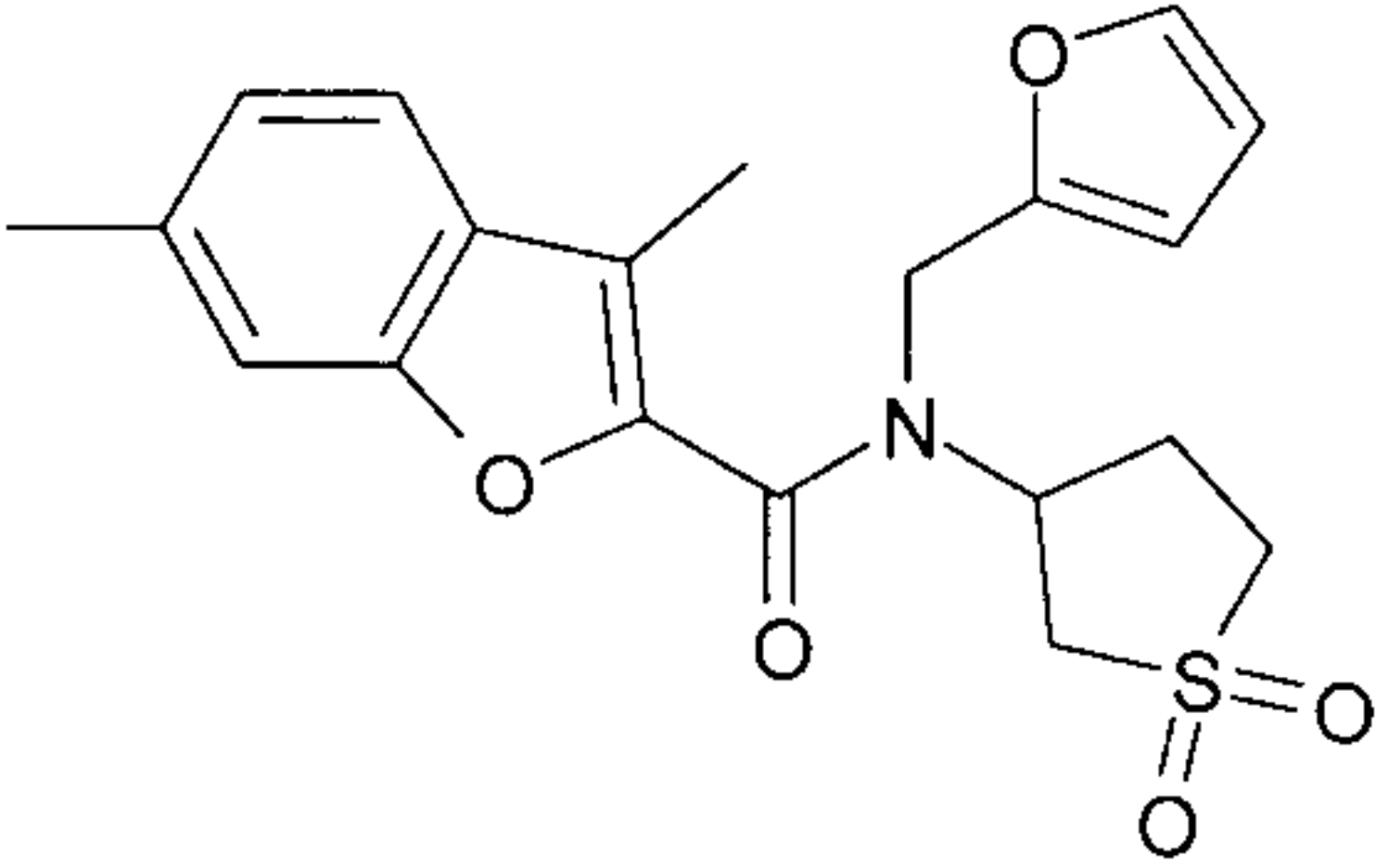
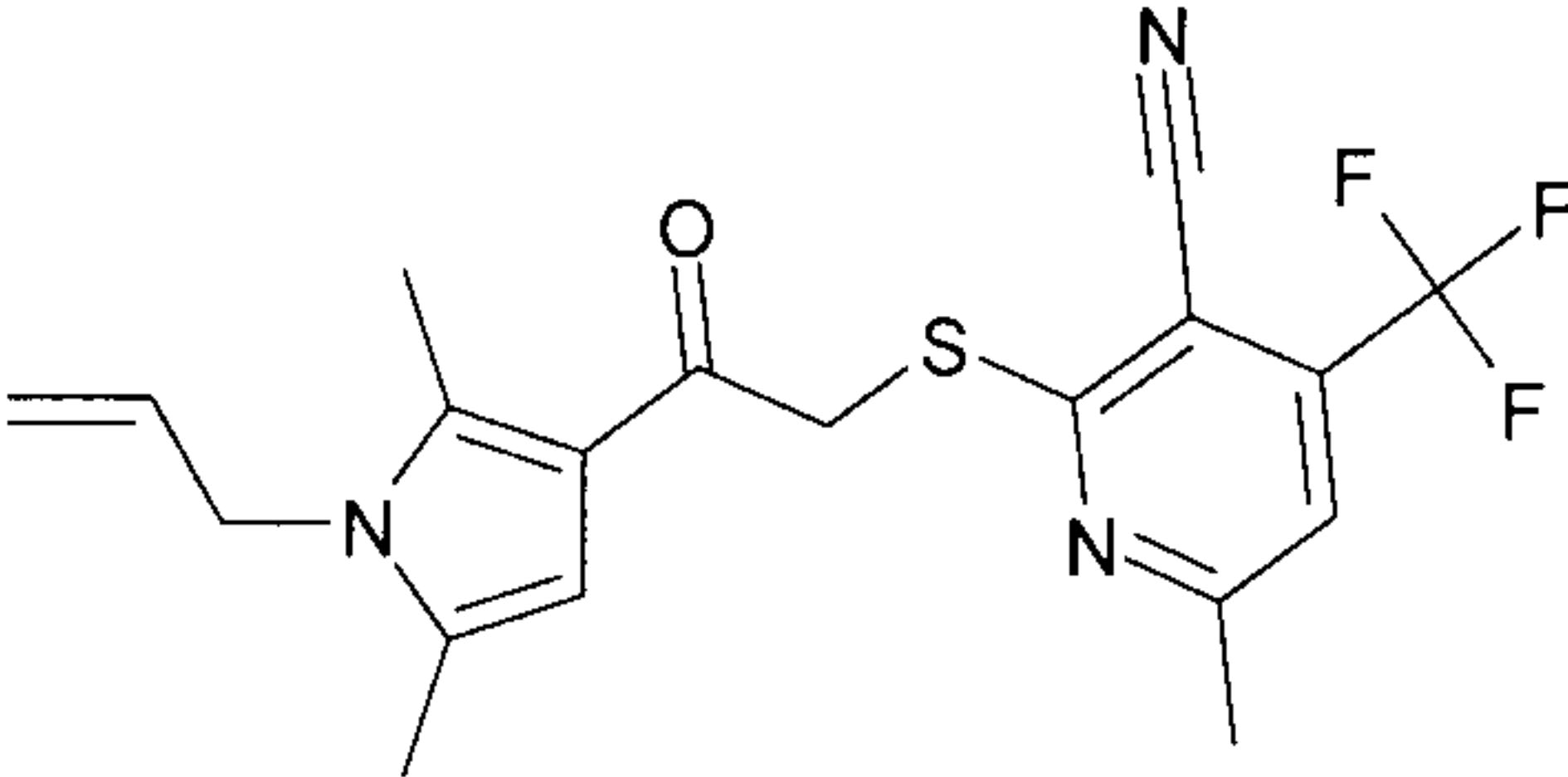
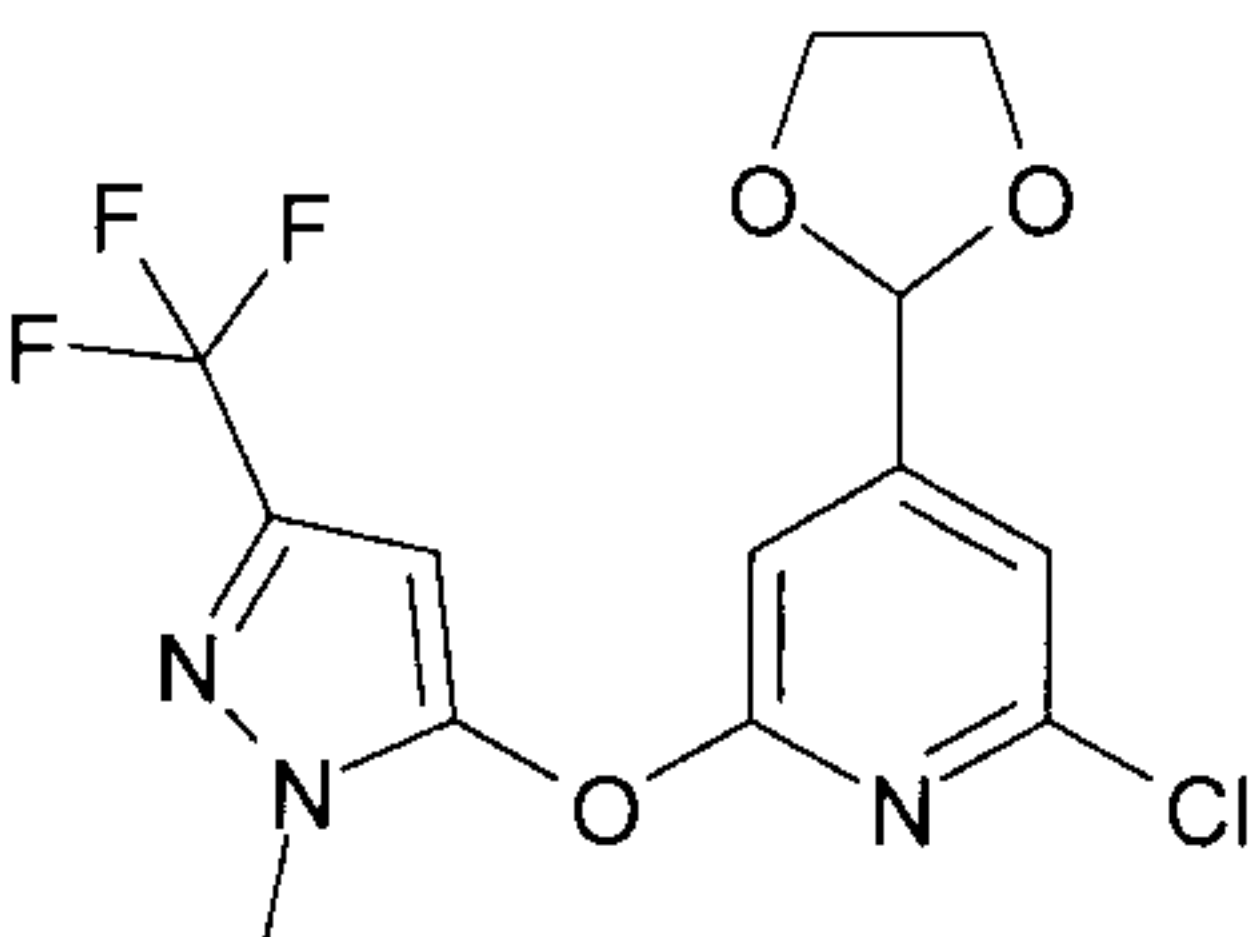
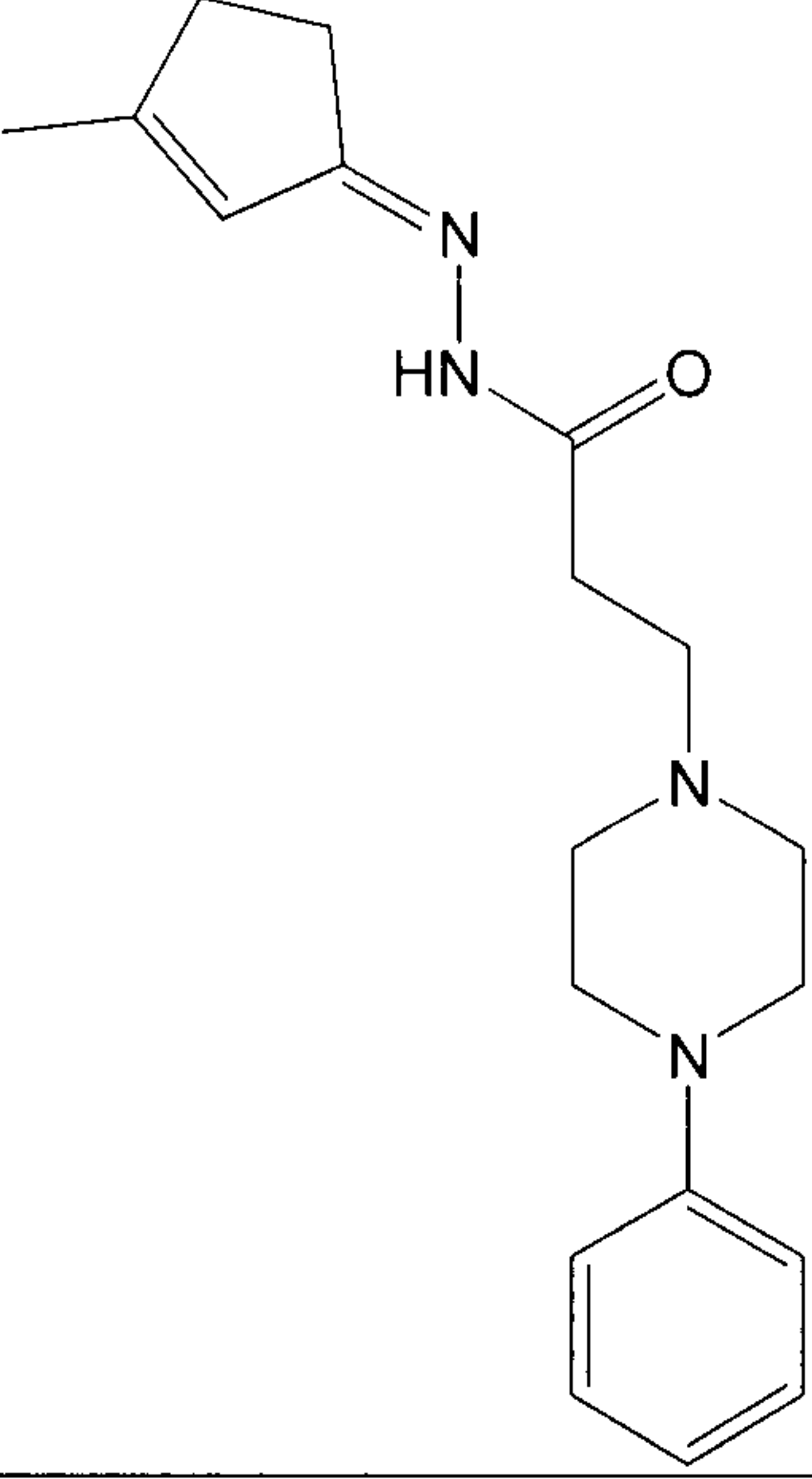
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10	 <chem>CN(C)CCN=Cc1c(C#N)c2ccccc2s1</chem>
11	 <chem>O=C(NCc1ccccc1)Nc2ccccc2</chem>
12	 <chem>COc1ccc(cc1)C(=O)Nc2c(CN(C)C)c3ccccc3s2</chem>
13	 <chem>CC1=CC=C2C(=C1)C(=CC=C2)CNCc3ccc(cc3)OC(F)F</chem>
14	 <chem>CCOC(=O)C1CCN(CC1)Cc2cc(C(C)C)c(=O)c(C(C)C)c2</chem>

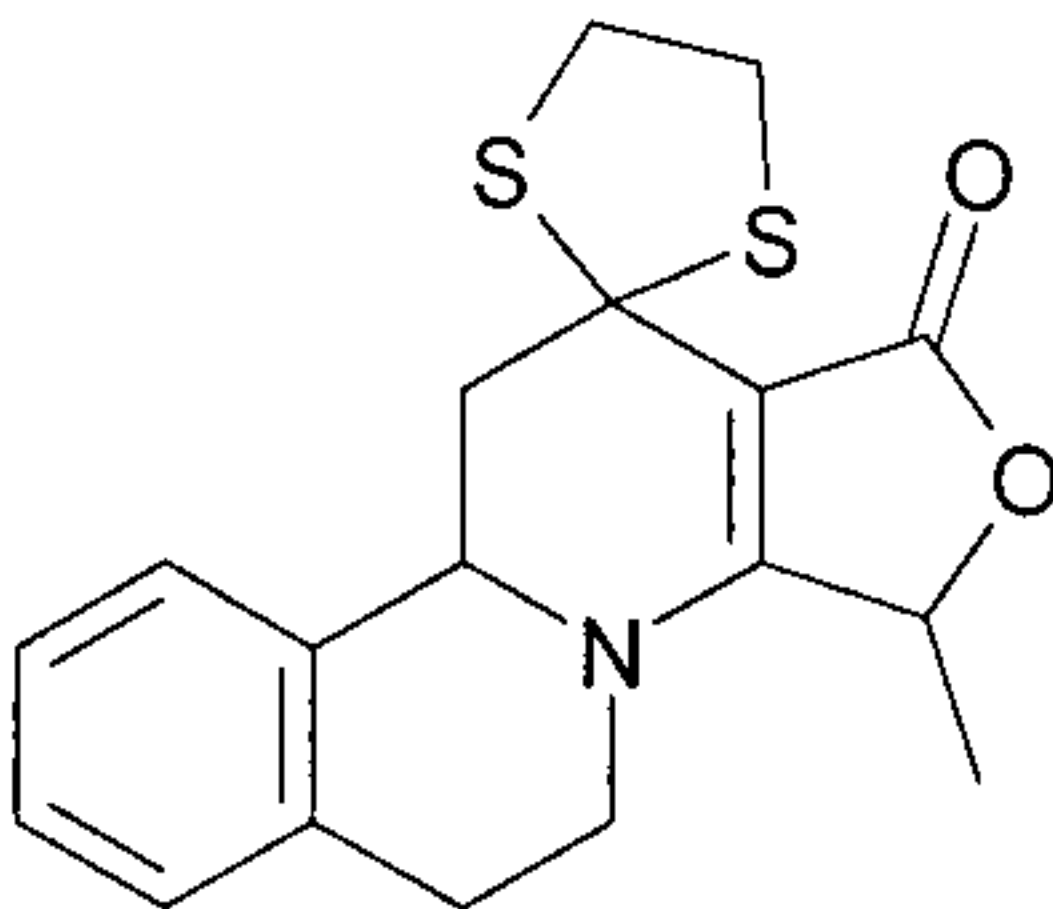
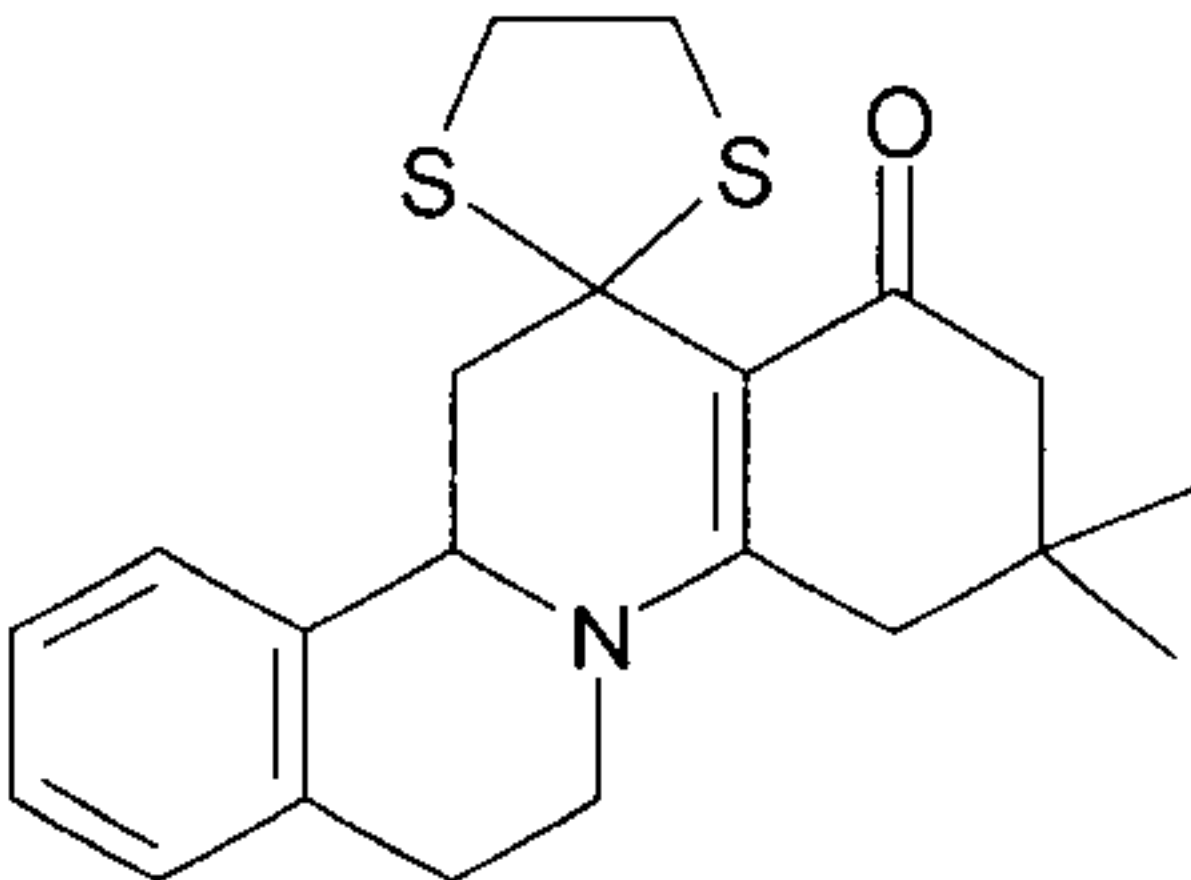
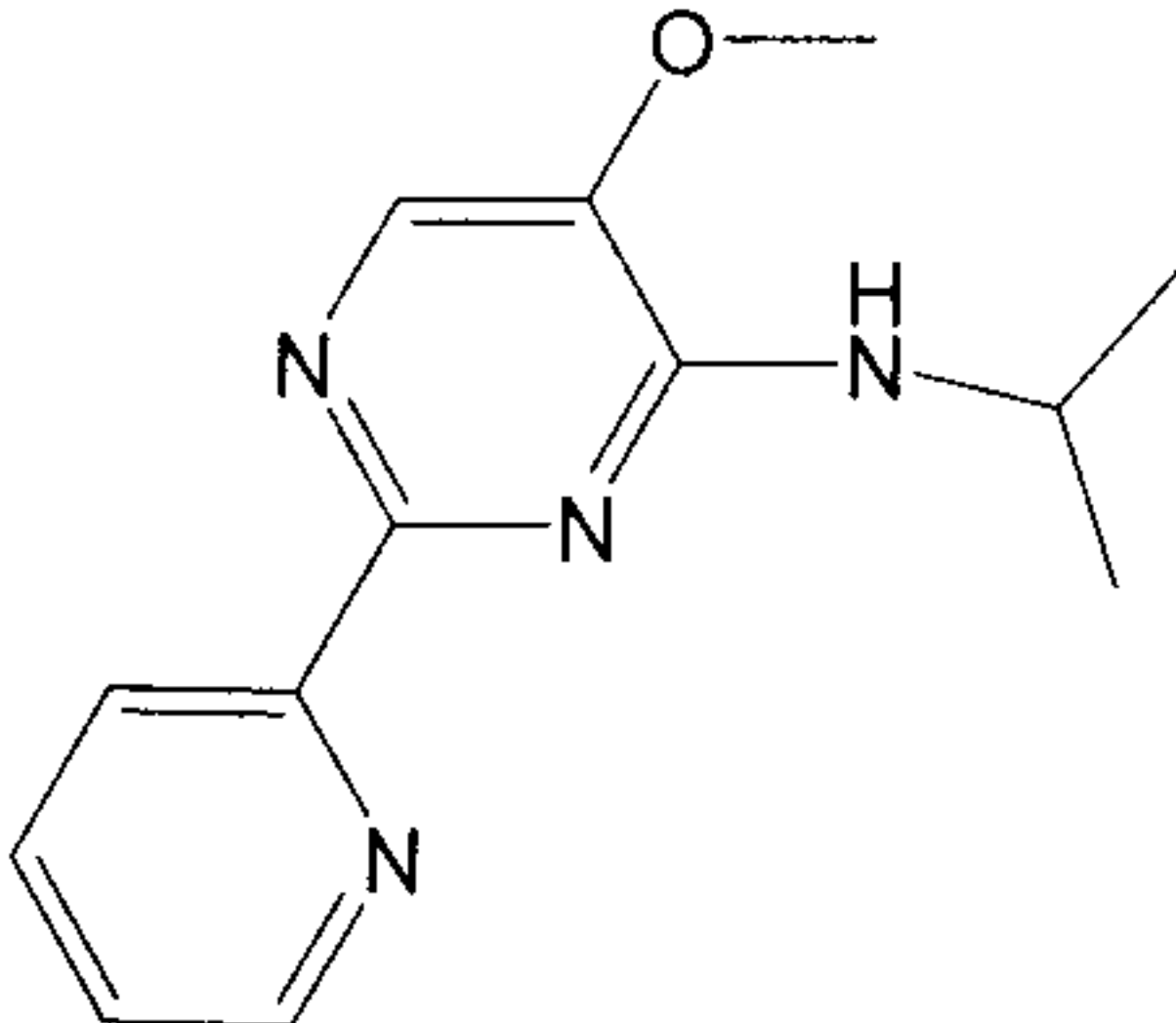
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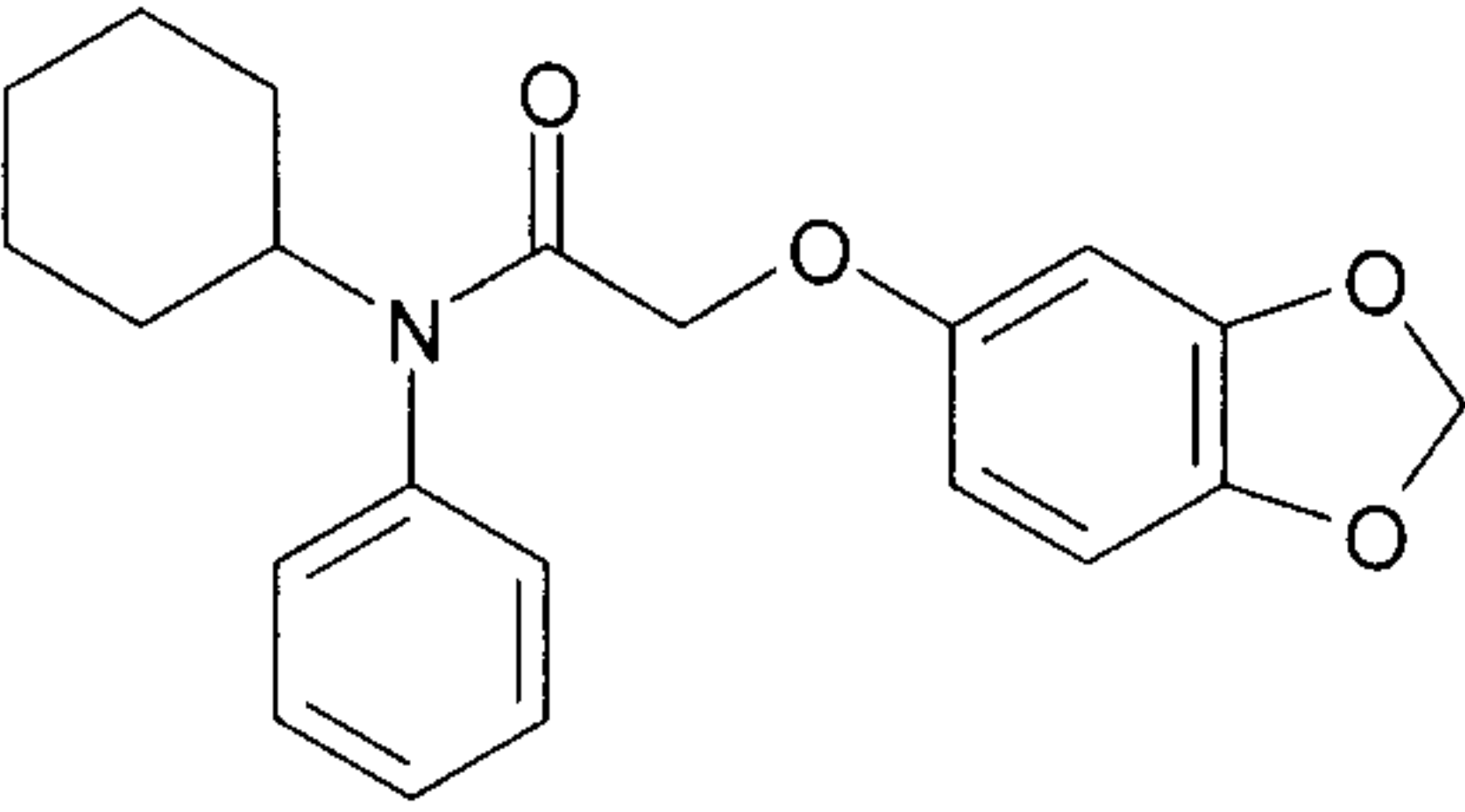
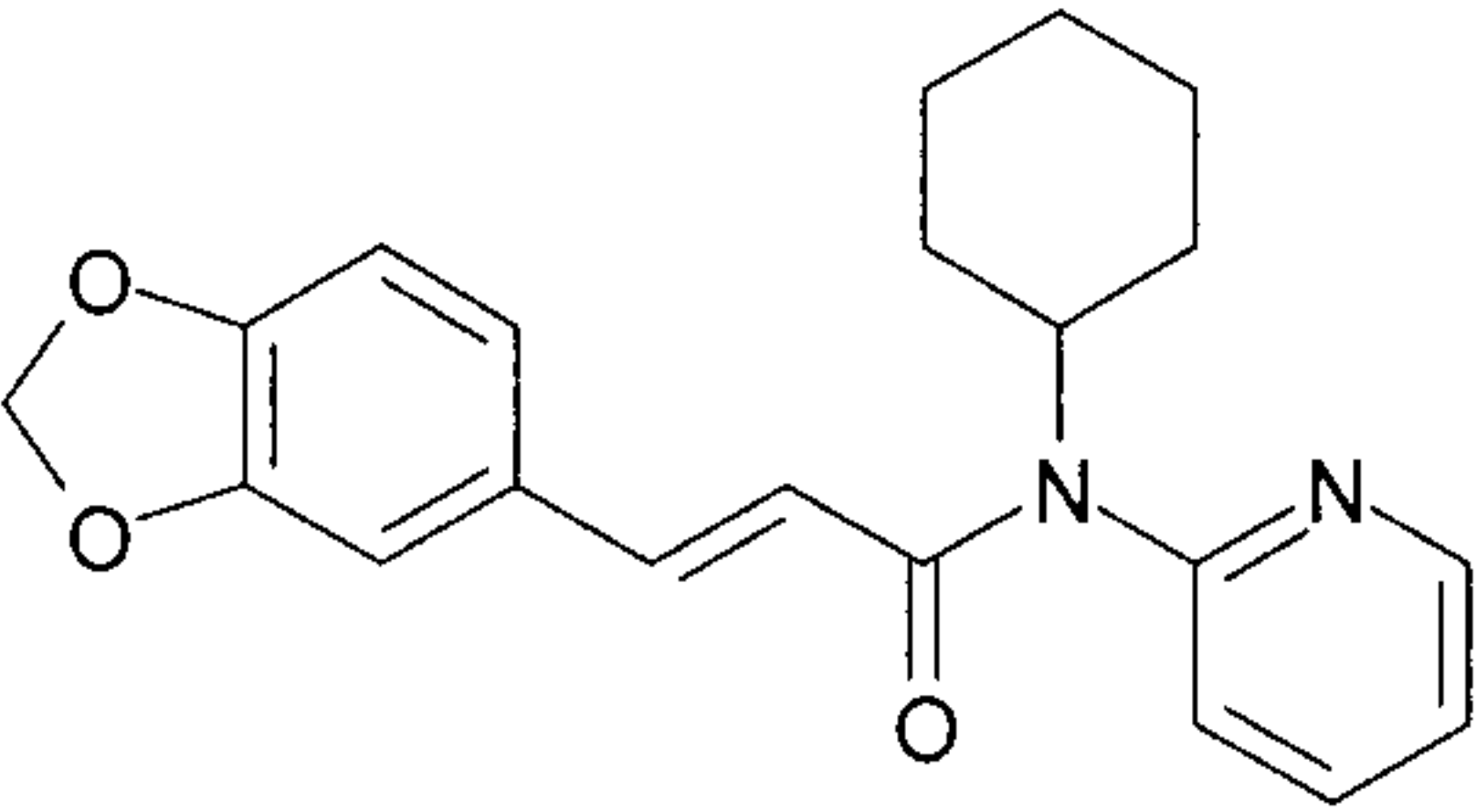
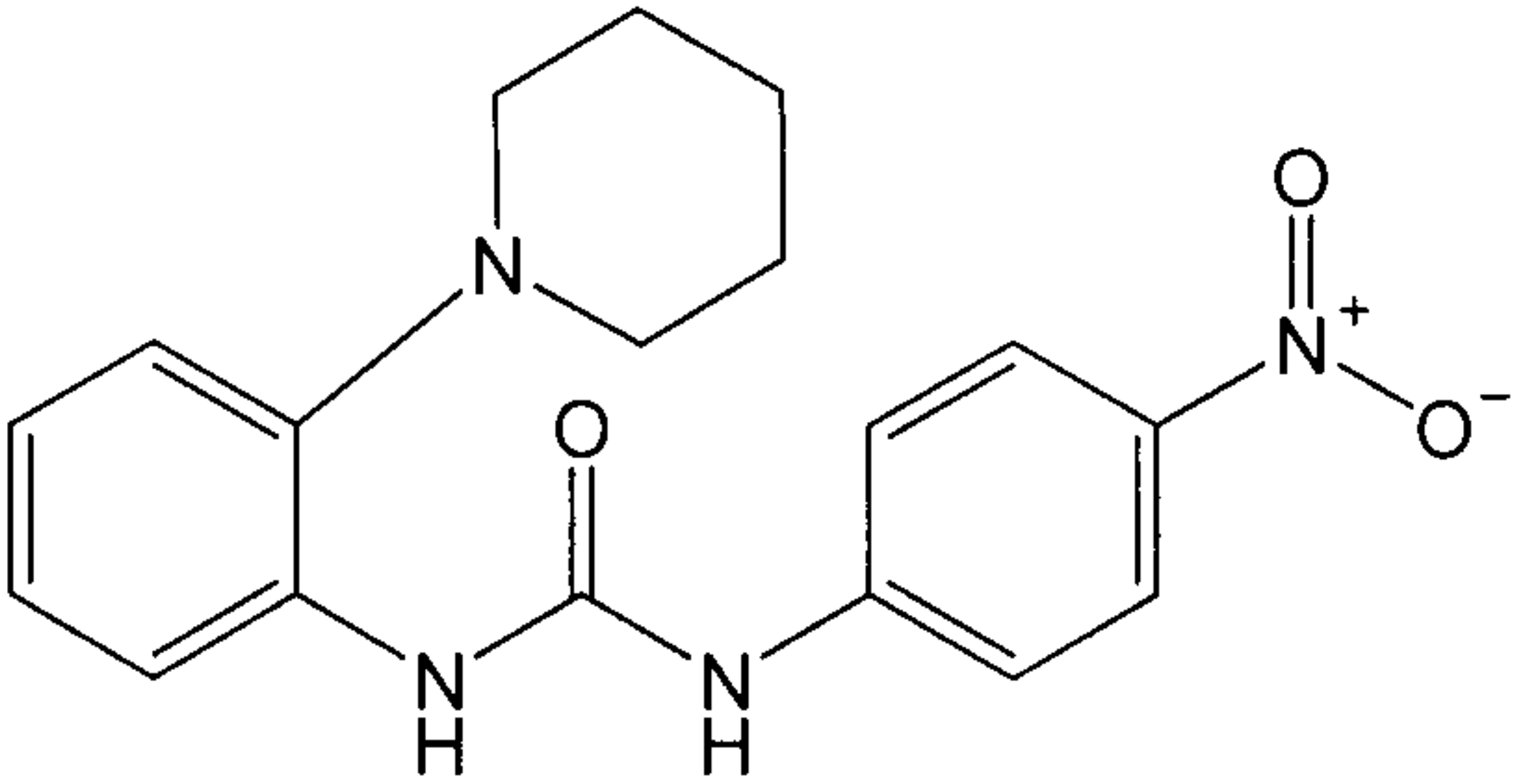
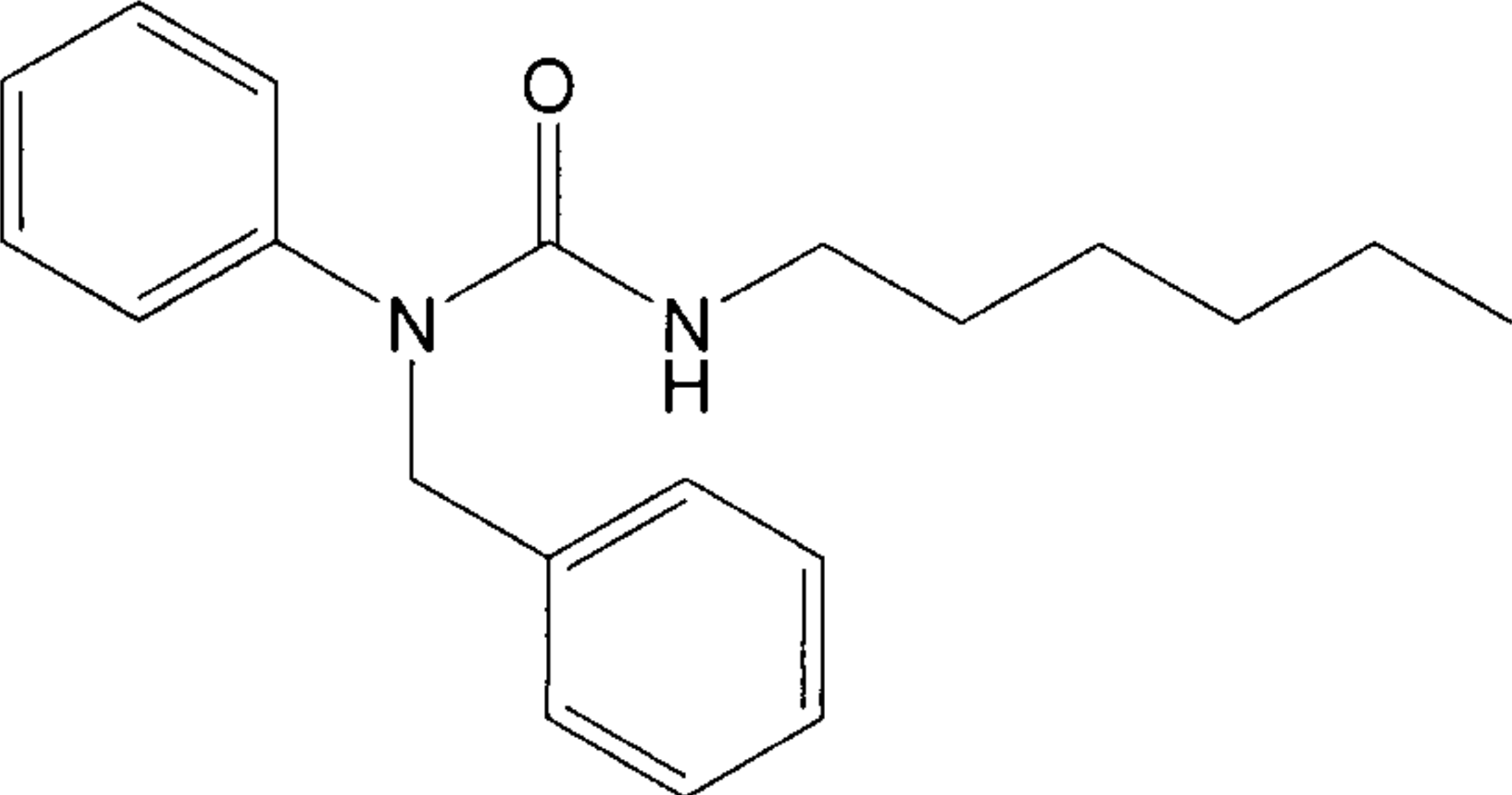
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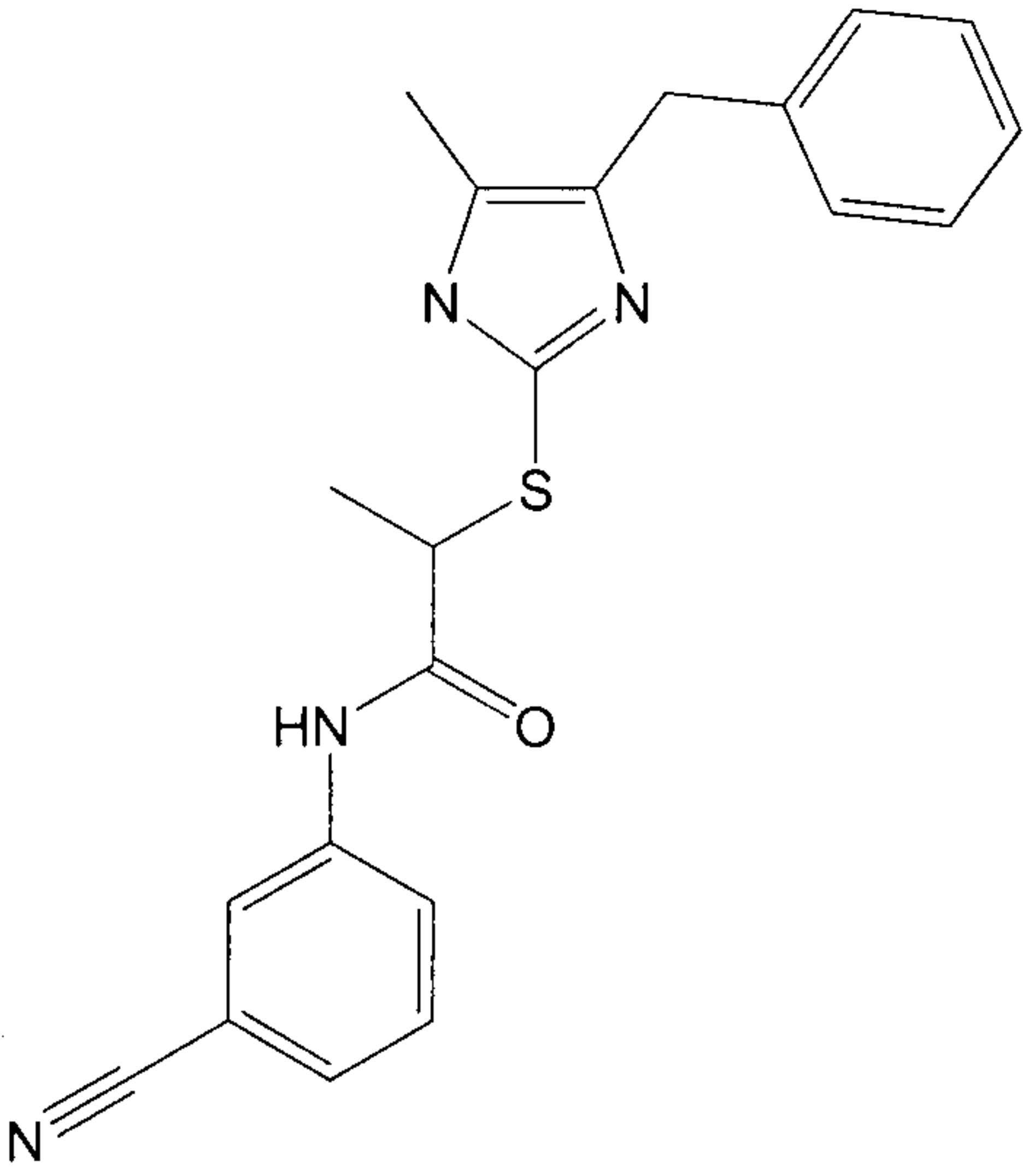
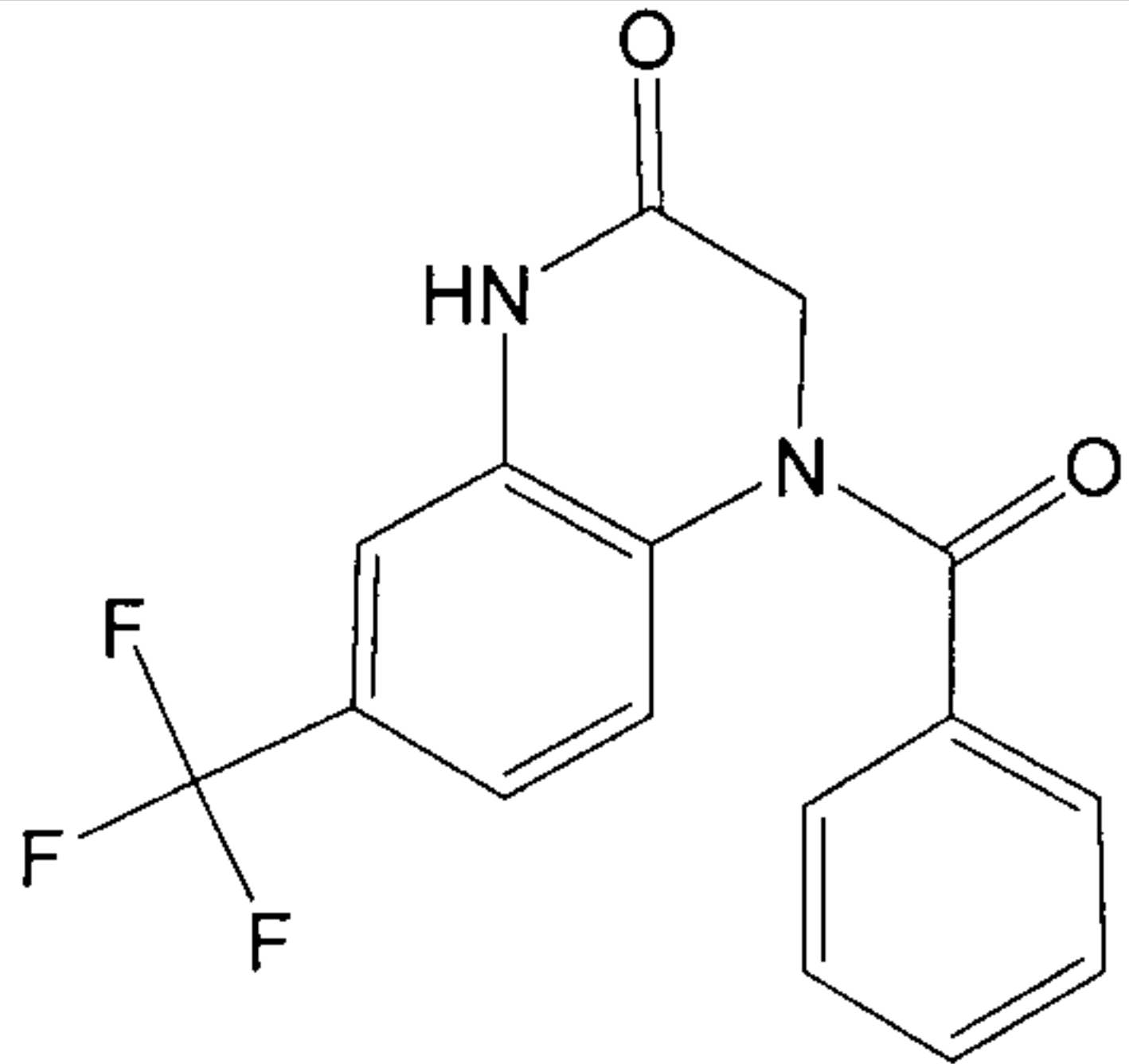
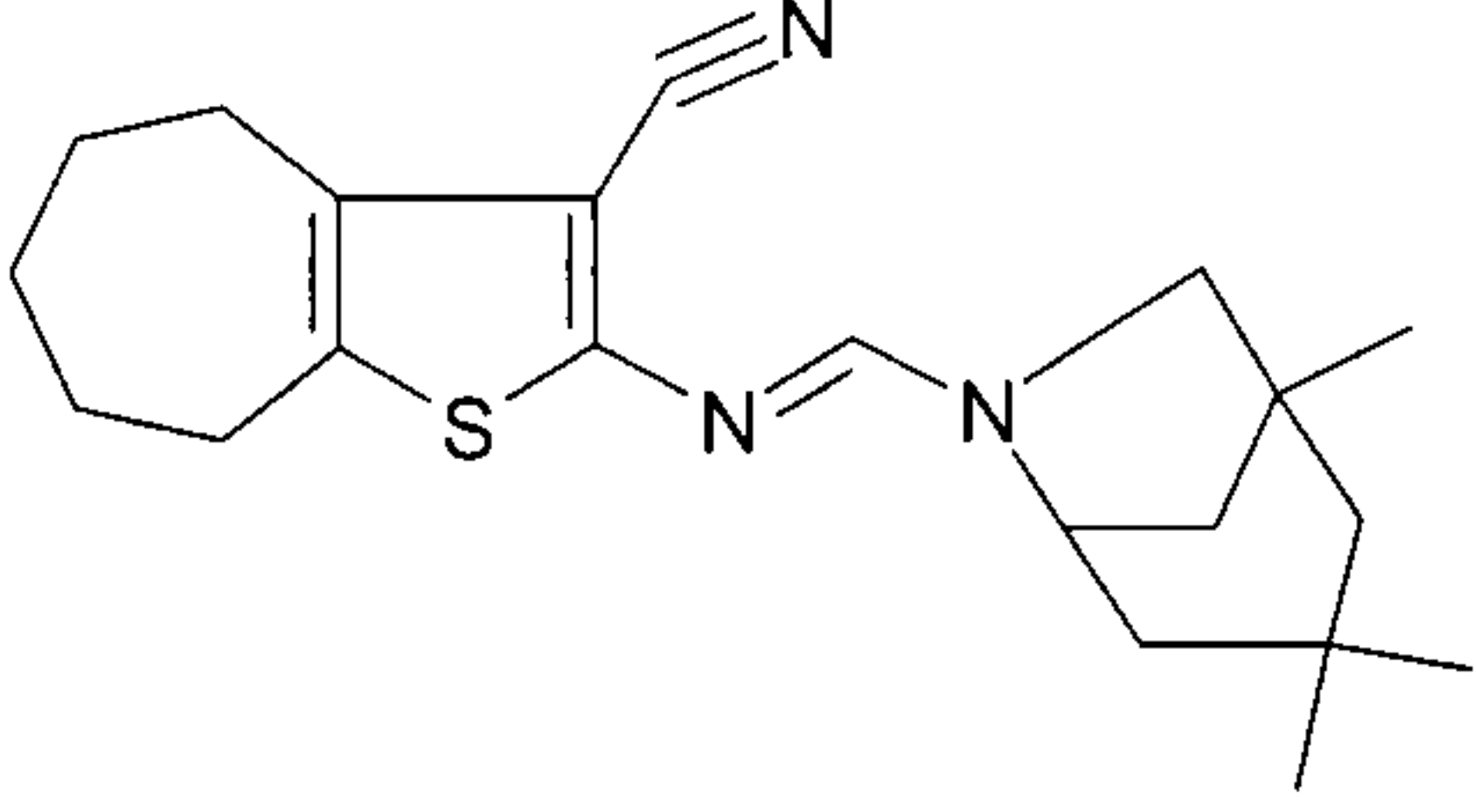
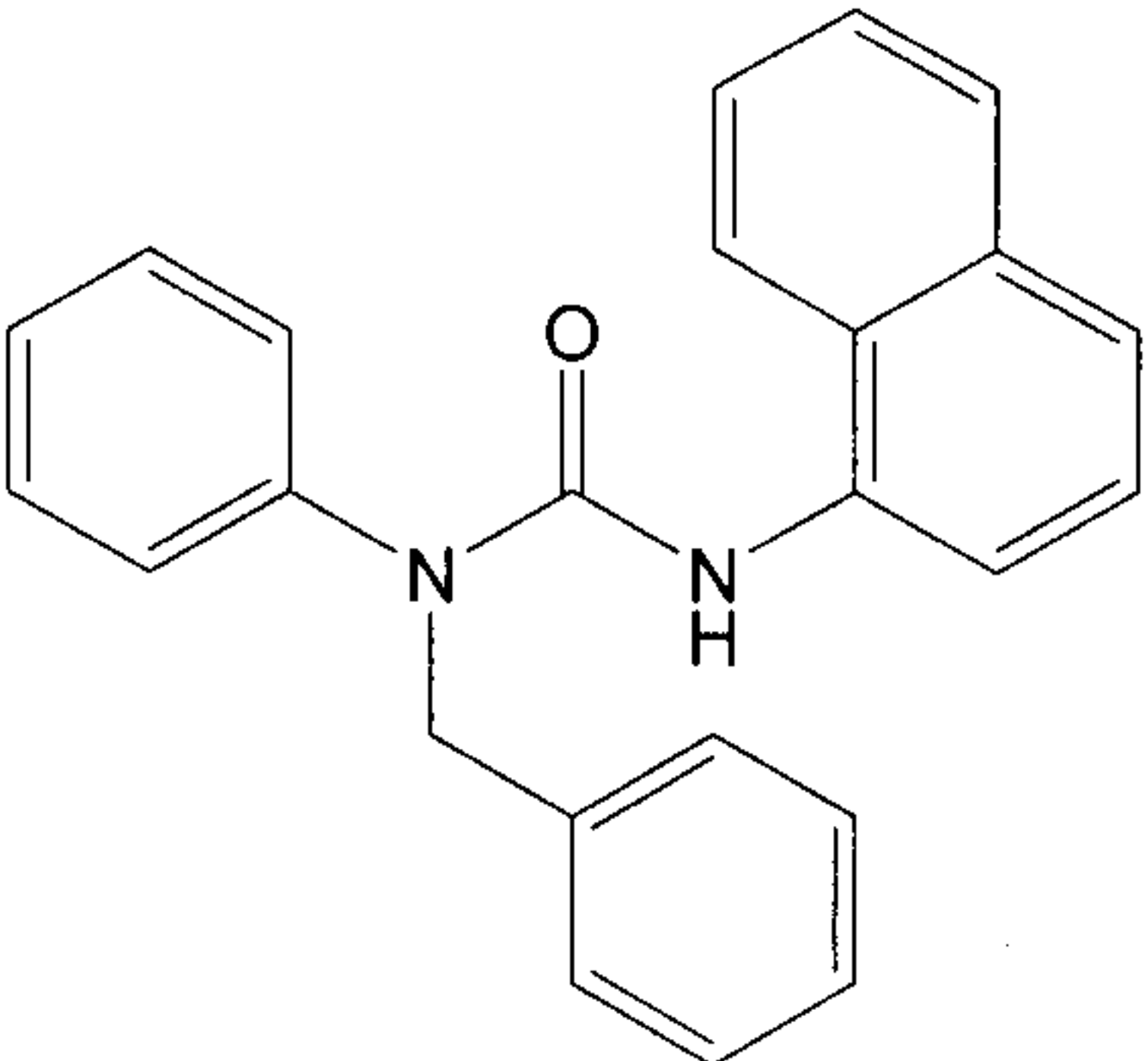
In another aspect, the invention relates to an *in vitro* method for inducing a sensation of coldness in at least one of a human or an animal, the method comprising contacting the human or animal with a polynuclear organic compound, wherein in a cellular activity test, the compound is a modulator of the Ca²⁺ ion permeability of a cell that recombinantly expresses a human TRPM8 receptor and wherein the modulator is a compound of formula 1 to 19:

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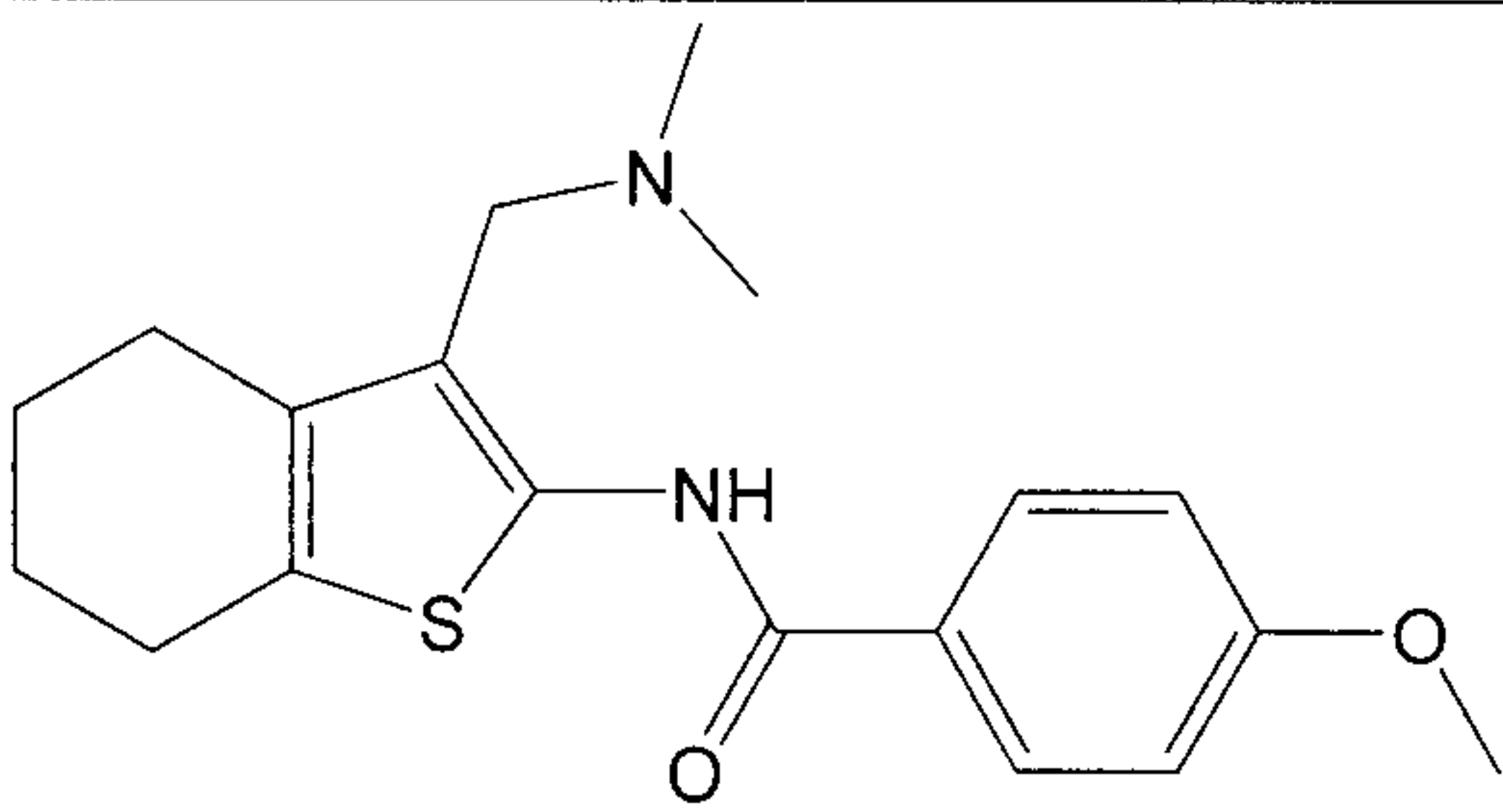
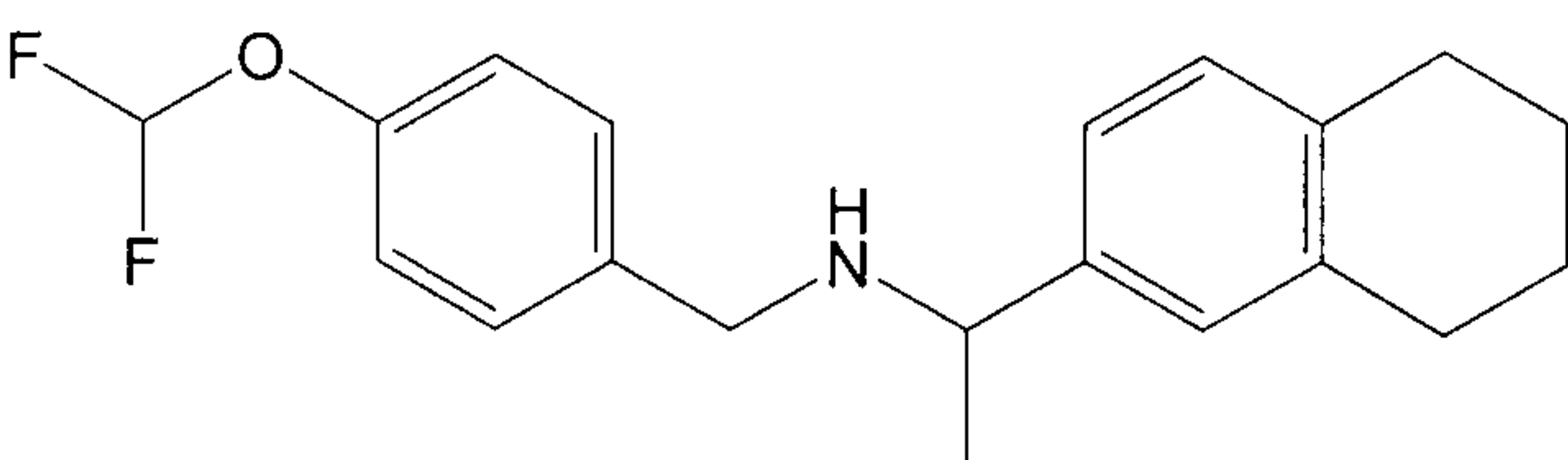
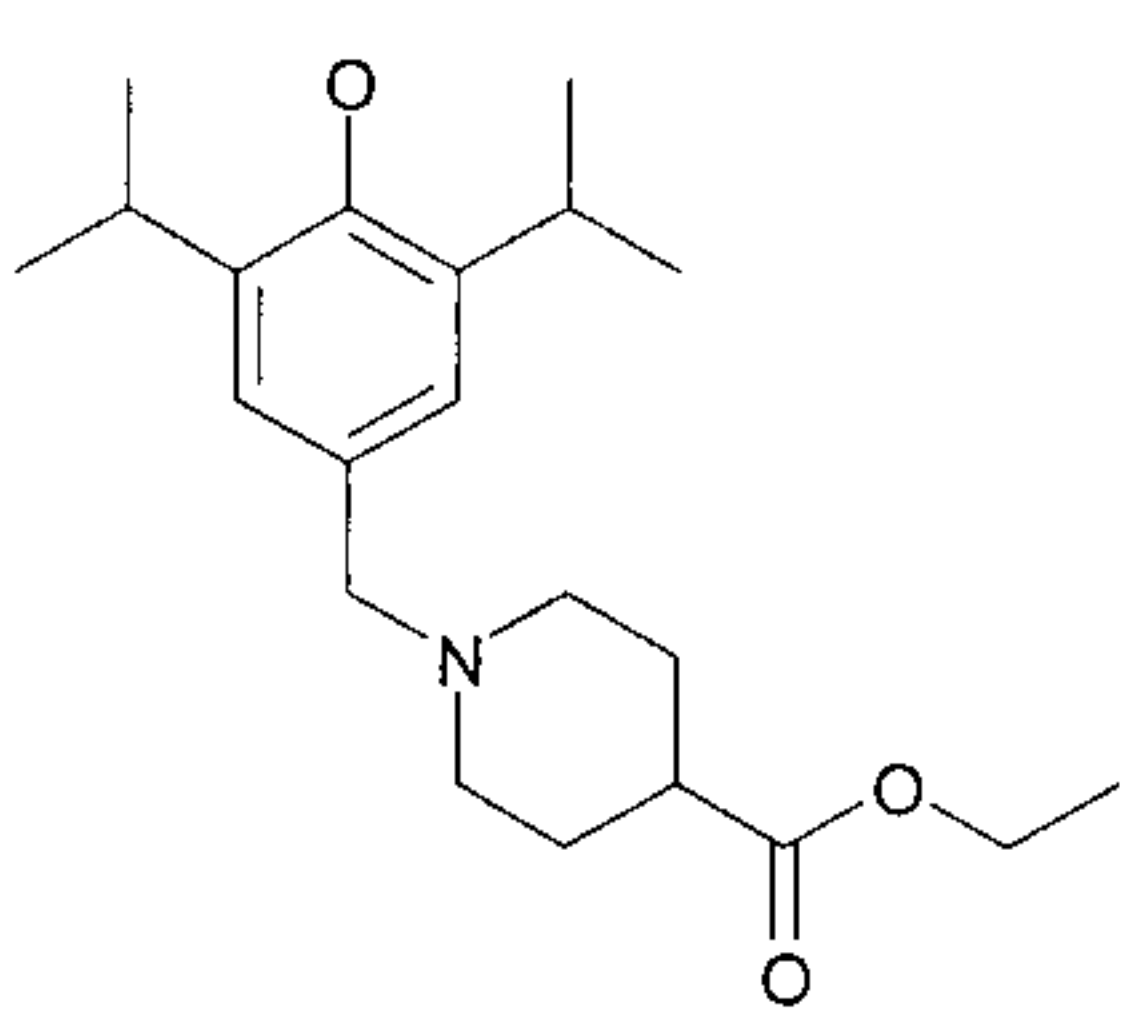
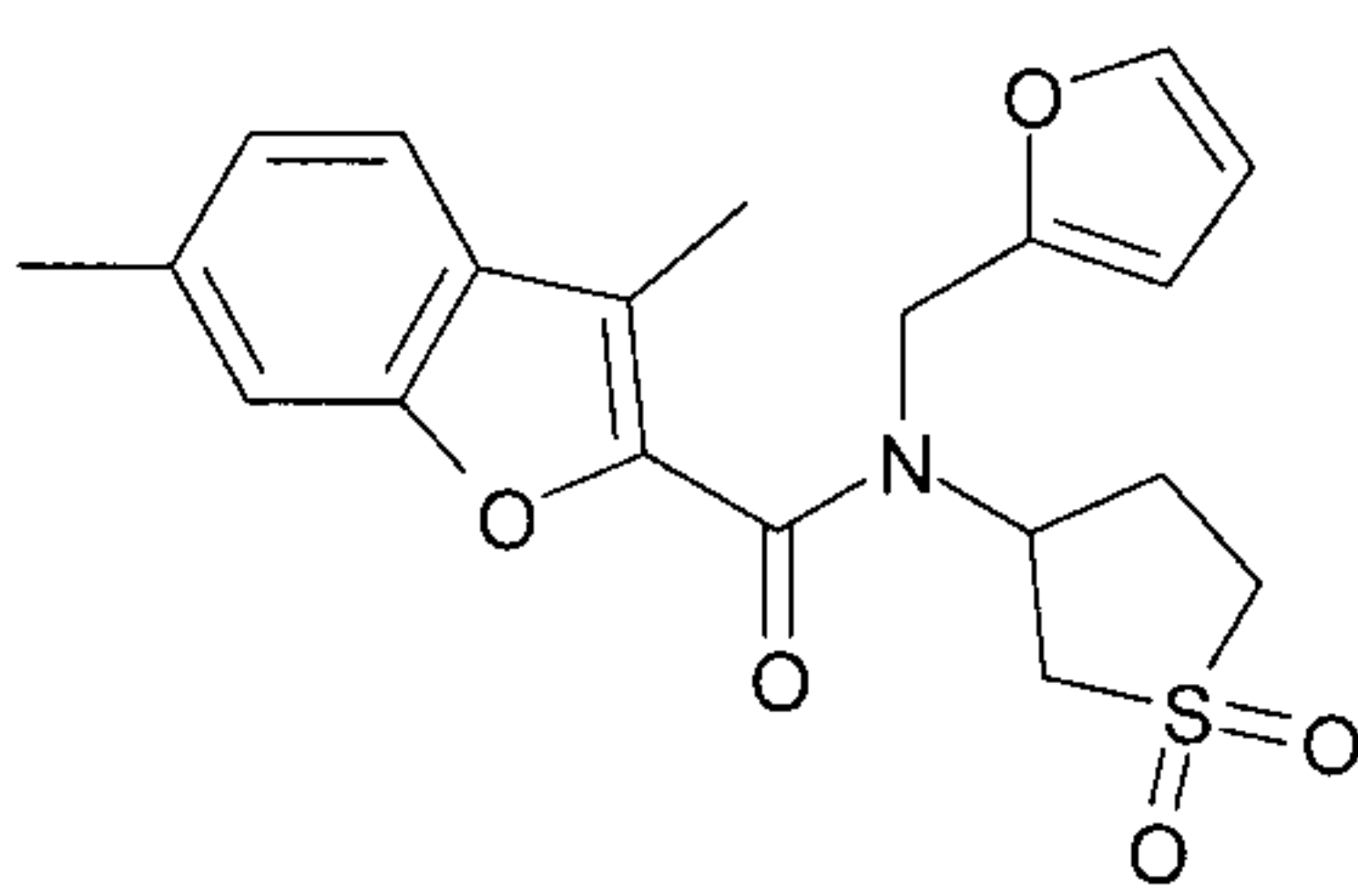
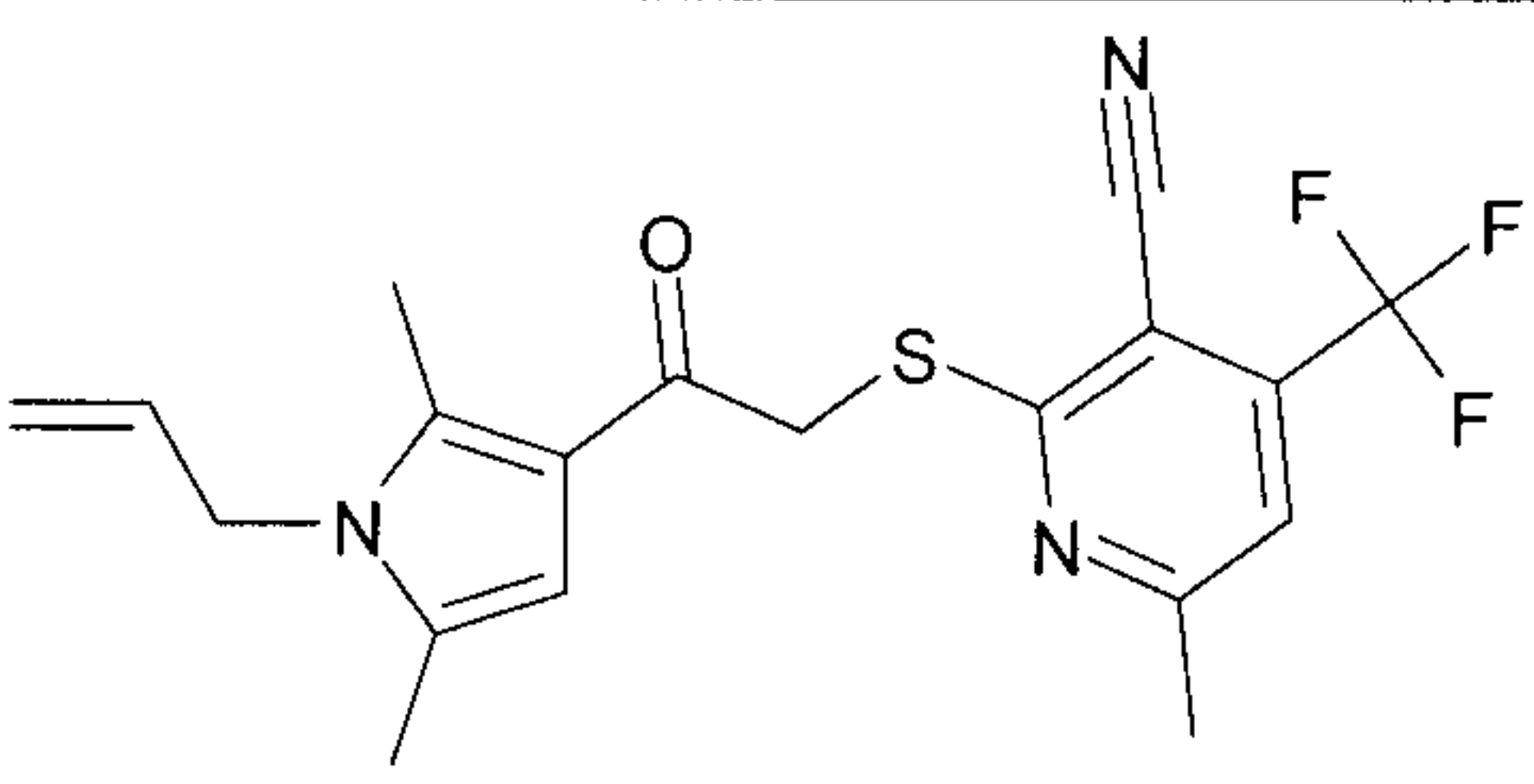
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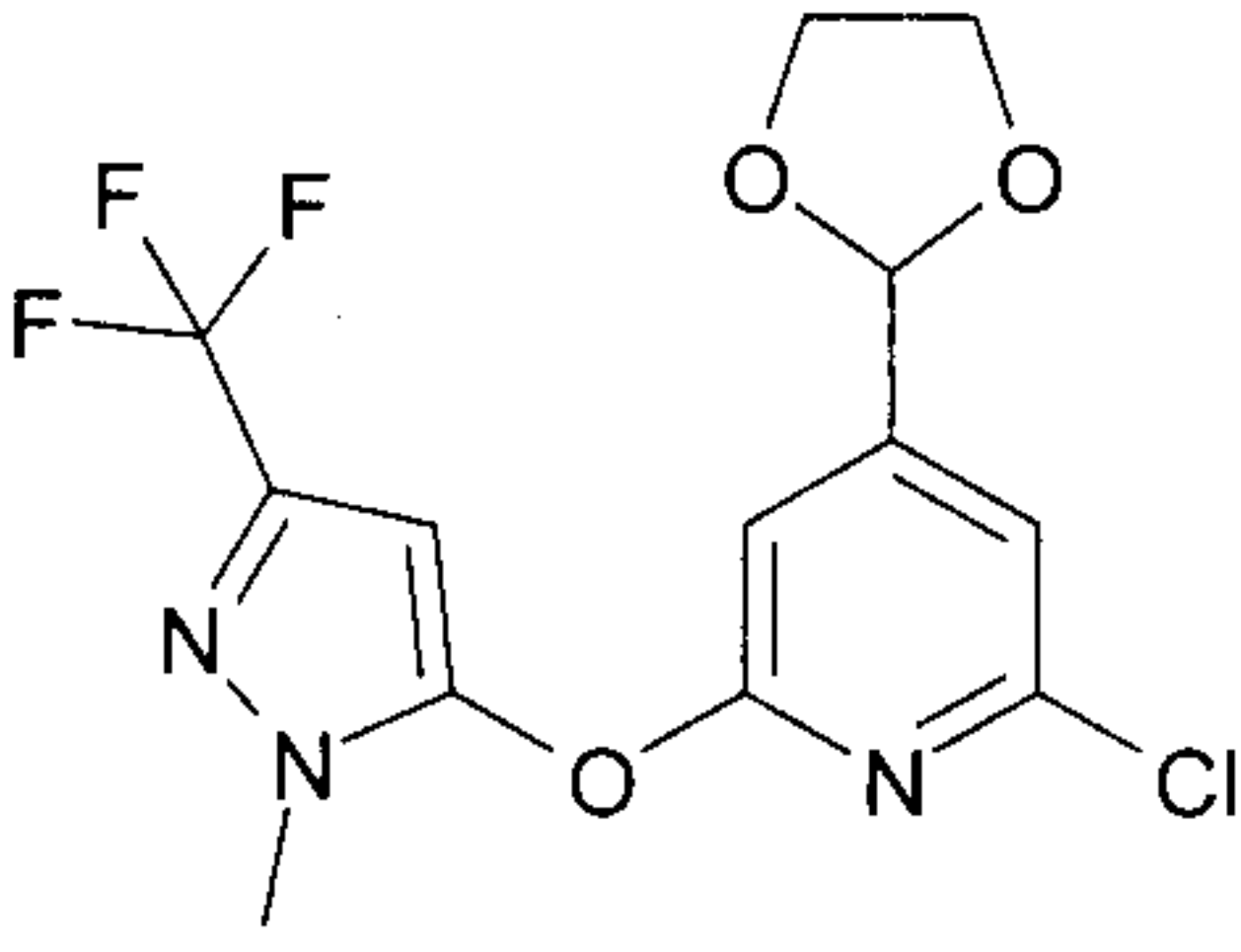
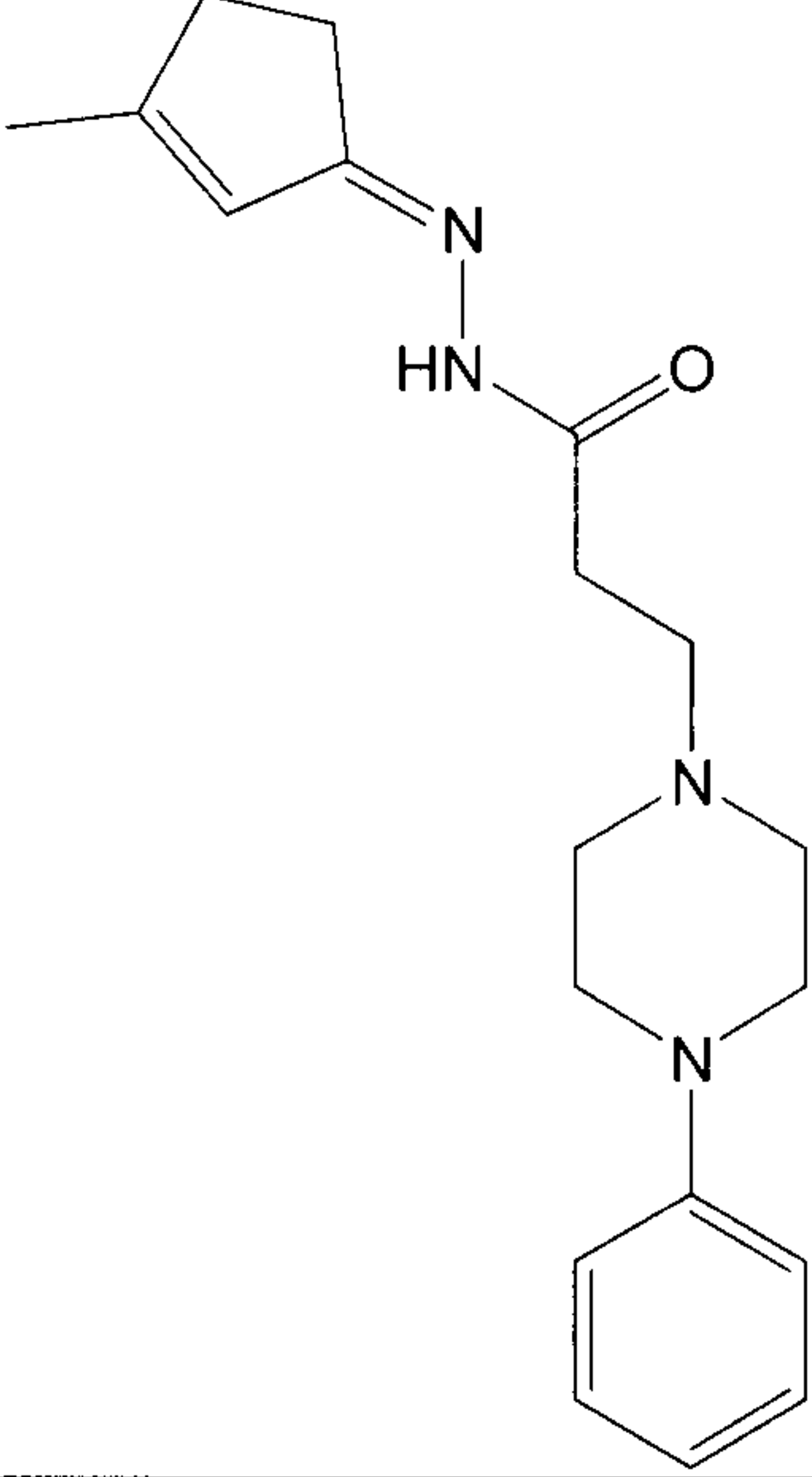
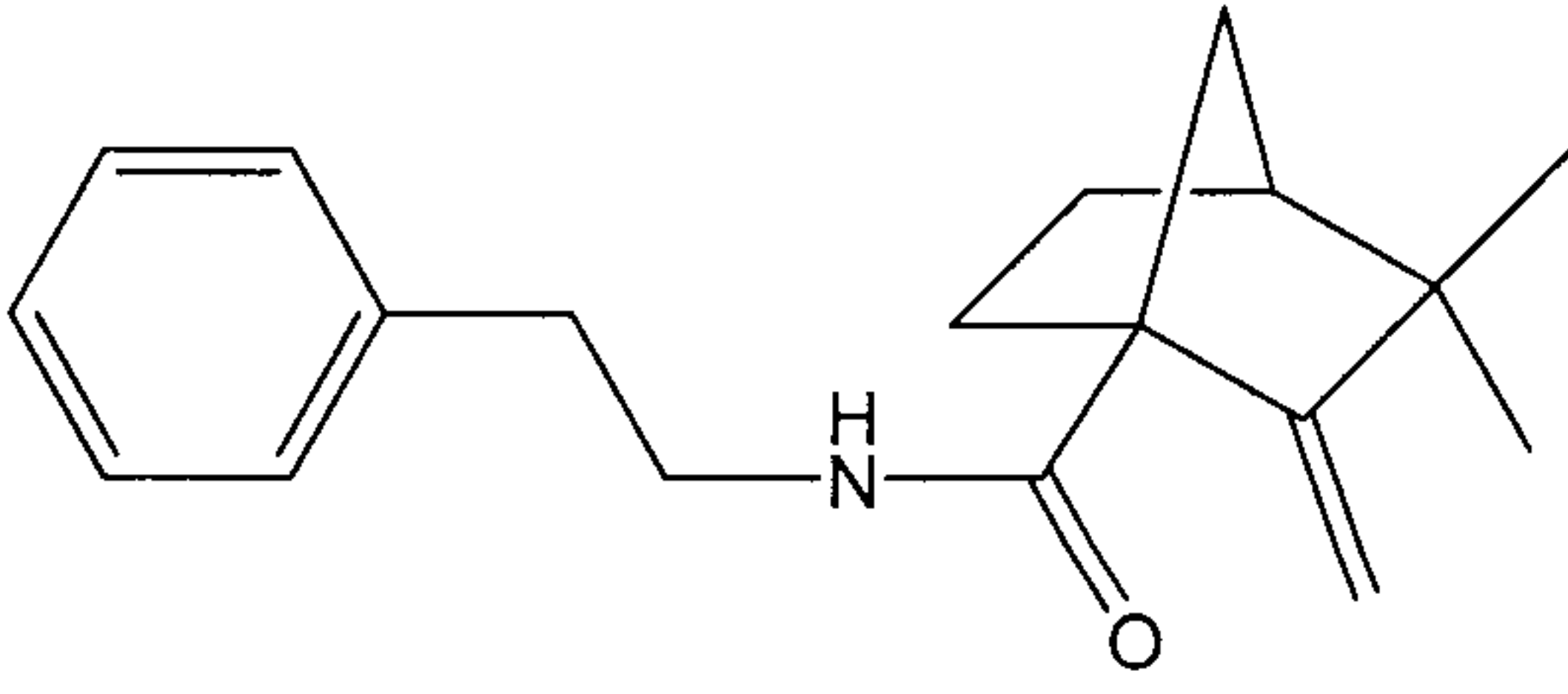
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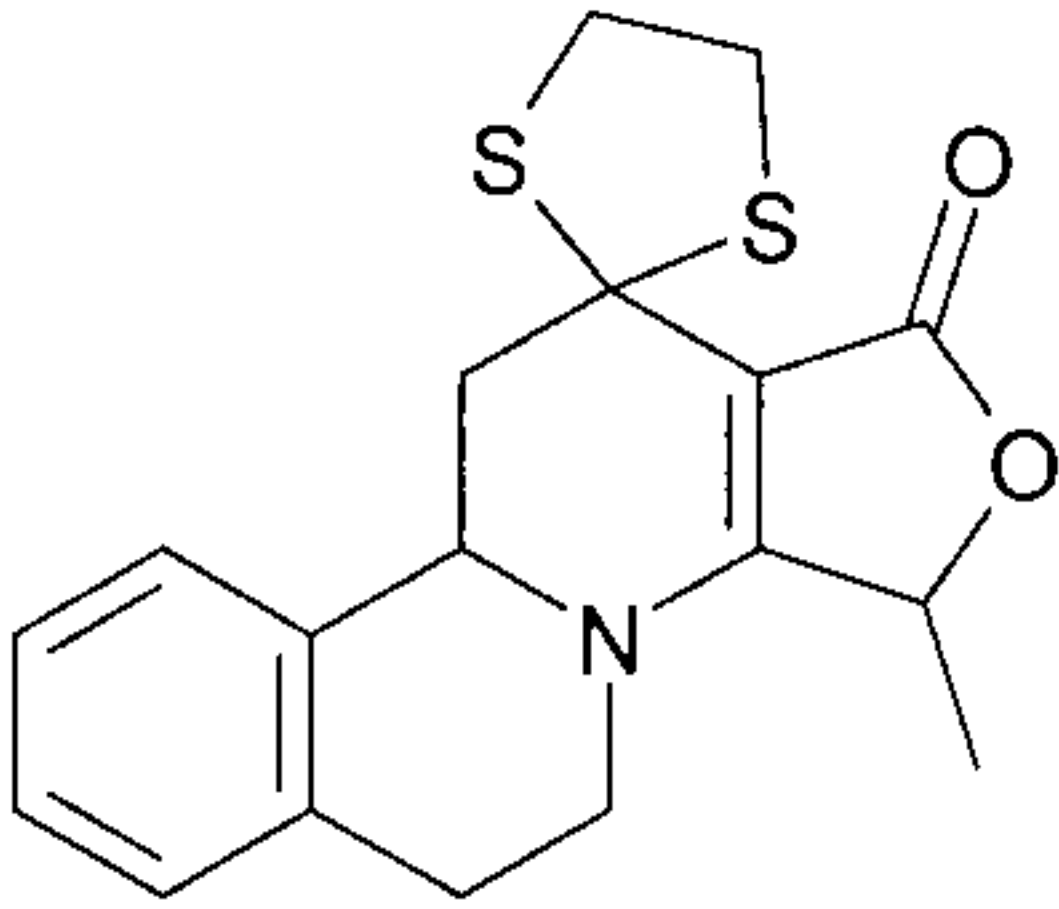
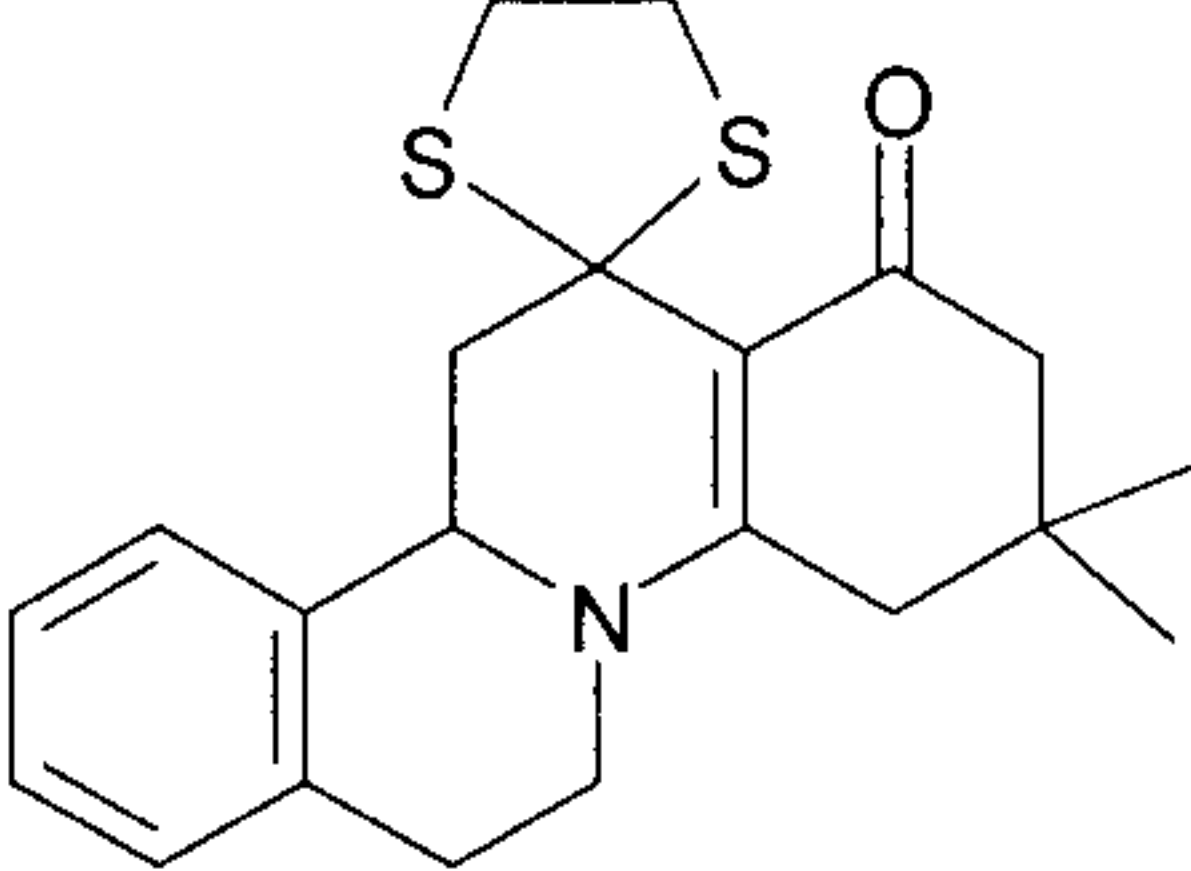
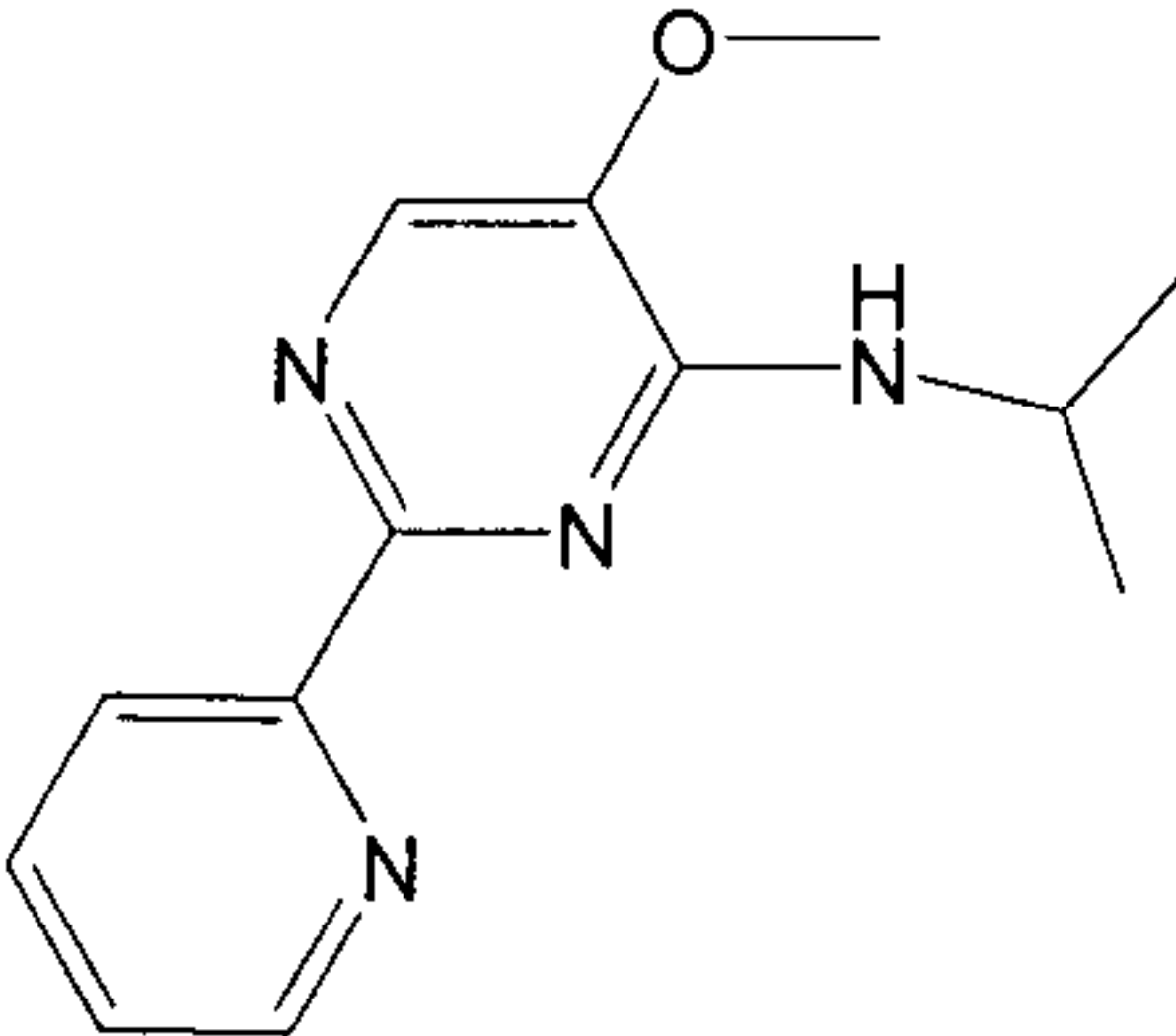
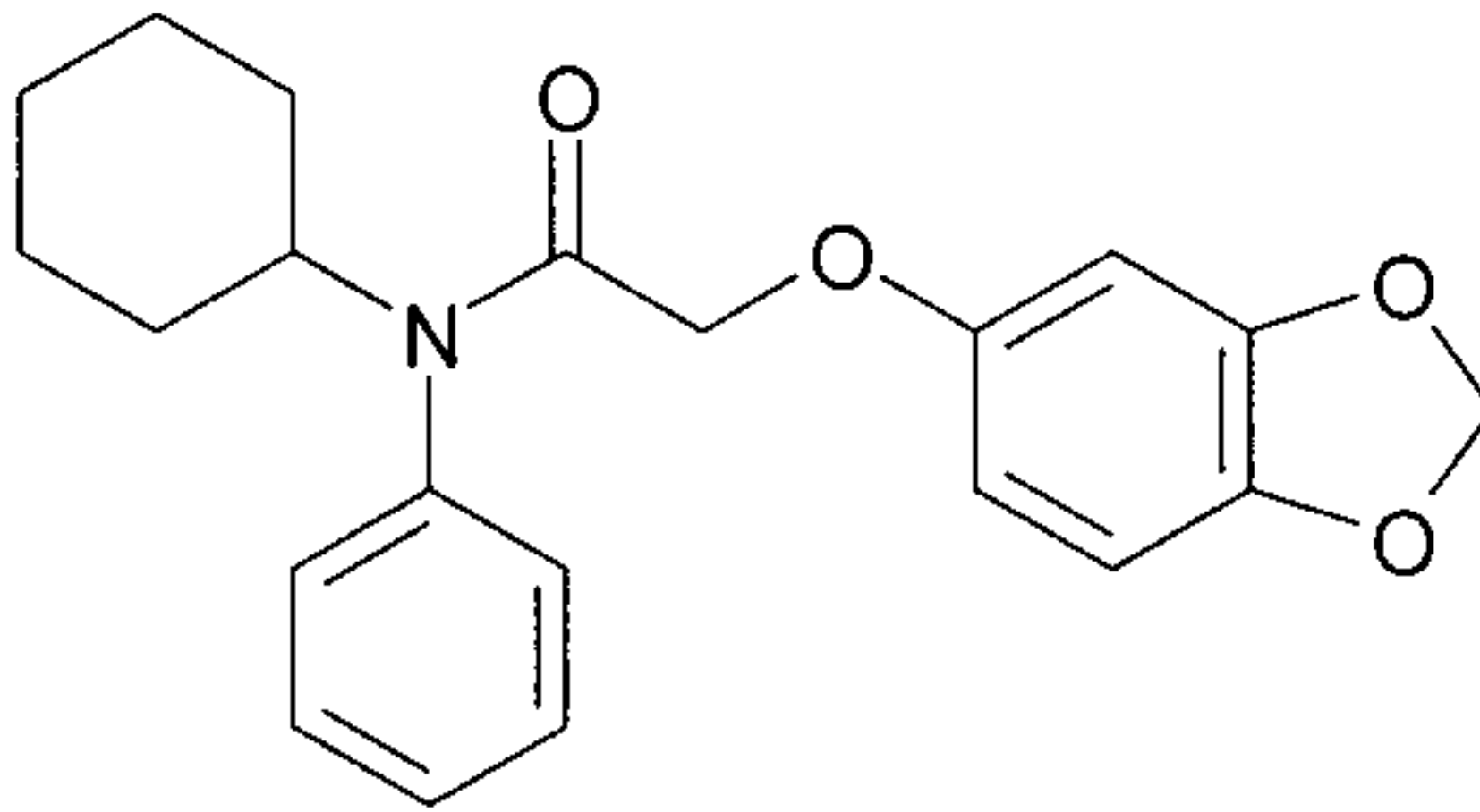
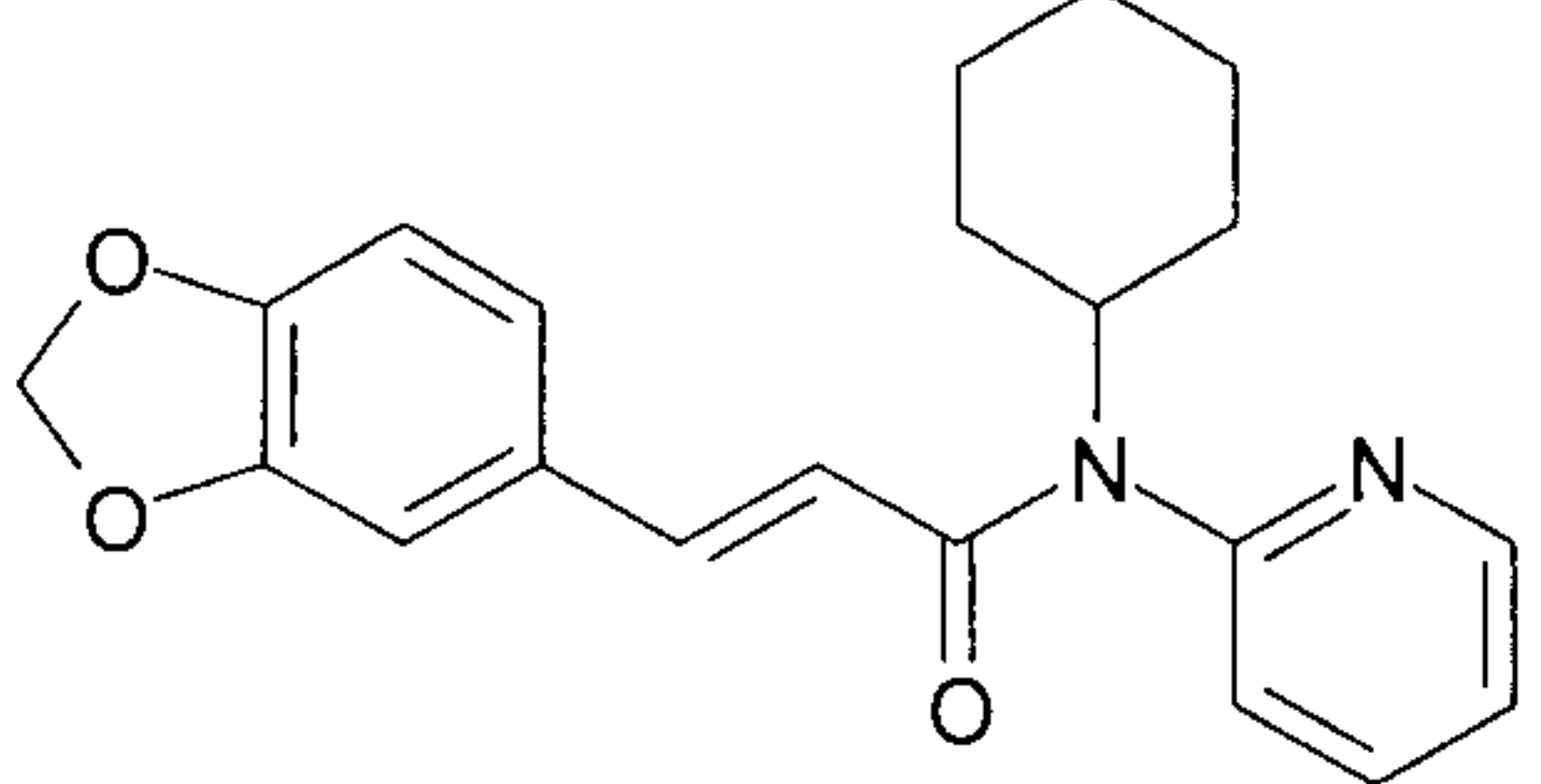
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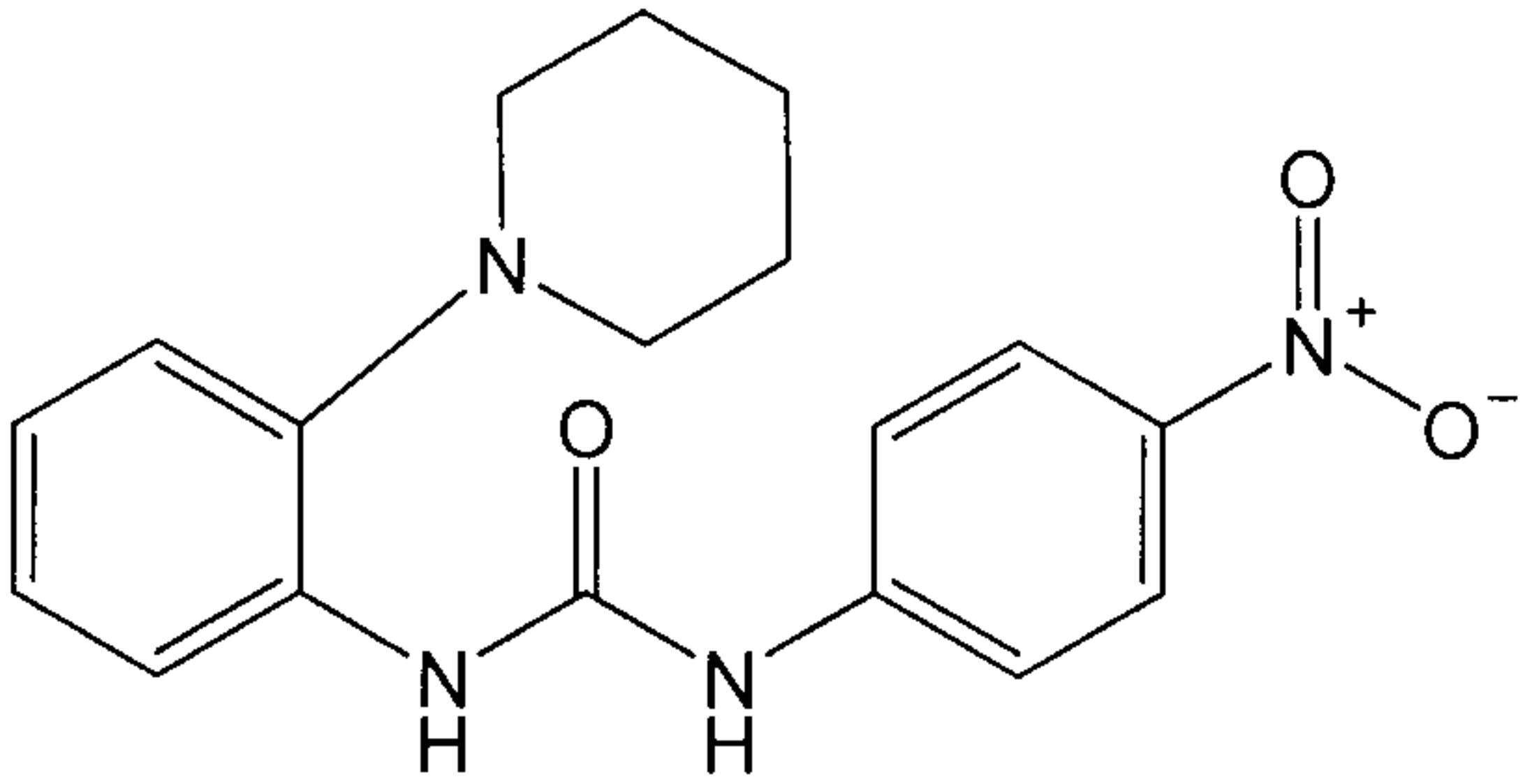
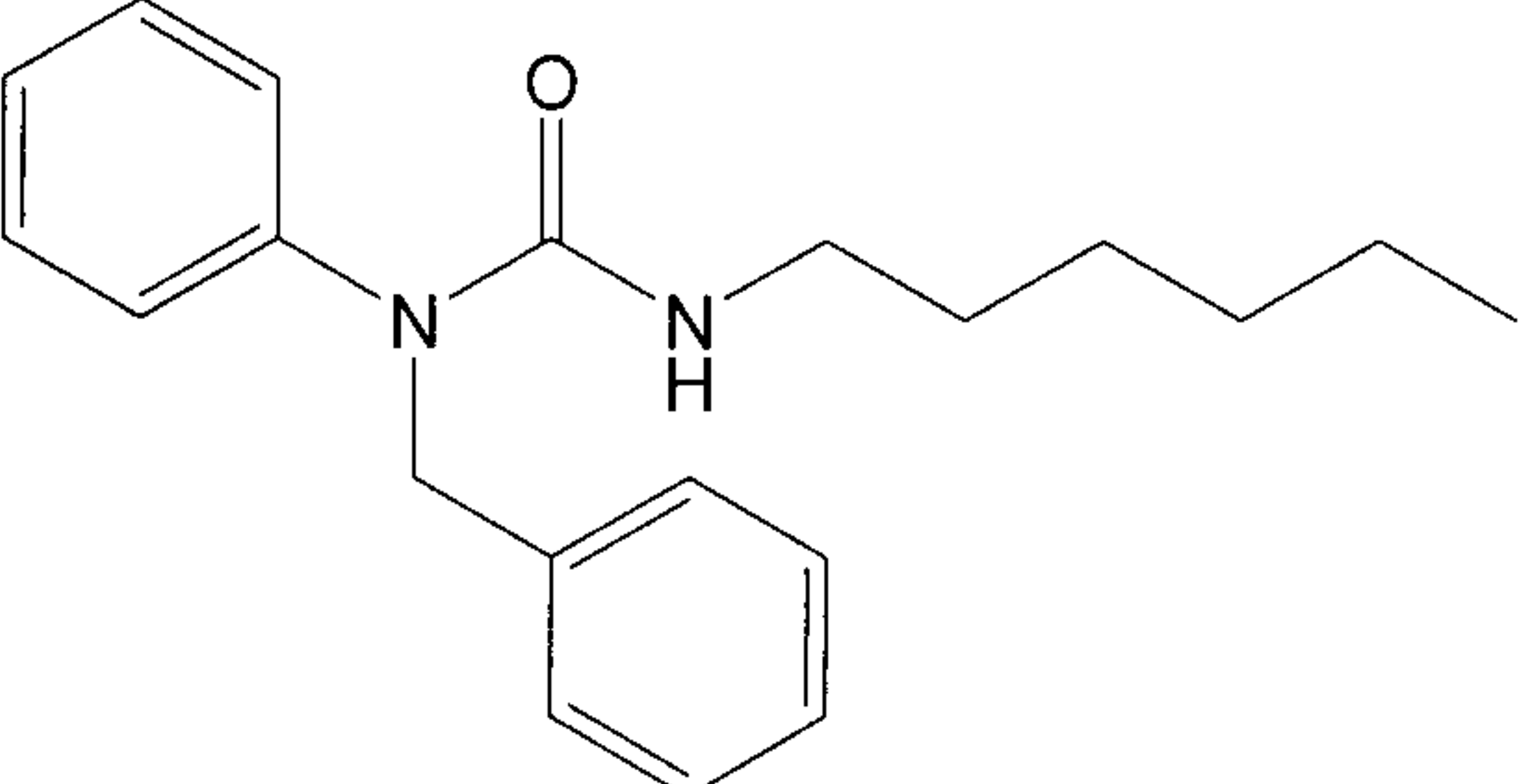
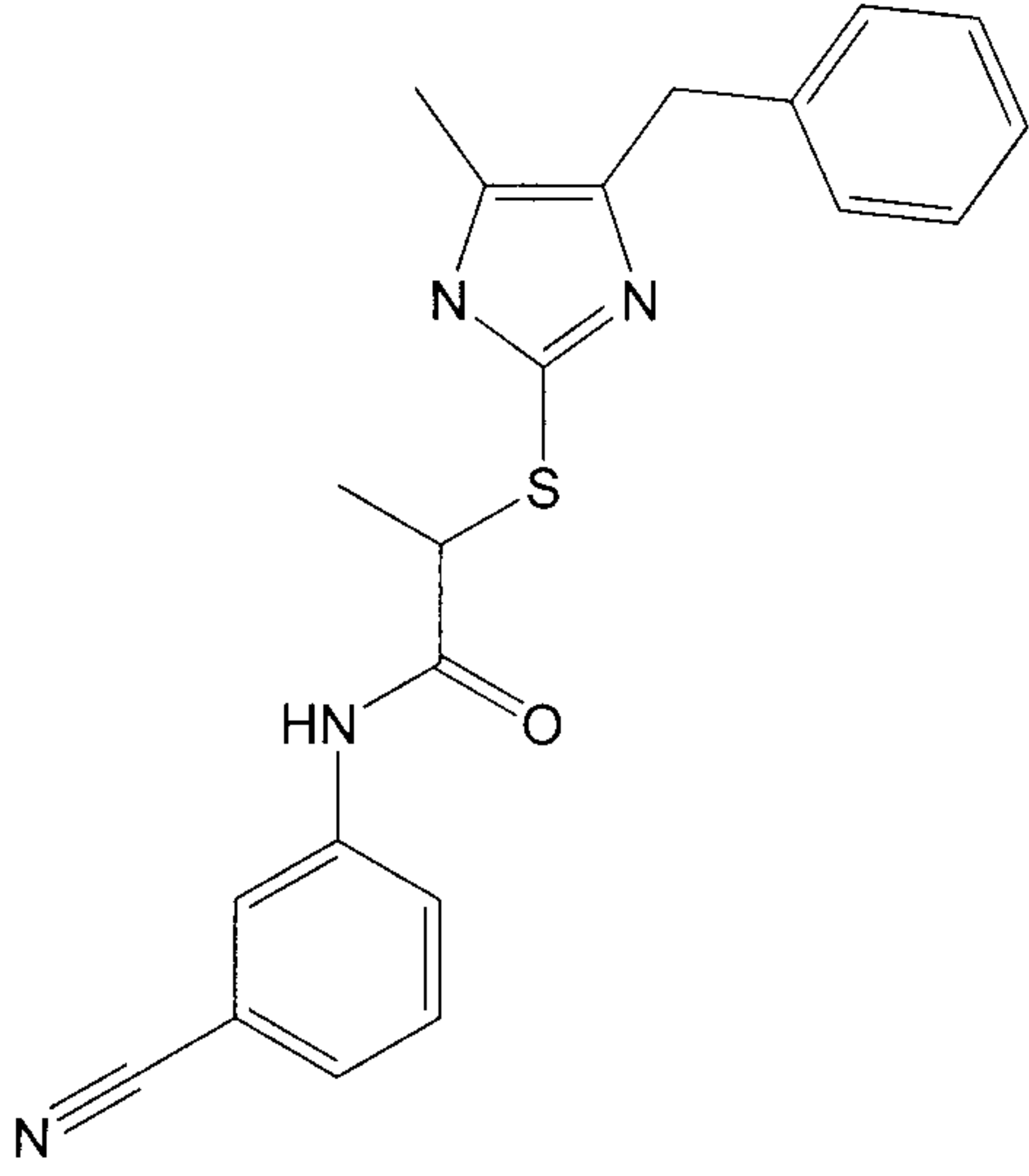
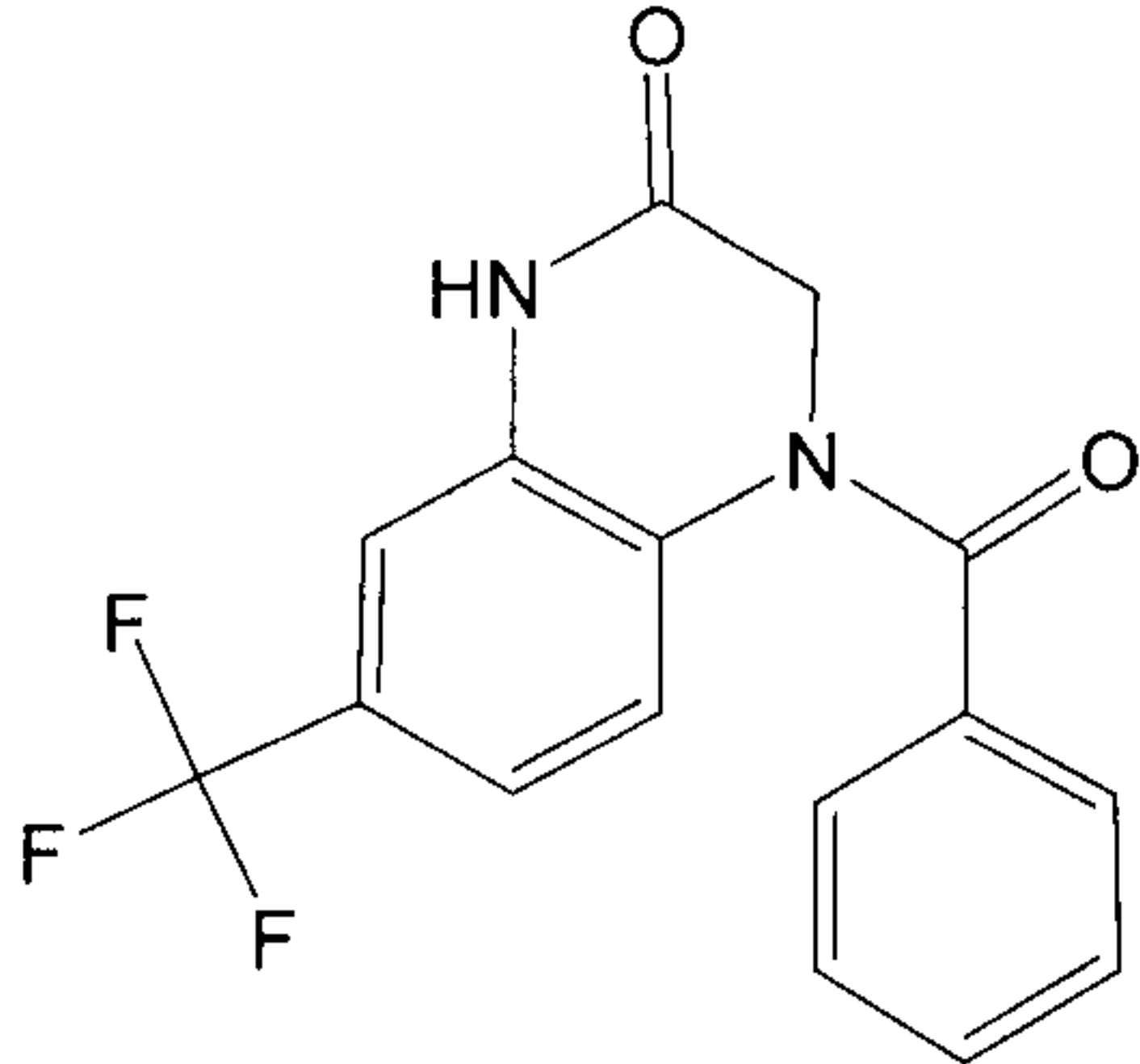
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In another aspect, the invention relates to a modulator for a TRPM8 receptor, wherein the modulator is a compound of formula 1 to 19:

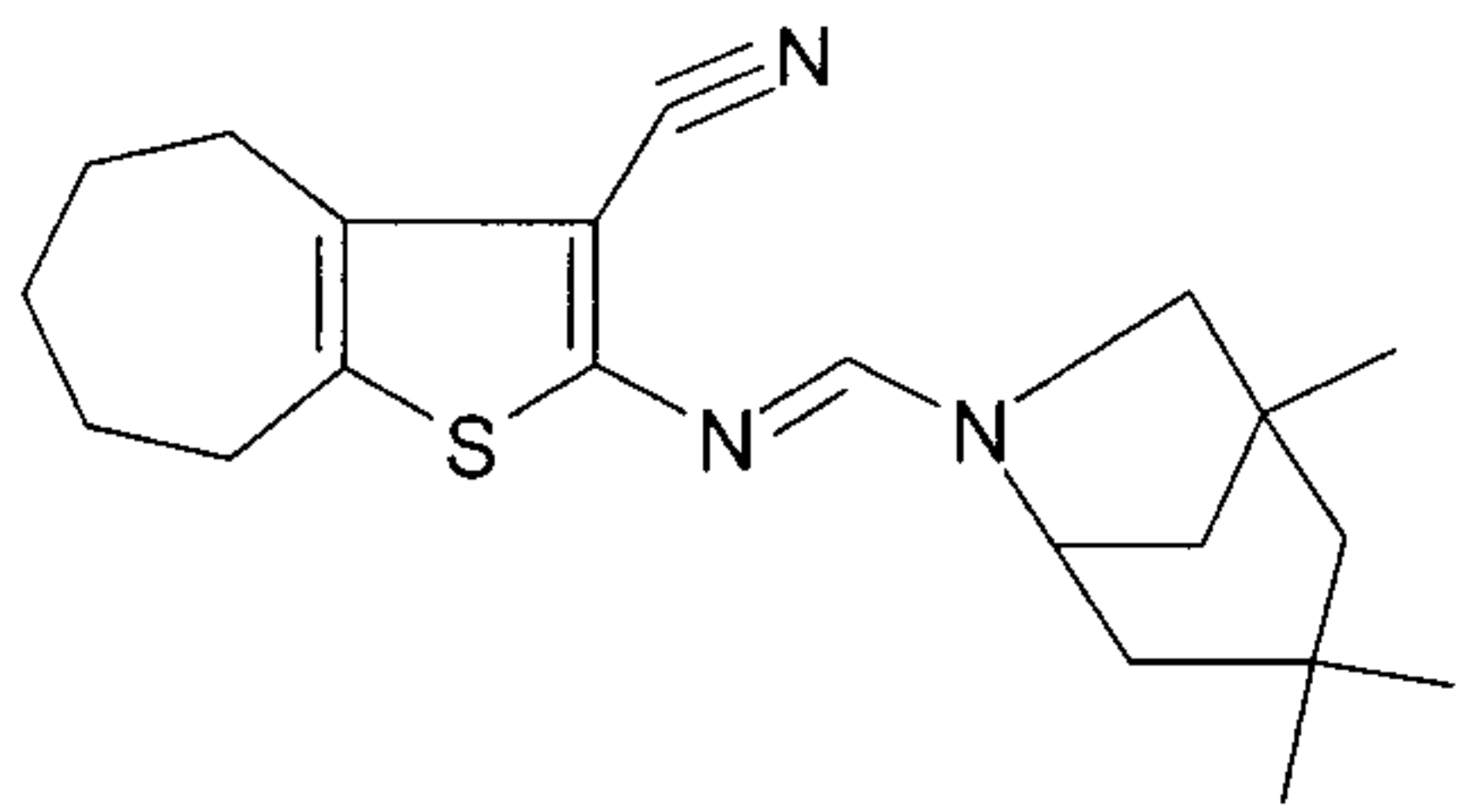
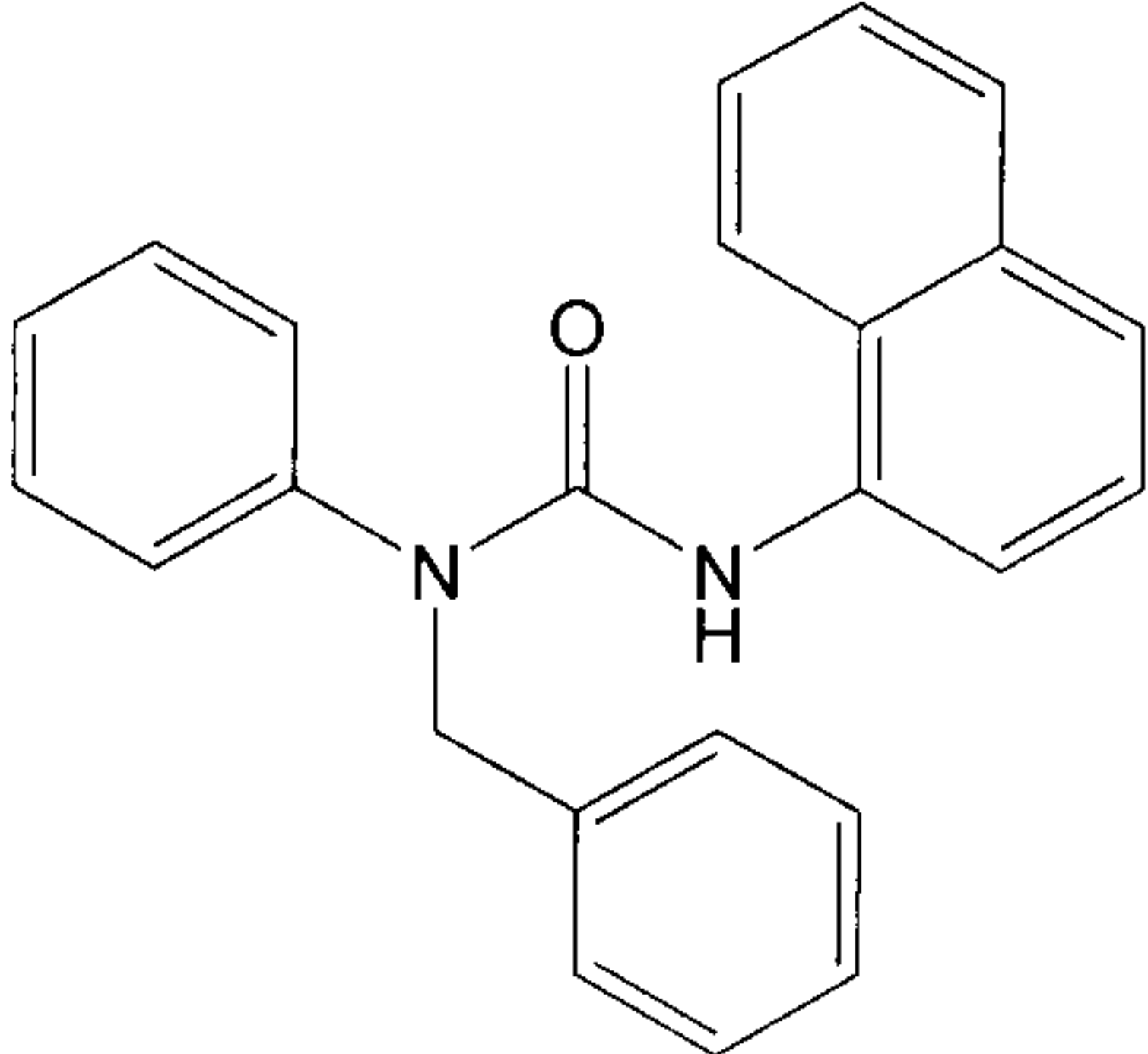
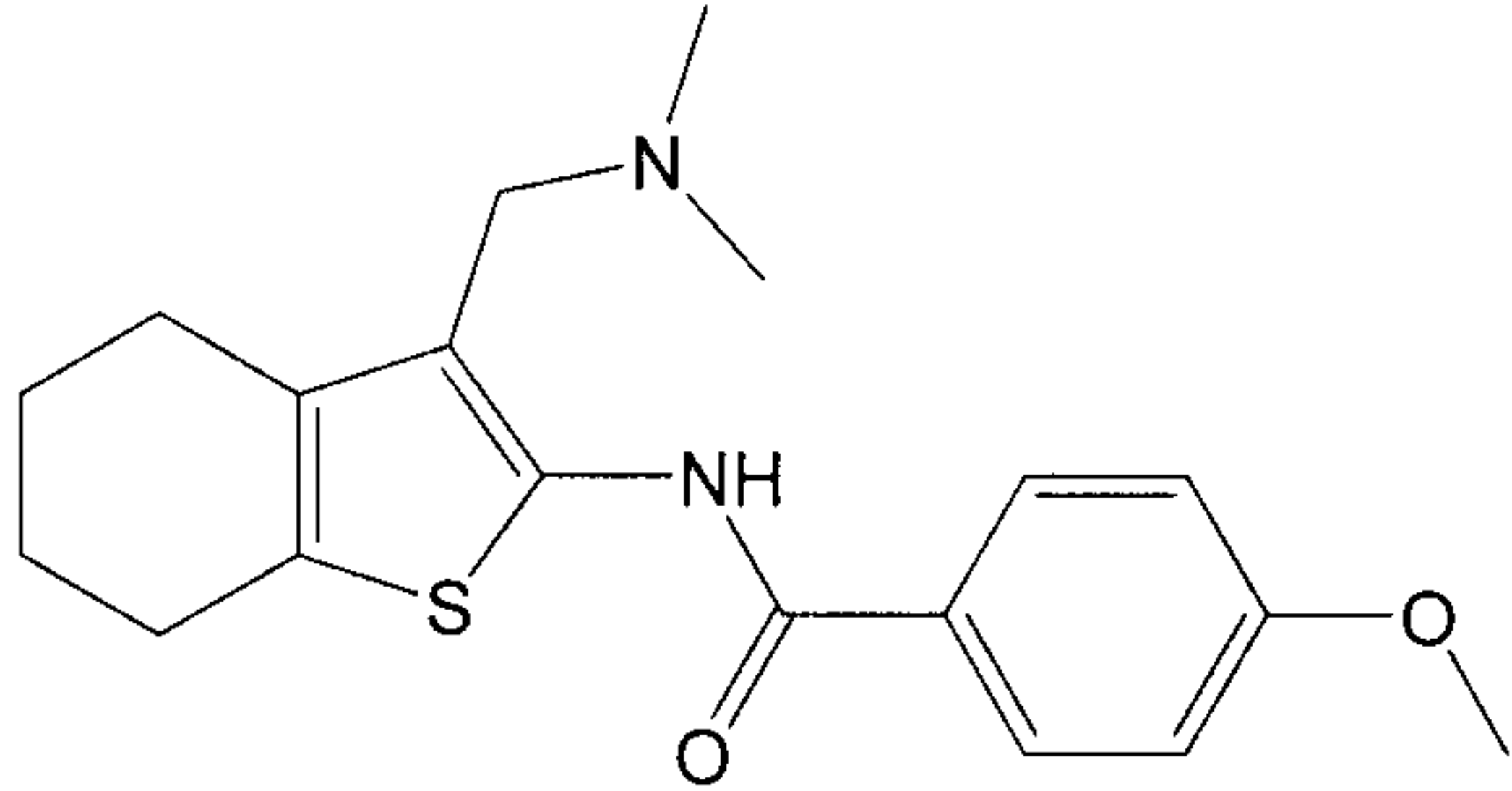
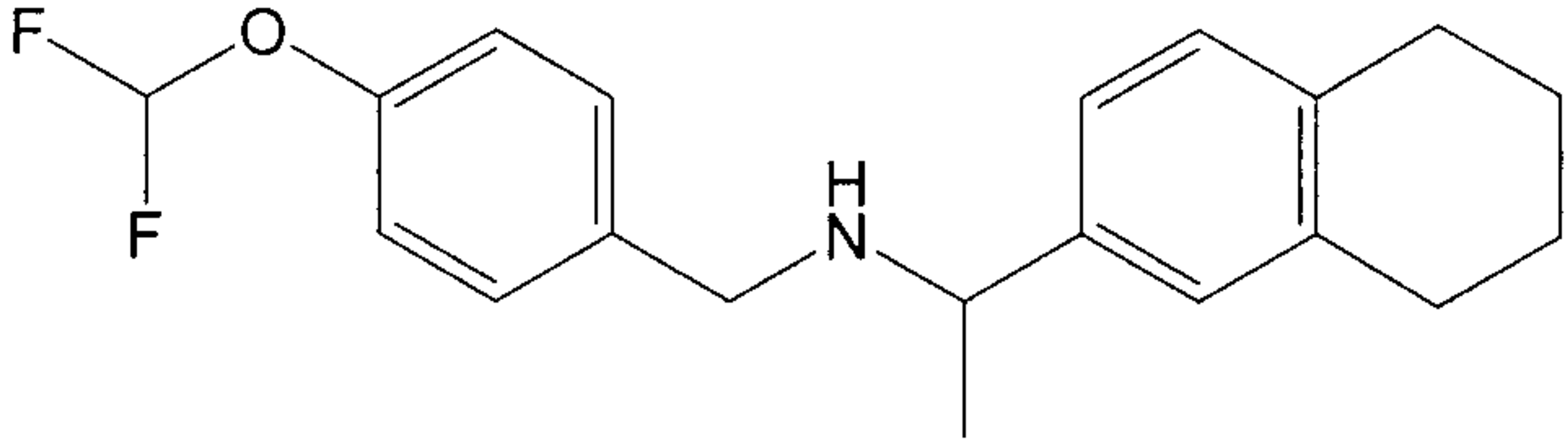
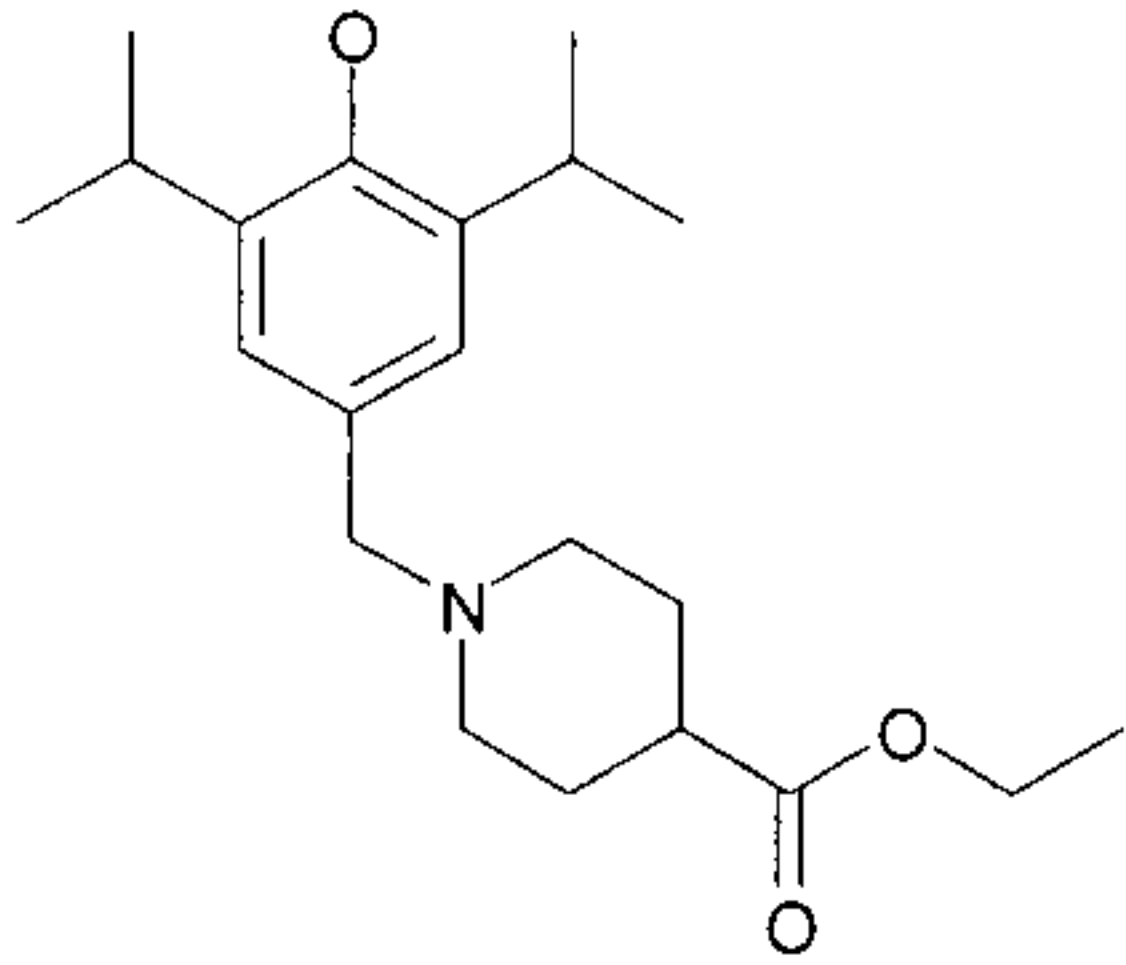
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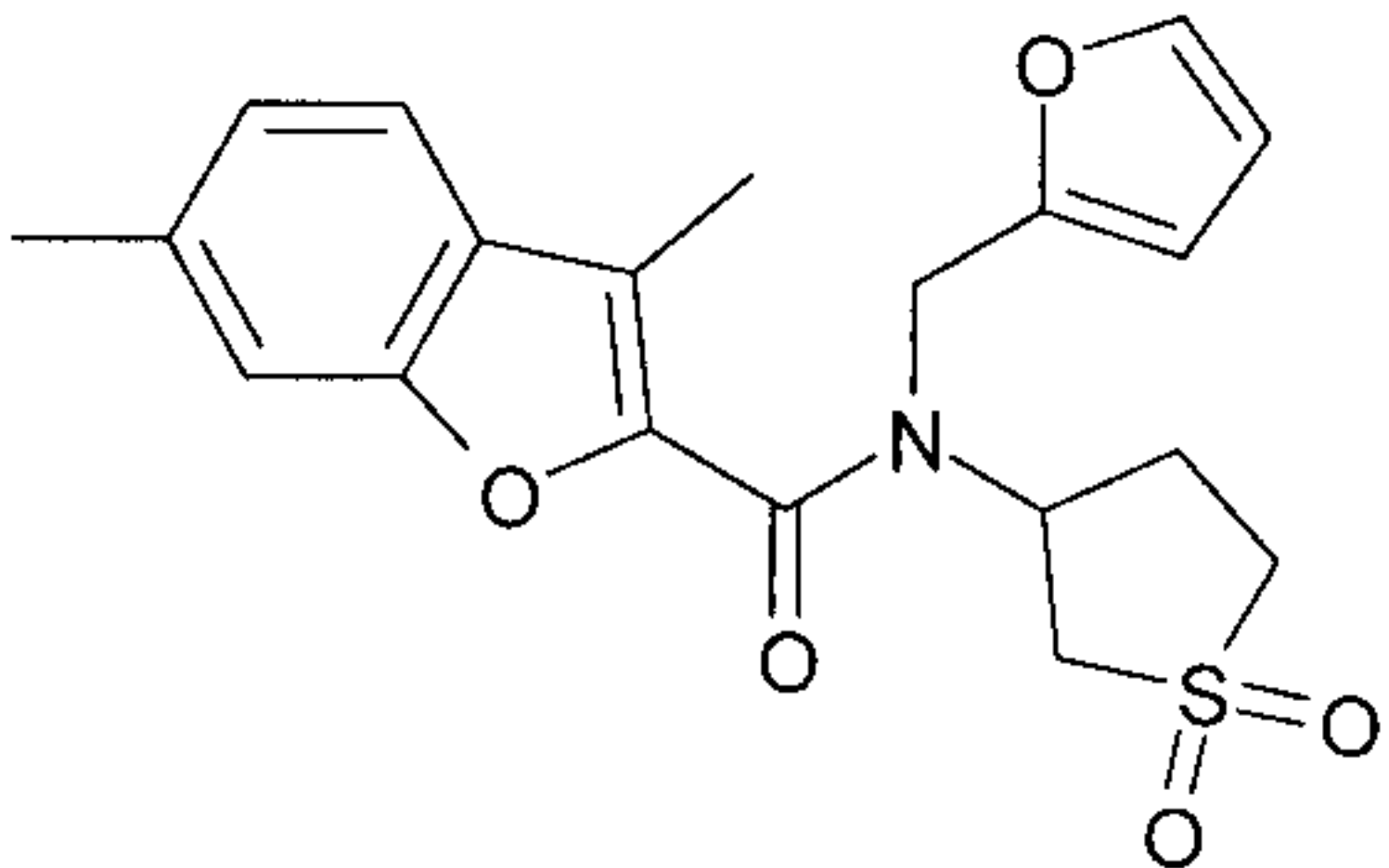
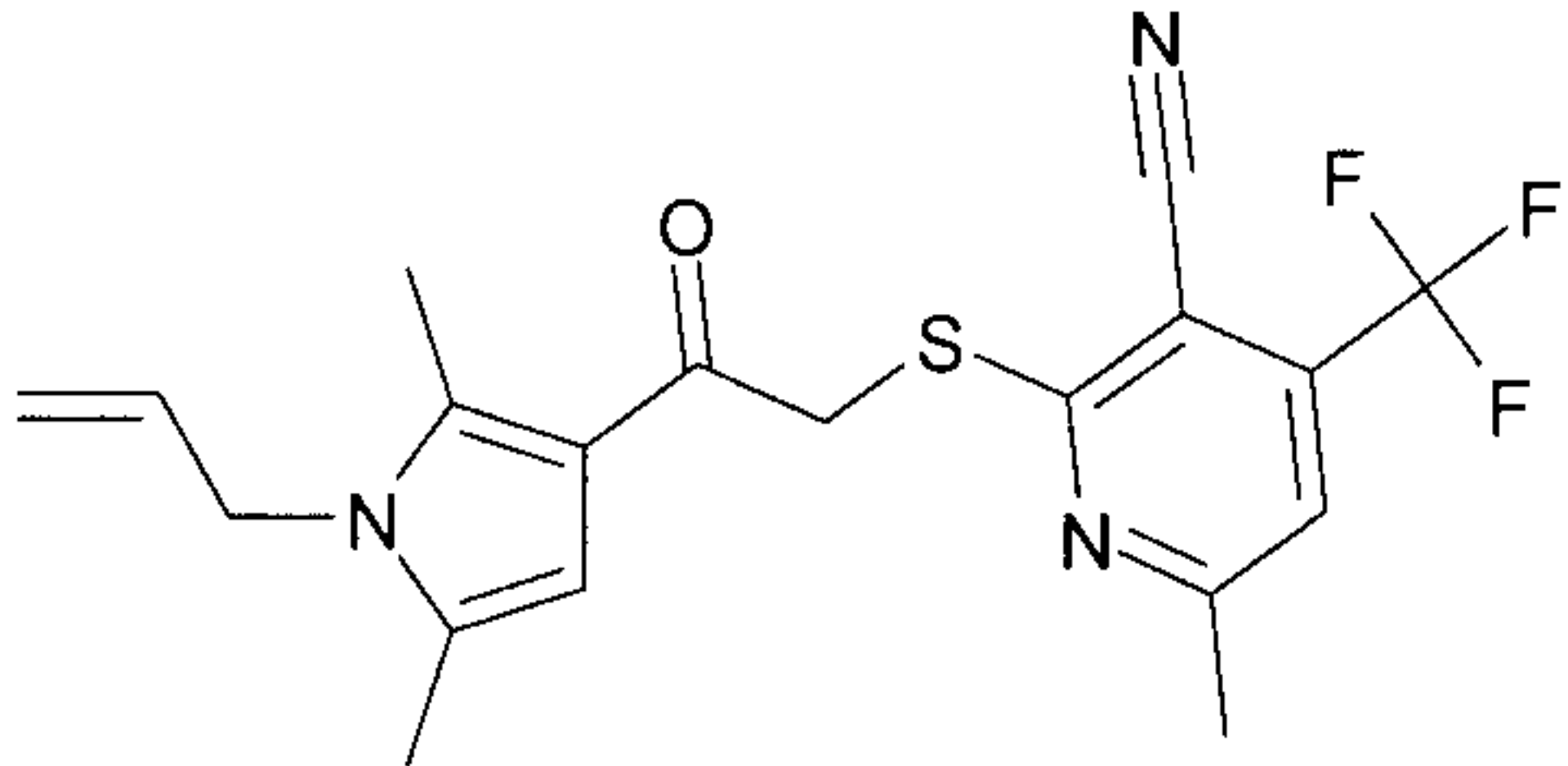
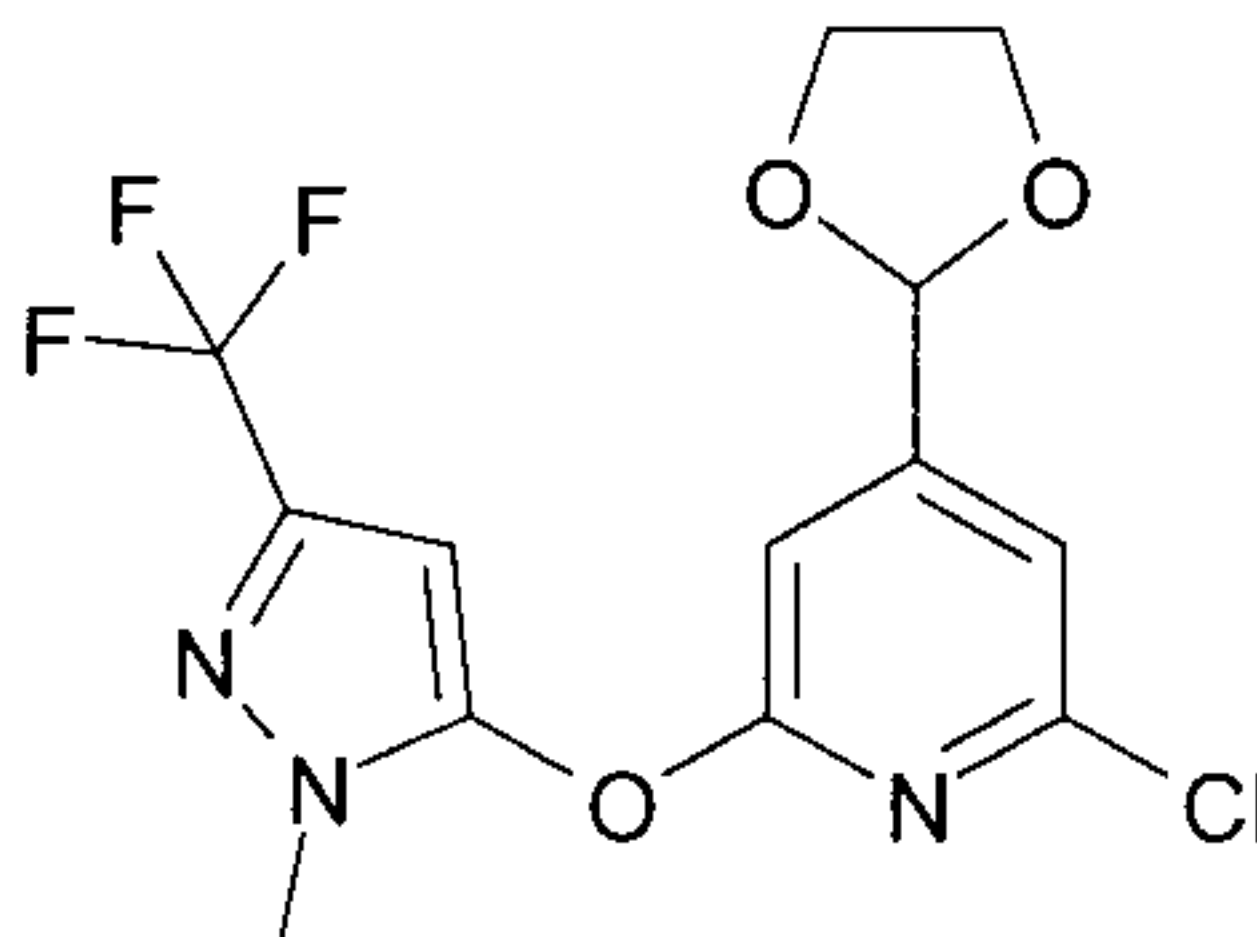
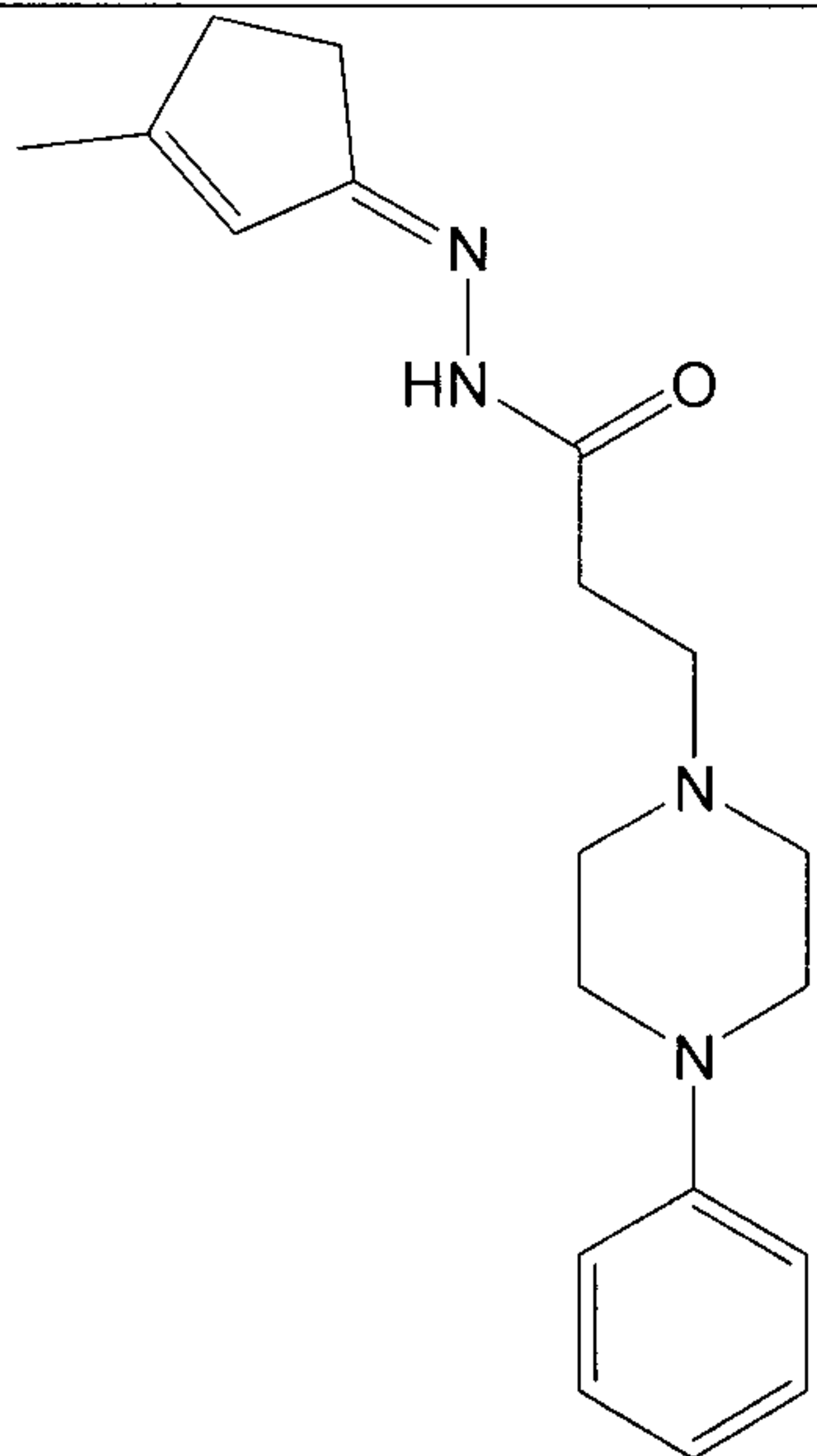
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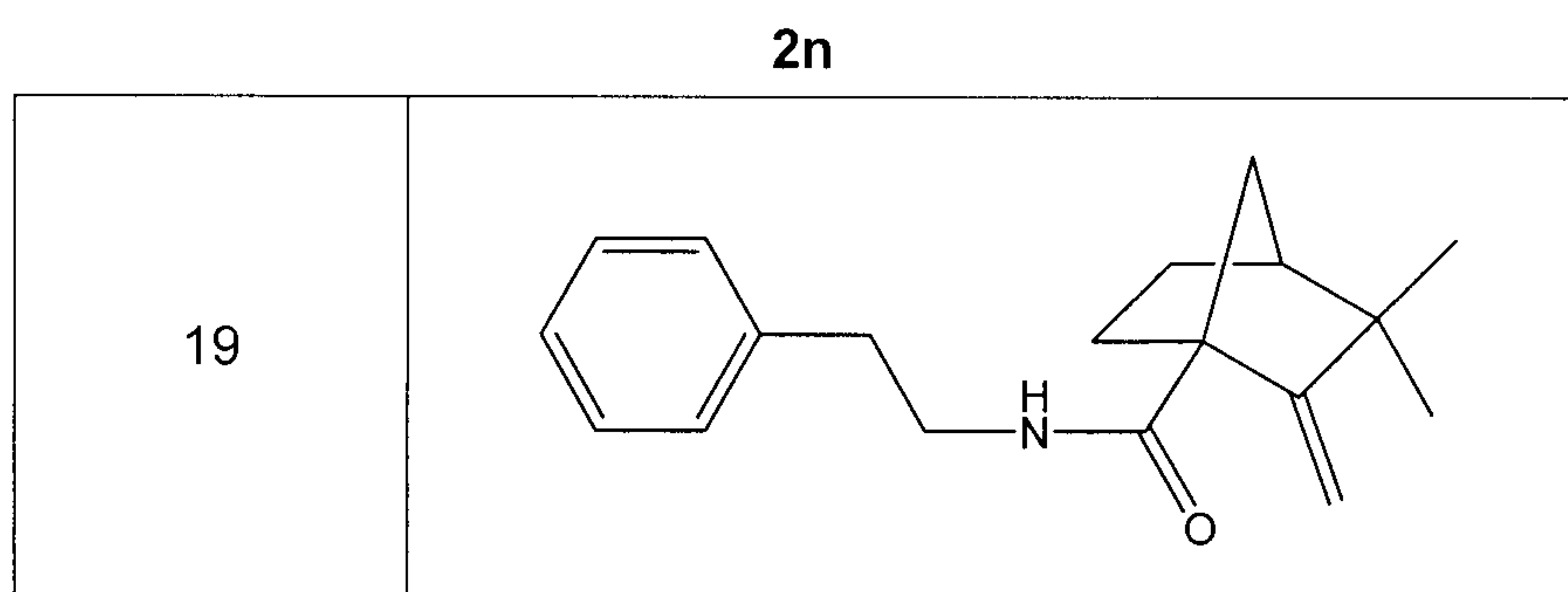
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10	 <chem>N#CC1=C(C2=CC=CC=C2S1)CN(C)CC3C(C)CC(C)C3</chem>
11	 <chem>O=C(Nc1ccc2ccccc2c1)N(Cc3ccccc3)c4ccccc4</chem>
12	 <chem>CN(C)CC1=C(C2=CC=CC=C2S1)NC(=O)c3ccc(OC)cc3</chem>
13	 <chem>COc1ccc(cc1)CNC(C)Cc2ccc(cc2)C3=CC=CC=C3</chem>
14	 <chem>CCOC(=O)C1CCN(C1)Cc2cc(C(C)C)c(=O)c(C(C)C)c2</chem>

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	or



In another aspect, the invention relates to a method for inducing a sensation of coldness in at least one of a human or an animal comprising contacting a packaging material comprising the modulator defined herein and a textile comprising the modulator defined herein.

In another aspect, the invention relates to a composition comprising the modulator defined herein, and an acceptable excipient, wherein the composition is

- a) a pharmaceutical composition,
- b) a food,
- c) a mouthcare composition,
- d) a skincare or haircare composition, or
- e) an insect repellent and insecticide.

In another aspect, the invention relates to a textile product comprising the modulator defined herein.

In another aspect, the invention relates to a packaging material comprising the modulator defined herein.

In another aspect, the invention relates to the use of one of the compound of formula 1 to 19, as defined herein, for the manufacture of a medicament useful for modulating the TRPM8 receptor.

In another aspect, the invention relates to the use of one of the compound of formula 1 to 19, as defined herein, for modulating the TRPM8 receptor.

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In another aspect, the invention relates to the use of one of the compound of formula 1 to 19, as defined herein, for the manufacture of a medicament useful for inducing a sensation of coldness in a human or animal.

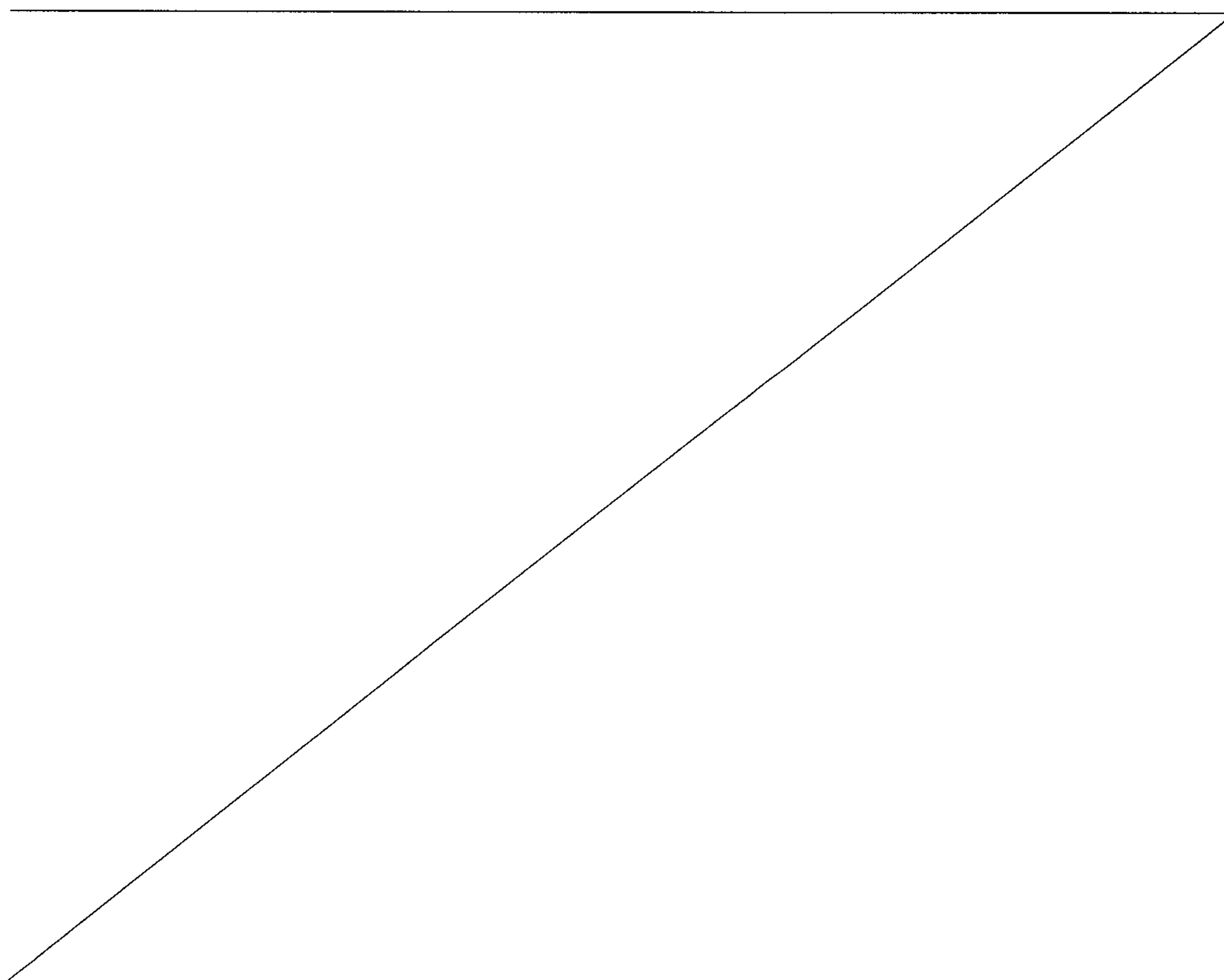
- 5 In another aspect, the invention relates to the use of one of the compound of formula 1 to 19, as defined herein, for inducing a sensation of coldness in a human or animal.

10 In another aspect, the invention relates to the use of one of the compound of formula 1 to 19, as defined herein, for the treatment of prostate carcinoma, bladder weakness or pain.

15 In another aspect, the invention relates to the use of one of the compound of formula 1 to 19, as defined herein, for the manufacture of a medicament for the treatment of prostate carcinoma, bladder weakness or pain.

Description of the figures:

Figure 1 shows the vector map of the plasmid pInd_M8 coding with hTRPM8, which has been used for the transfection of HEK293 cells.



Detailed description of the invention:**1. Definition of general terms:**

5 In the literature there are various synonyms for "TRPM8": TRPP8, LTRPC6, CMR1, MGC2849, transient receptor potential cation channel subfamily M member 8. Within the context of the present invention, all names are encompassed. Also encompassed are all functional modifications of the receptor, such as, in particular, splice variants, isoforms, such as e.g. TRPM8 CRA_a, TRPM8 CRA_b and all analogous receptors
10 from various organisms, such as human, mouse, rat. The nucleotide and amino acid sequences of the various receptors are known per se and listed in sequence databases. Thus, e.g. the sequence information for hTRPM8 is entered under the number NM_024080.

15 Within the context of the invention, a "modulator" is a compound which can act as agonist and/or antagonist of the TRPM8 receptor *in vivo* and/or *in vitro*.

Suitable modulators here can act either only as antagonist or agonist or both as antagonist and also as agonist. Here, in particular an agonistic or an antagonistic effect
20 can be established depending on the particular modulator concentration selected.

Here, an "agonist" is a compound which mediates an activation of the TRPM8 receptor, thus induces a Ca^{2+} ingress into the cold-sensitive neurons and thereby mediates a sensation of coldness. By contrast, an "antagonist" is a compound which can
25 counteract this activation of the TRPM8 receptor.

The mediators according to the invention can exert their effect by binding reversibly or irreversibly, specifically or nonspecifically to a TRPM8 receptor molecule. Usually, the binding takes place noncovalently via ionic and/or nonionic, such as e.g. hydrophobic,
30 interactions with the receptor molecule. Here, "specific" encompasses both exclusive interaction with one or more different TRPM8 receptor molecules (such as e.g. TRPM8 molecules of different origin or various isoforms). By contrast, "nonspecific" is an interaction of the modulator with a plurality of various receptor molecules of different function and/or sequence but where, as a consequence, a desired agonistic and/or
35 antagonistic modulation (as described above) of the TRPM8 receptor can be established.

2. Preferred embodiments

The invention relates firstly to a method for the in-vitro or in-vivo modulation of the cold menthol receptor TRMP8, in particular of the human TRPM8 receptor, where the
5 receptor is brought into contact with at least one compound which is selected from polynuclear organic compounds which, in a cellular activity test, in particular under standard conditions, using cells which recombinantly express the human TRPM8 receptor, modulate the permeability of these cells for Ca^{2+} ions.

10 In this connection, "standard conditions" is understood as meaning an activity test carried out with HEK293 cells which have been transformed with human TRPM8 and loaded with calcium-sensitive dye (such as e.g. Fluo-4AM, i.e. fluo-4-acetoxymethyl ester), subsequent addition of the test compound and detection of the color change, the experimental procedure taking place at 37°C; as described e.g. example 3 below,
15 or in Behrendt et al. (2004) loc. cit.).

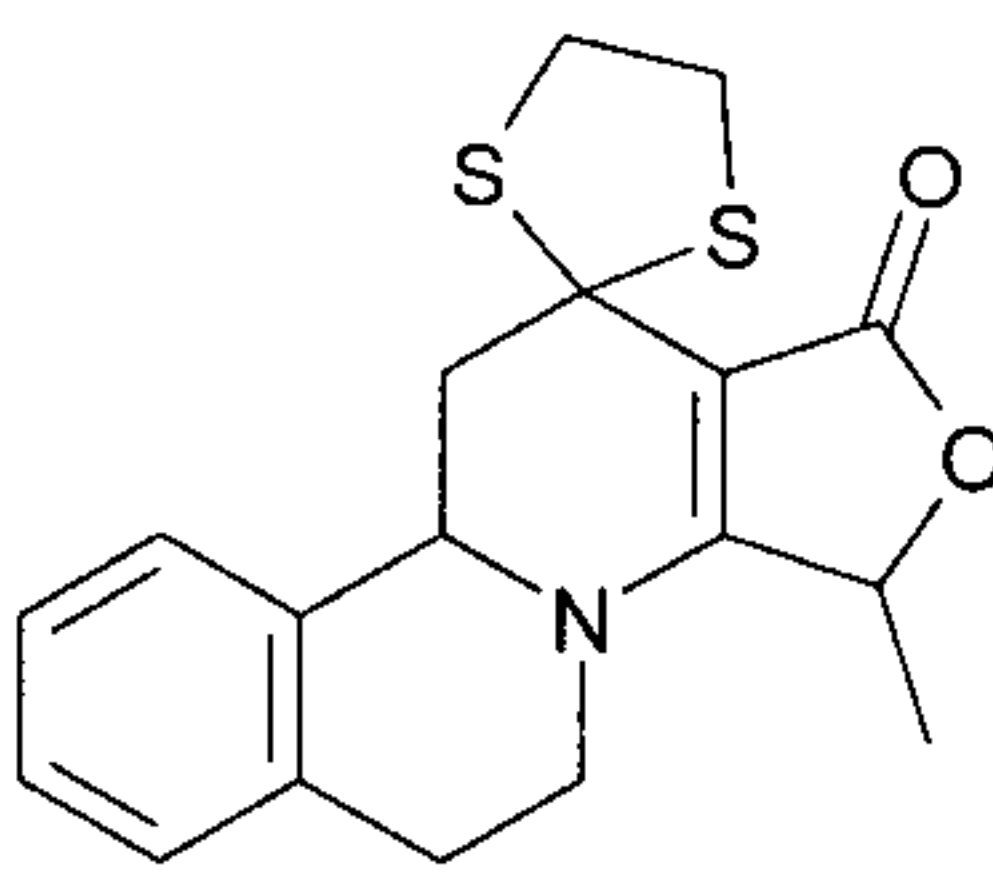
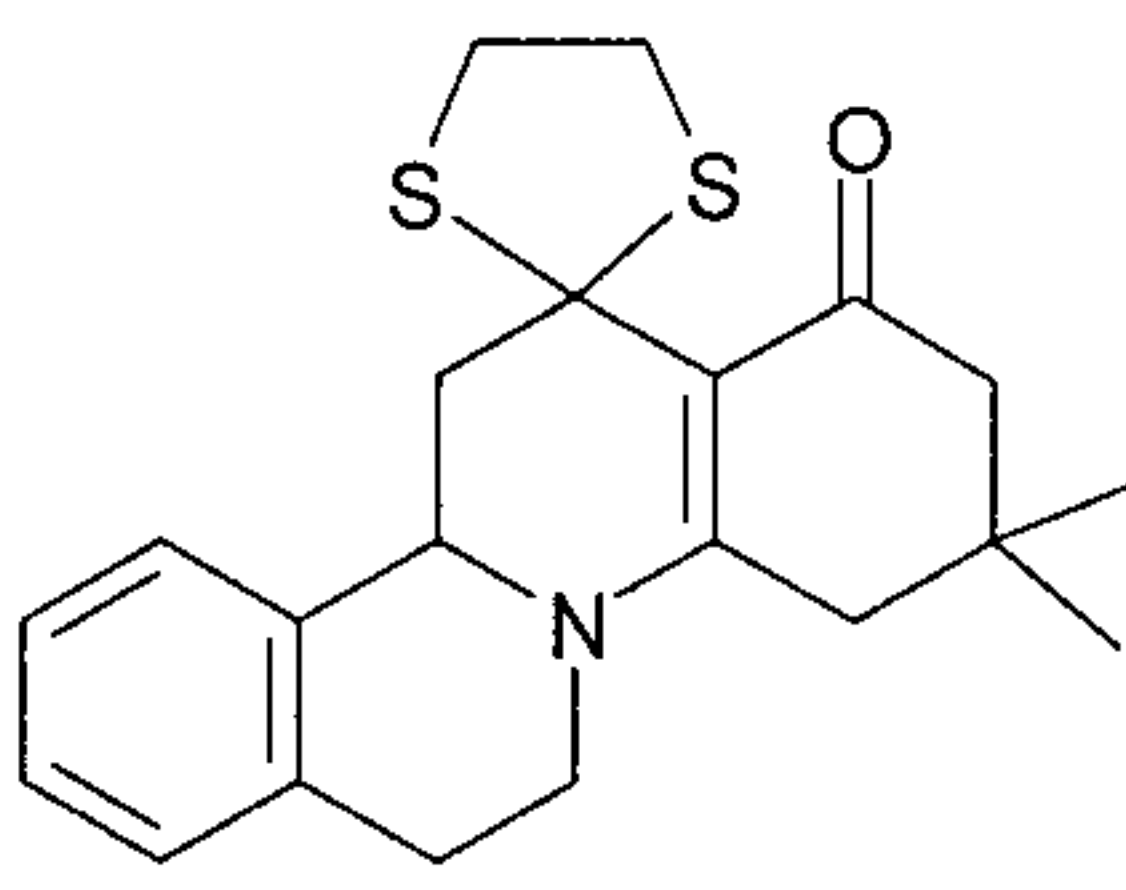
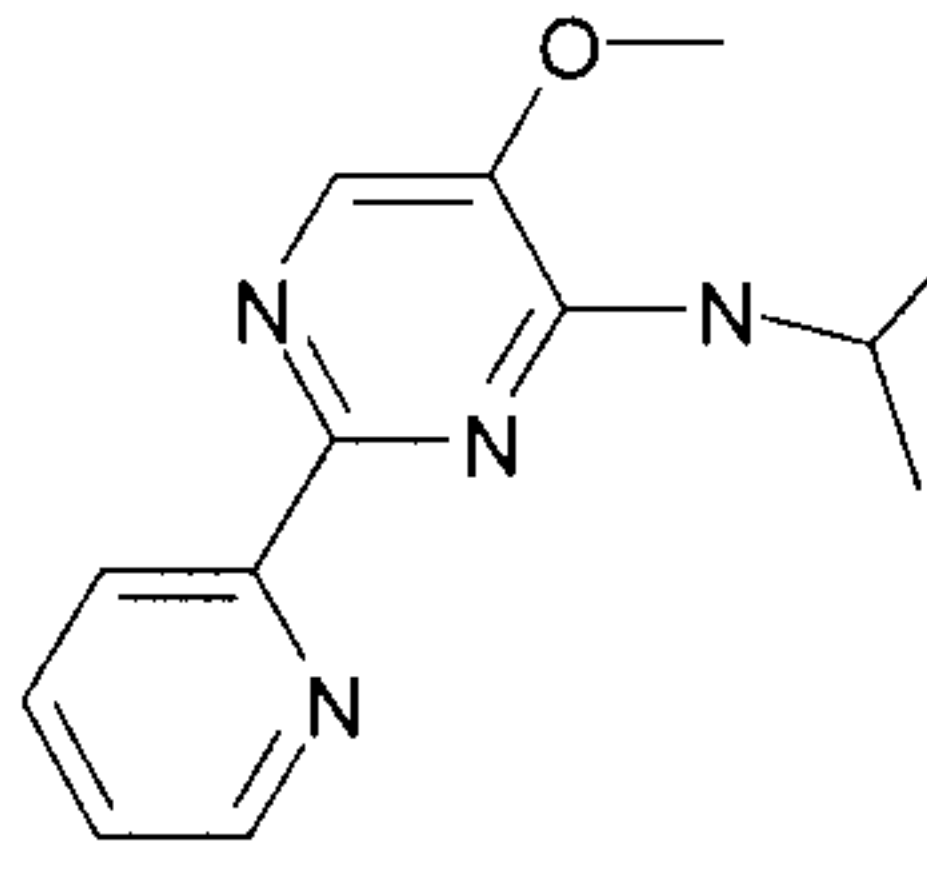
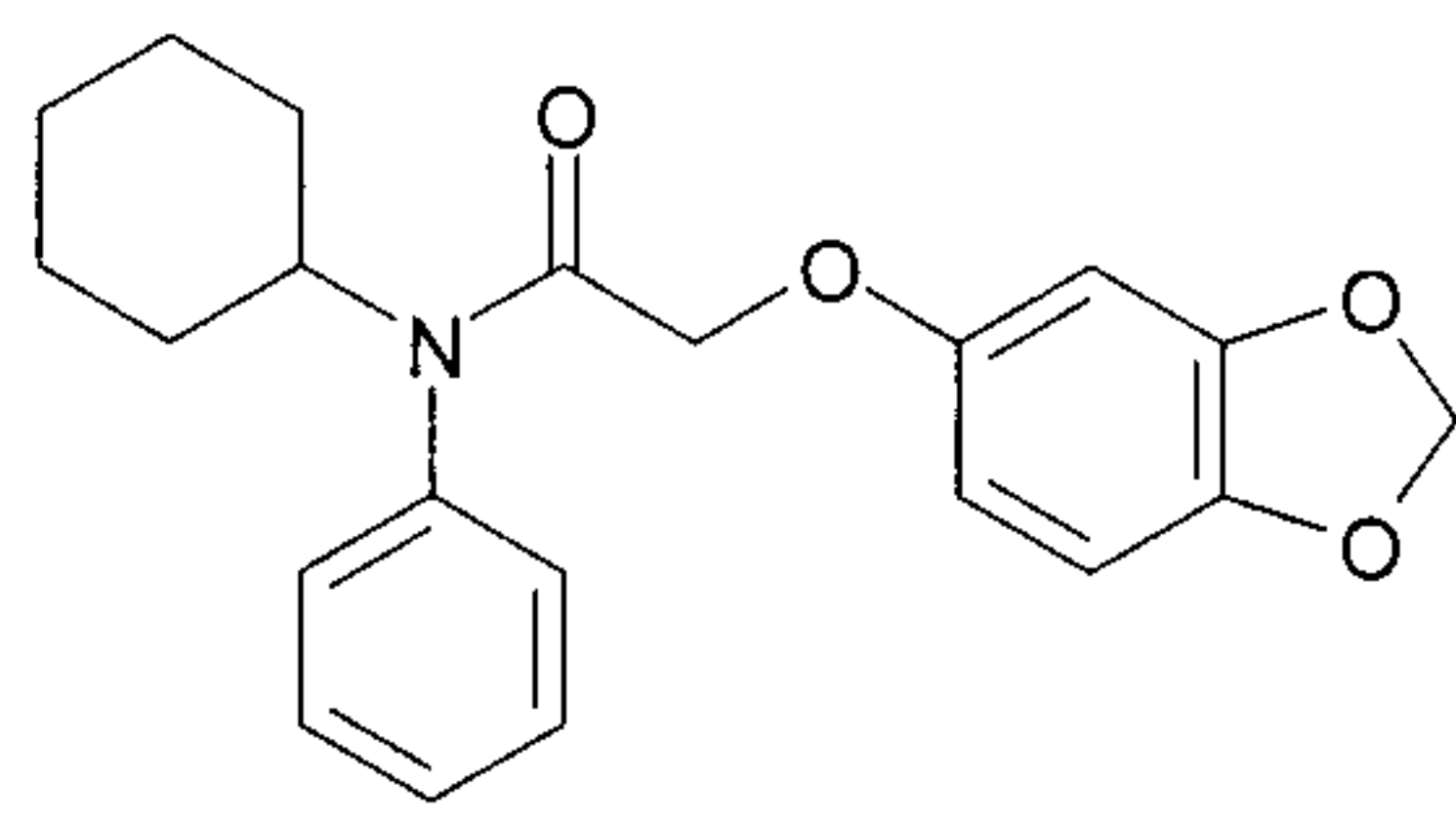
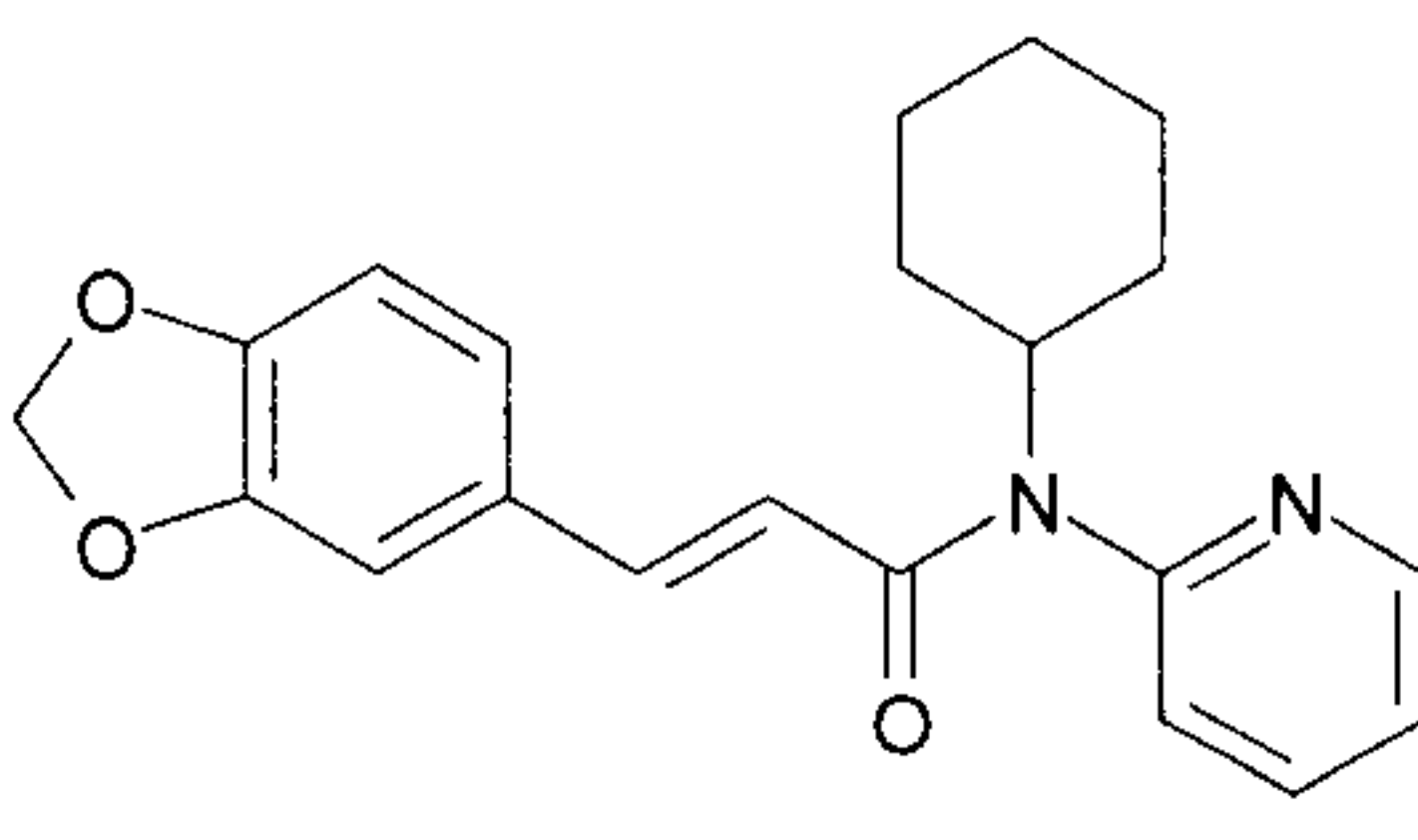
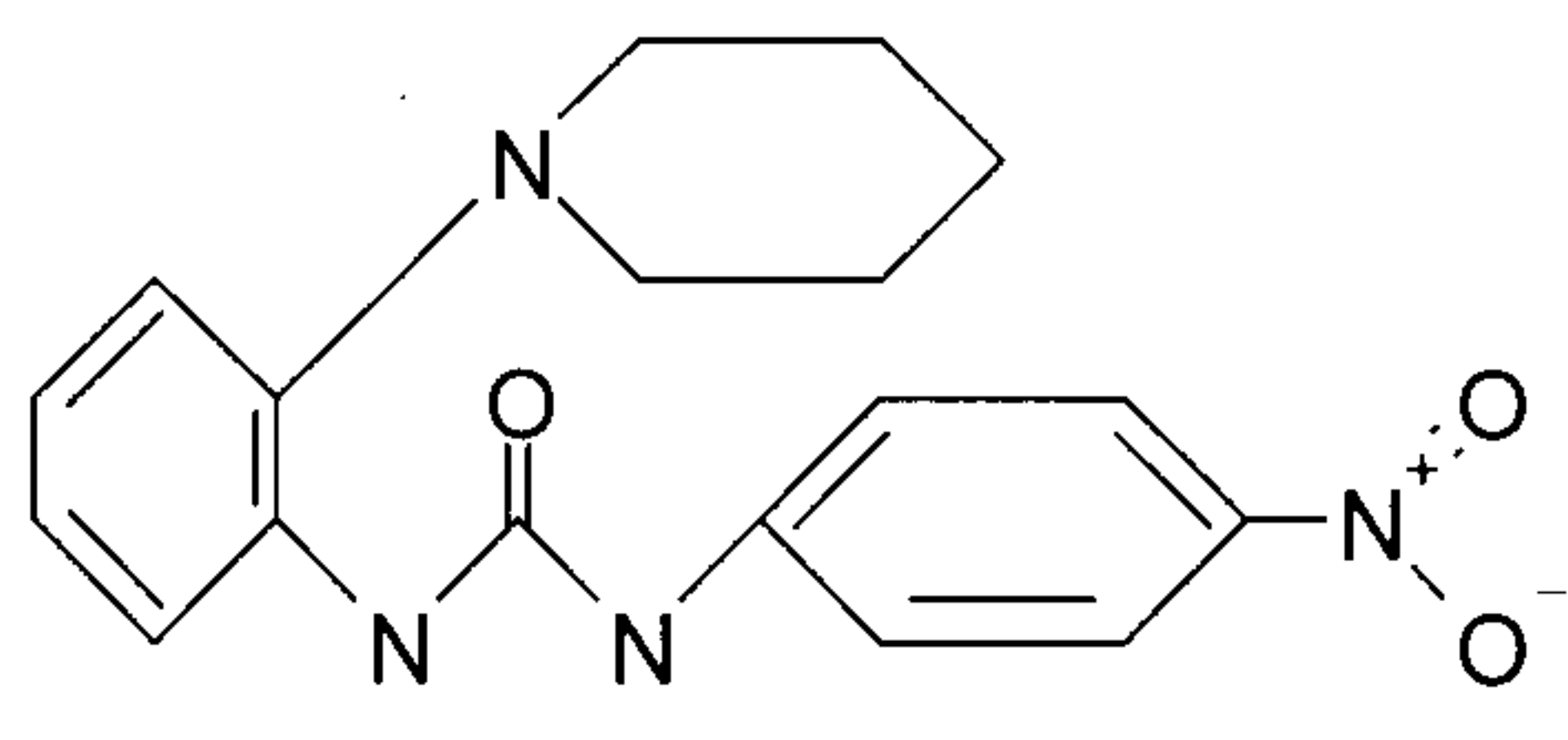
In particular, the modulating compound here comprises at least two 4- to 7-membered rings which, independently of one another, are carbocyclic or heterocyclic, monocyclic or polycyclic, and where at least two of these rings may be optionally condensed or
20 spiro-linked. Other nonlimiting examples of suitable ring linkages comprise chemical single bonds between ring carbon atoms and/or ring heteroatoms, via 2 to 6-membered carbon bridging groups, where individual carbon atoms may be replaced by heteroatoms, such as N, O or S. Moreover, the ring groups and bridging groups may optionally carry substituents which are selected from keto groups, -OH, -SH, -CN,
25 -NO₂, -C₁₋₆-alkyl, or C₂₋₄-alkenyl, where, in the alkyl or alkenyl groups, one or more H atoms may be replaced by halogen, such as F, Cl, Br or I.

Carbocyclic rings comprise here 4, 5, 6 or 7 carbon atoms; besides the ring carbon atoms, heterocyclic rings comprise 1 to 3 identical or different ring heteroatoms, such
30 as O, N and S atoms. The rings here may be, independently of one another, saturated, mono- or polyunsaturated, such as e.g. aromatic rings.

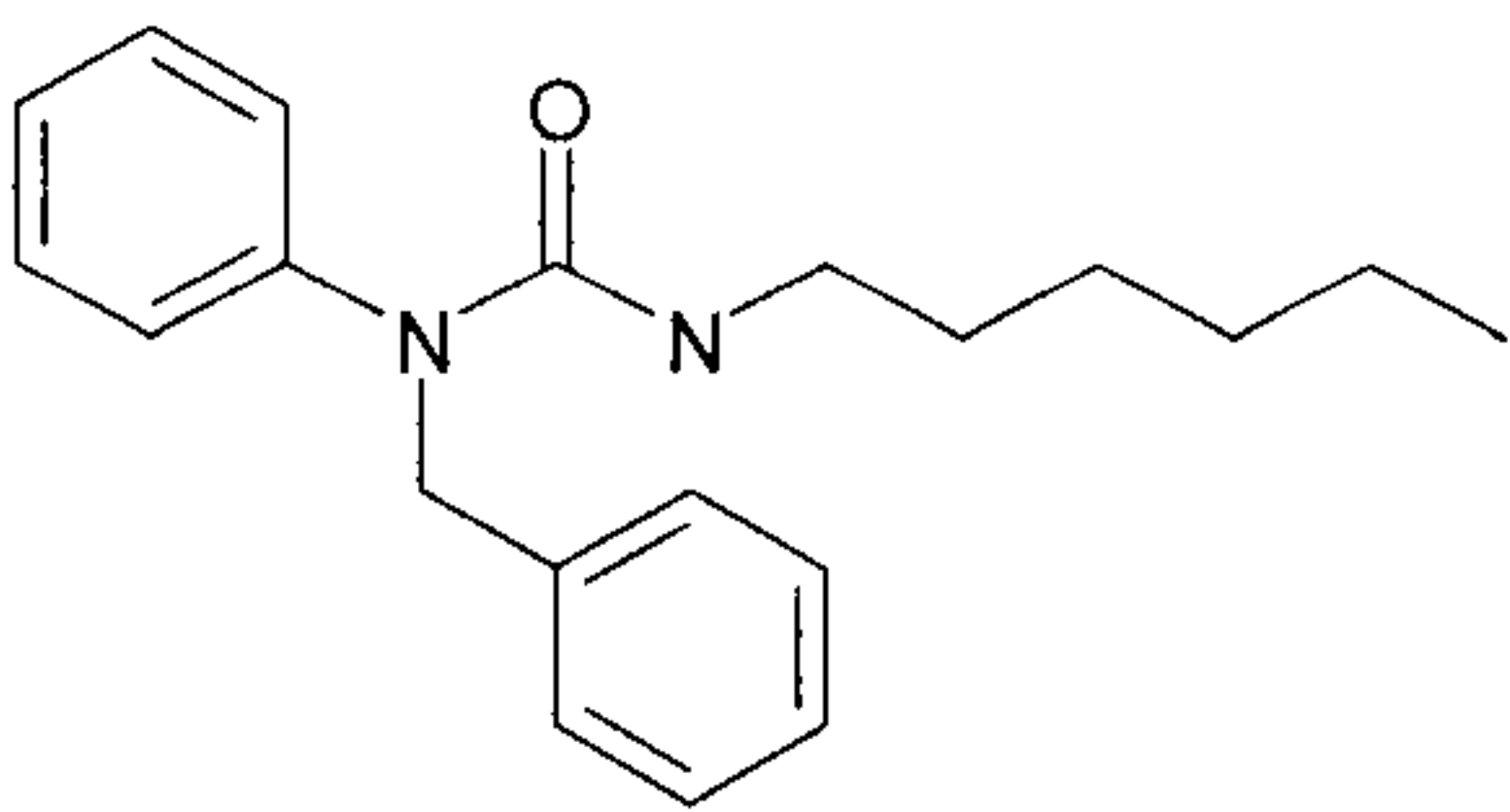
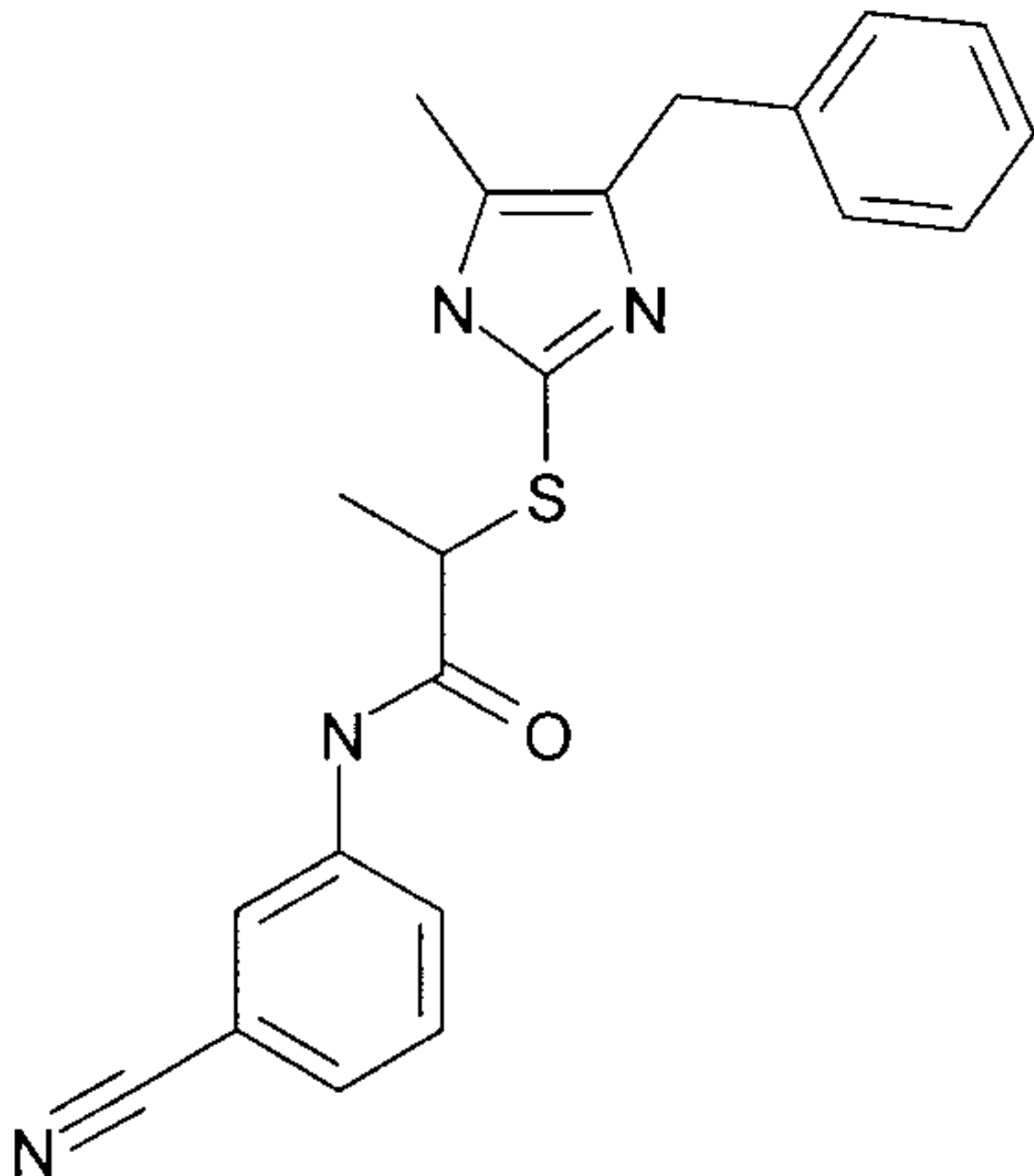
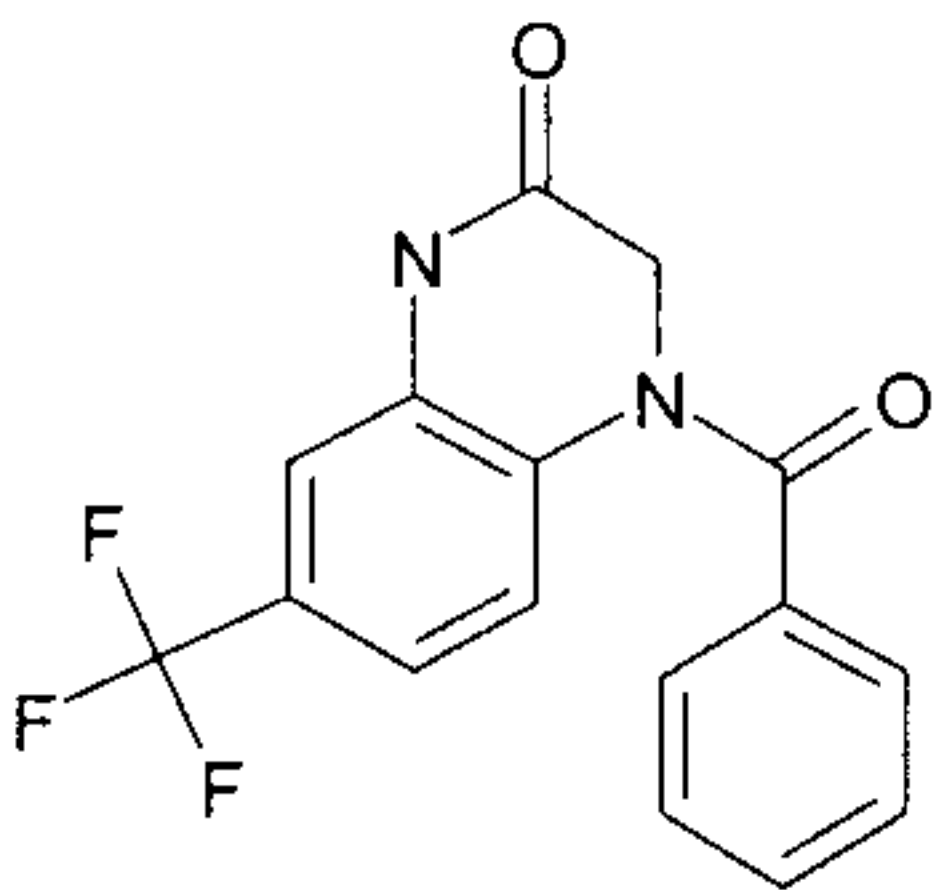
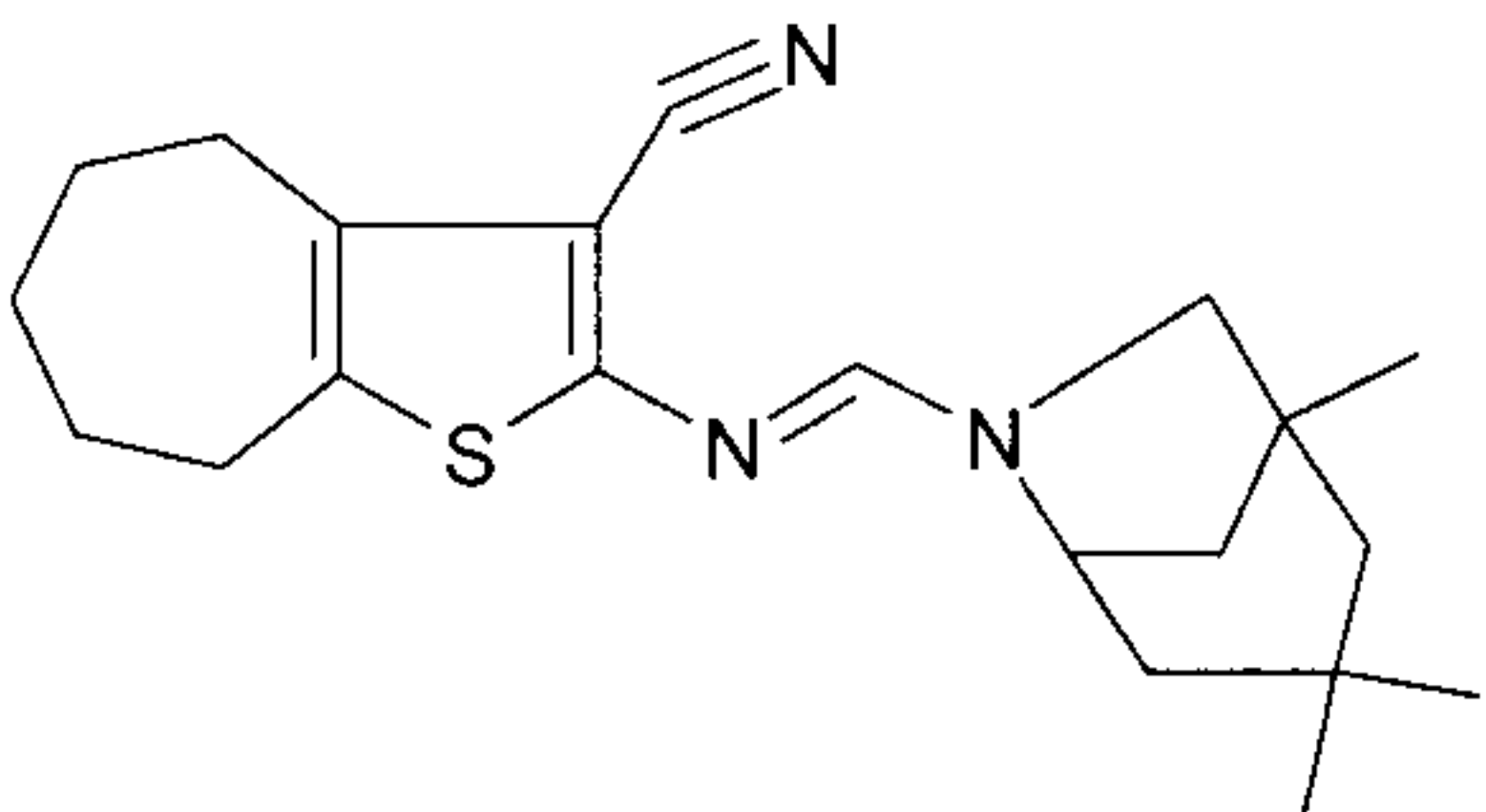
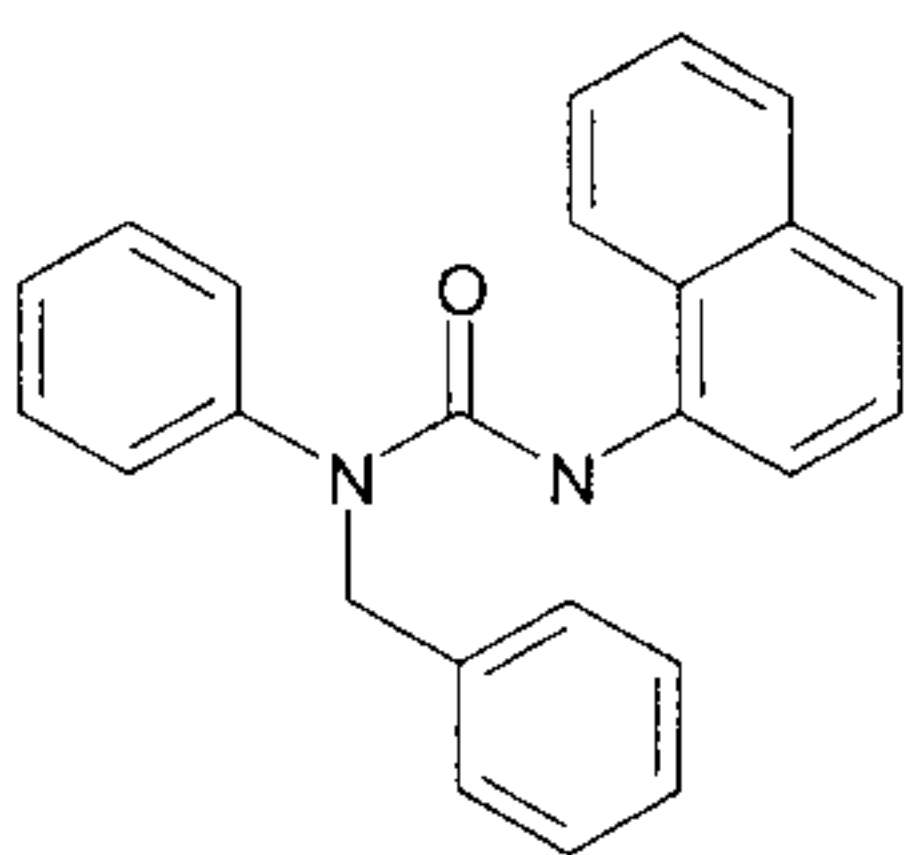
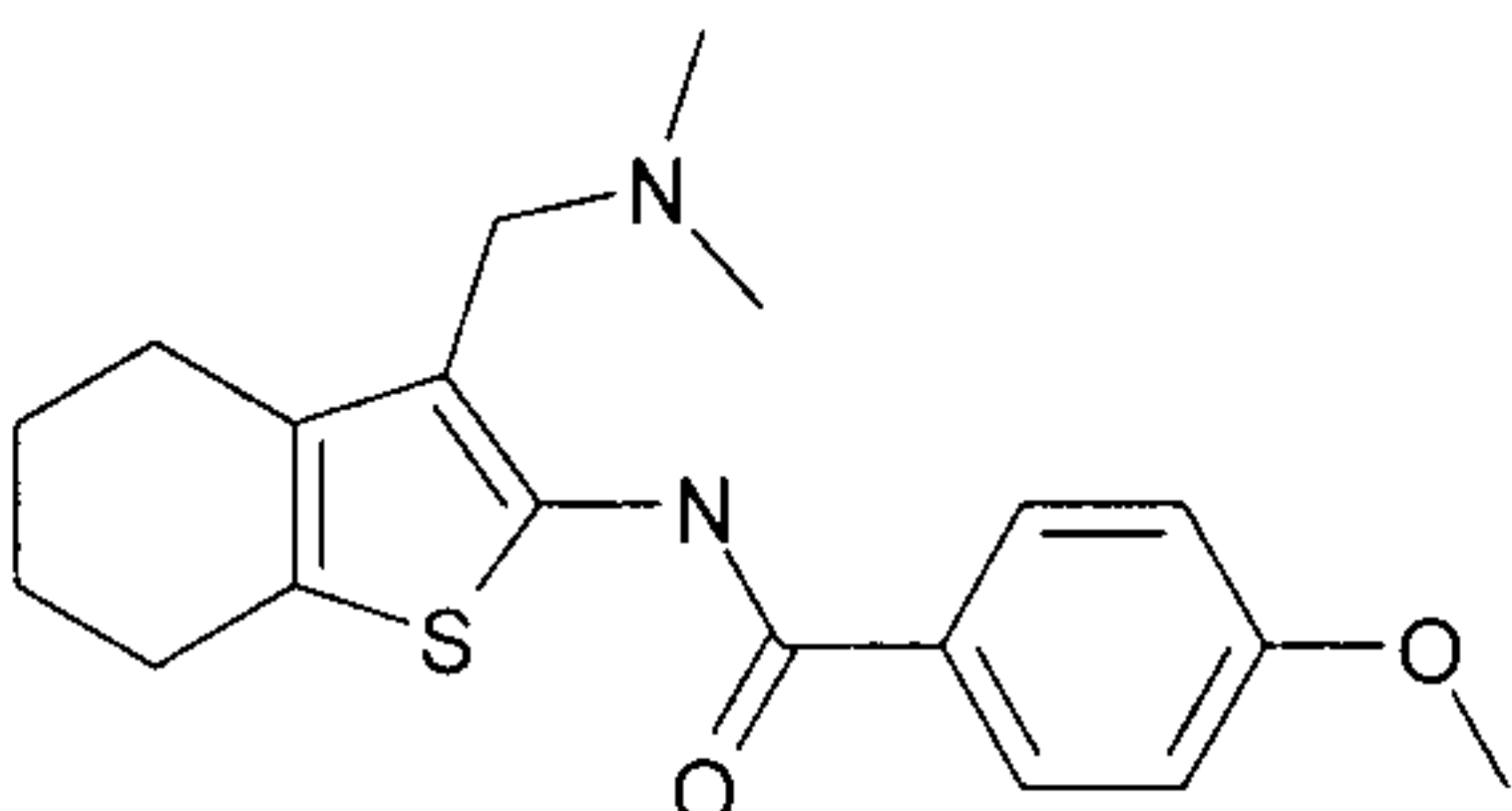
The modulator used according to the invention have an agonistic or antagonistic effect here on the cellular Ca^{2+} ion permeability. In particular, the modulator is at least one
35 compound selected from compounds of the following formulae 1 to 19 according to table 1 below.

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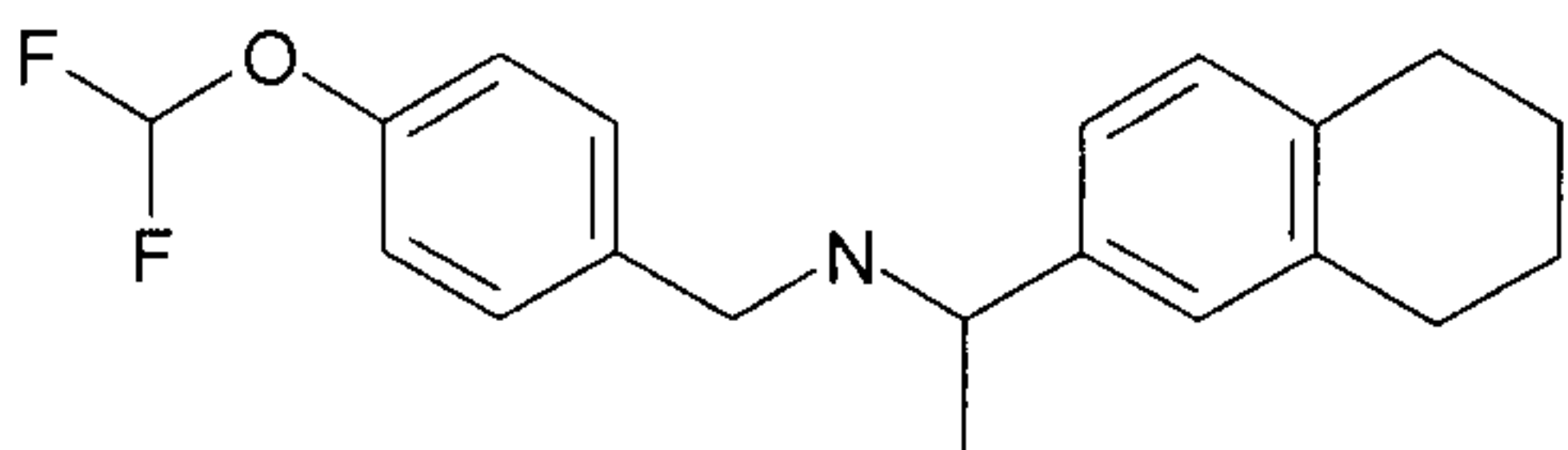
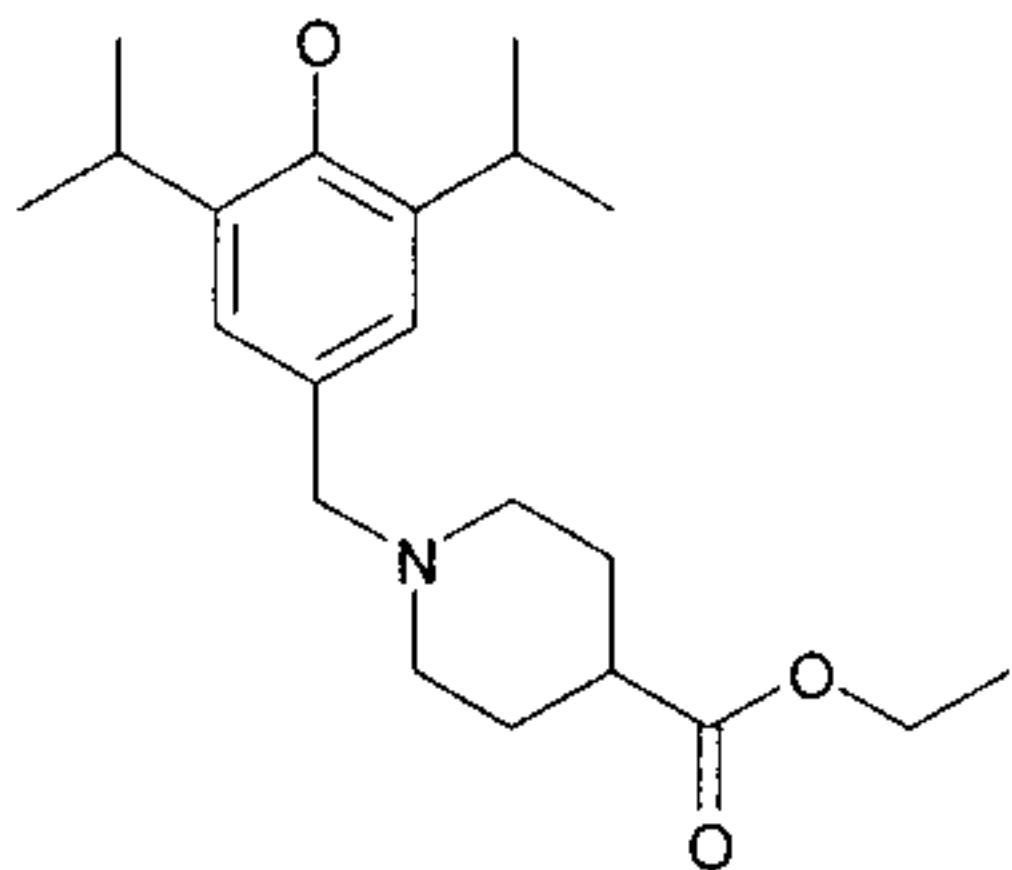
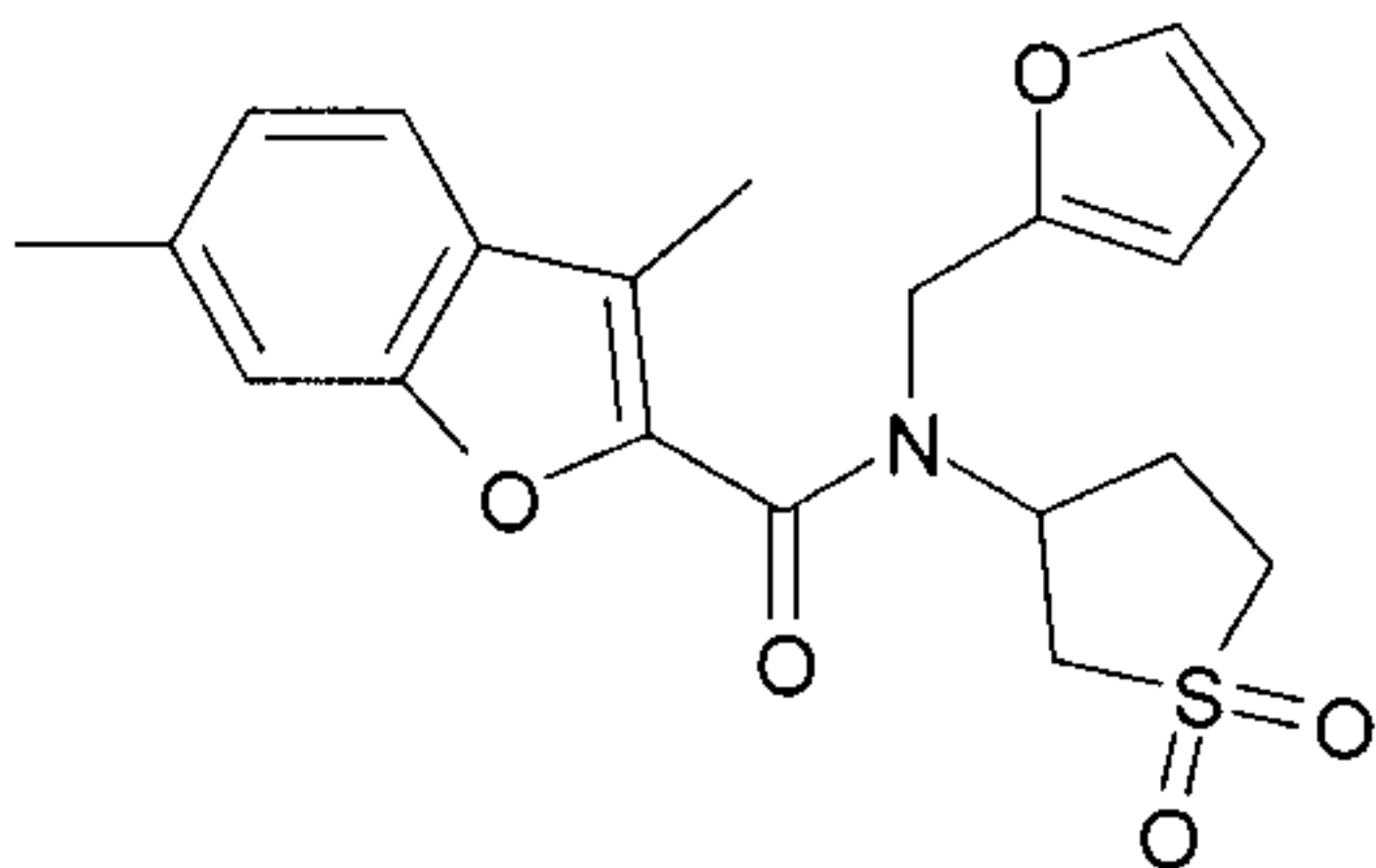
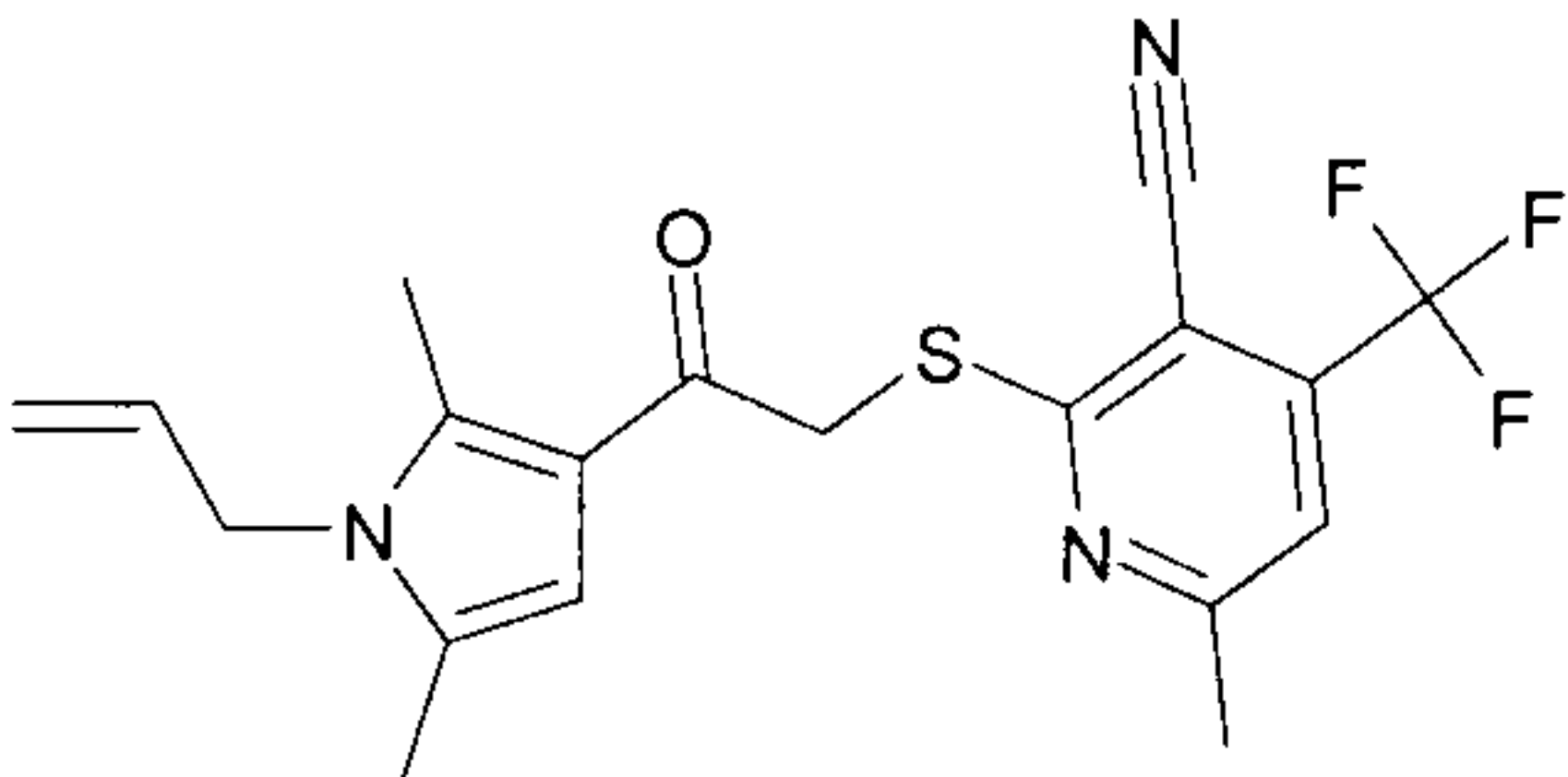
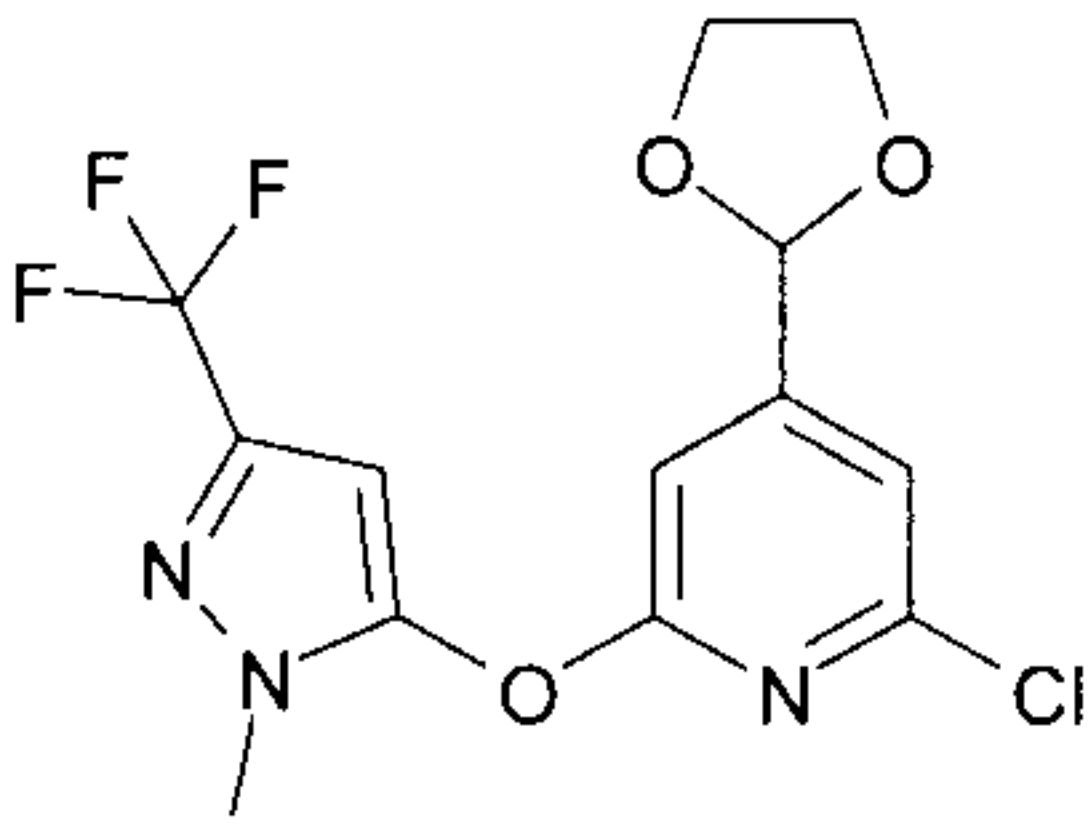
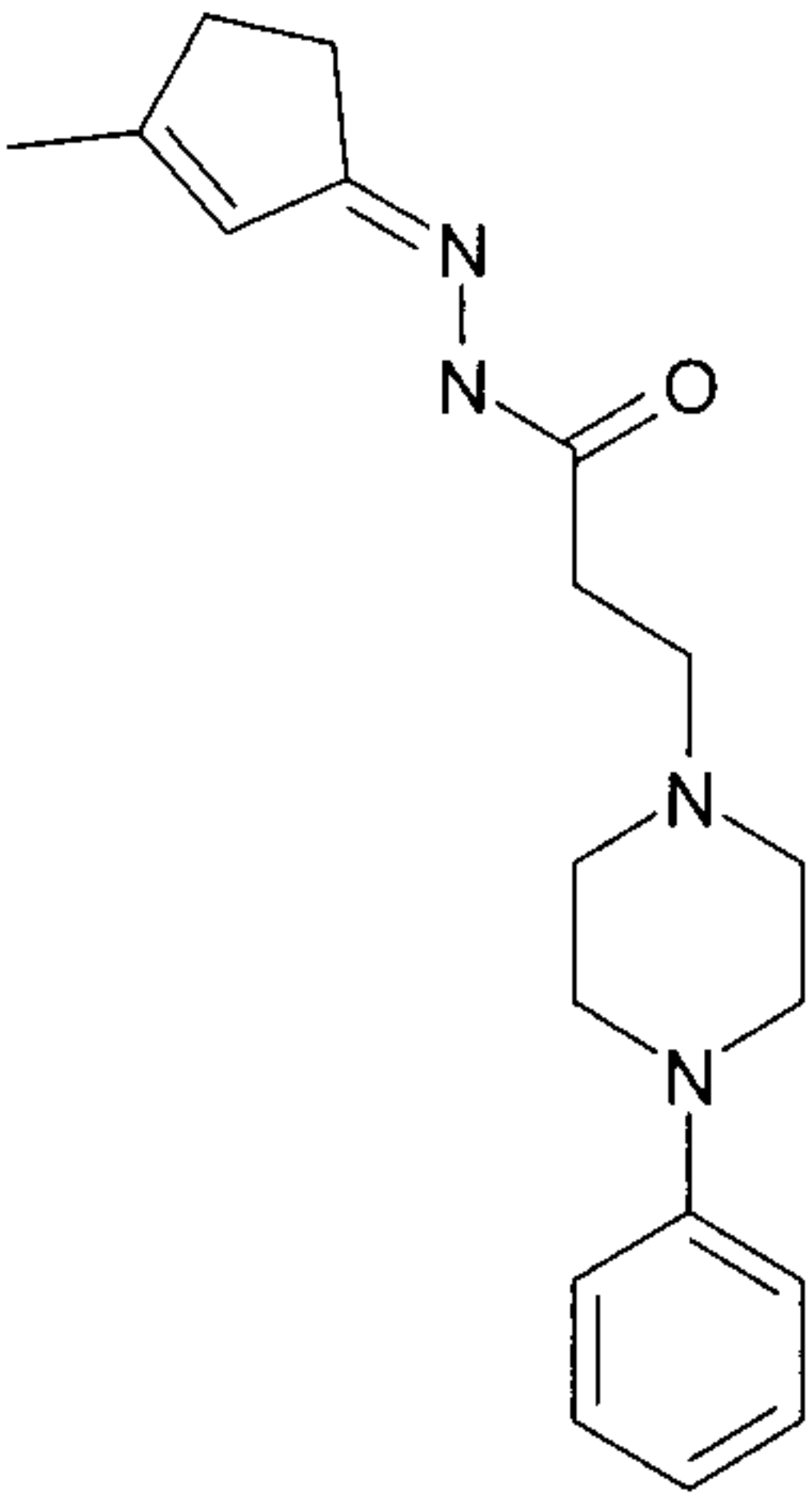
Table 1: Modulators according to the invention

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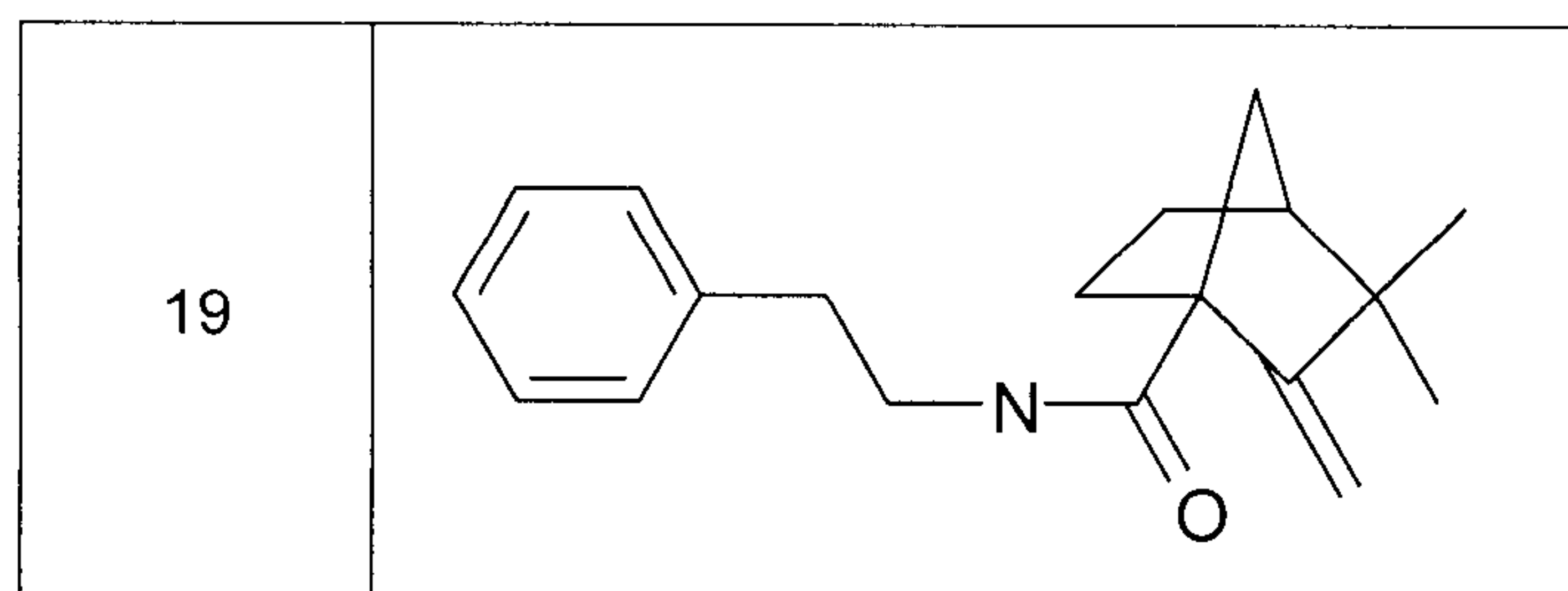
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9	
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7

13	 <chem>COc1ccc(cc1)CN(C)c2ccc3ccccc3c2</chem>
14	 <chem>CCOC(=O)C1CCN(CC1)Cc2cc(C(C)C)c(C(C)C)c2=O</chem>
15	 <chem>CC1=C(C(=O)N(C1Cc2ccccc2O)S(=O)(=O)C3CCSC3)c4cc(C)ccc4O</chem>
16	 <chem>C=Cc1cc(C)n(c1)C(=O)CSc2cc(C)c(C#N)c(c2)F(F)F</chem>
17	 <chem>Clc1cc(OC2=C(C(F)(F)F)N=C2)c(C3CCOC3)c4cc(Cl)nc14</chem>
18	 <chem>Cc1ccccc1N2CCN(CC2)CCC(=O)N=Nc3cc(C)ccc3</chem>

8



where the compound may be present in chemically pure or enriched form, as individual stereoisomer or in the form of stereoisomer mixtures. Furthermore, the compounds can be present uncharged or in the form of their salts, such as e.g. as acid addition salt. Functional groups may optionally be replaced by equivalent chemical groups; fluorine atoms may thus be replaced e.g. by other halogen atoms, such as Cl, Br or I; oxygen atoms (such as e.g. ether groups) may be replaced by corresponding sulfur groups, and vice versa; keto groups may be replaced by corresponding thionyl groups. The compounds specified above are chemical substances known per se which are either commercially available or are obtainable using customary organic synthesis methods.

Thus, the following are known for example:

Compound 1 under CAS number: 99602-94-5 (3R-cis form)

Compound 2 under CAS number: 165753-08-2

Compound 3 under CAS number: 338771-57-6

Compound 4 under CAS number: 878942-21-3

Compound 5 under CAS number: 748783-13-3

The modified forms or derivatives are also referred to as functional analogs or functionally equivalent compounds, if they furthermore exhibit the desired biological activity (receptor TRPM8 modulation).

Furthermore, particularly derivatives which permit a coupling of the specifically disclosed substances to solid carriers are also encompassed within the context of the invention; a large selection of corresponding linker/spacer groups is known to the person skilled in the art. The derivatization can take place here prior to the coupling to a solid phase or only as a result of the coupling.

The invention further relates to the use of a modulator, in particular agonists, for the TRPM8 receptor, where the modulator is as defined above, for inducing a sensation of coldness, in particular topically, i.e. cutaneously or orally, in humans and/or animals. An "induction of a sensation of coldness" is present when the compound in the cellular

activity test described above exhibits an agonistic effect on hTRPM8.

5 The invention further relates to the use of a modulator for the TRPM8 receptor, where the modulator is as defined above, as active constituent of a pharmaceutical composition.

10 The invention further relates to the use of a modulator for the TRPM8 receptor, where the modulator is as defined above, for the treatment of prostate carcinomas, for the treatment of bladder weakness or in pain therapy.

The invention further relates to the use of a modulator for the TRPM8 receptor, where the modulator is as defined above, as insect repellent or insecticide.

15 The invention further relates to the use of a modulator for the TRPM8 receptor, where the modulator is as defined above, for inducing a sensation of coldness in packagings (e.g. made of paper or plastic) in a very wide variety of processing forms (such as e.g. fibers, fabrics, moldings), where the sensation of coldness becomes noticeable in particular upon contact with the packaging material. In this connection, the substances can be associated in very diverse ways with the packaging material: e.g. by spin-
20 coating, imprinting, in the form of microencapsulation, direct incorporation into the packaging material (e.g. extruding), covalent coupling of suitable derivatives of the modulators (via suitable spacer/linker groups, with the help of which the molecule is reversibly or irreversibly bonded to the packaging material). Suitable methods are known to the person skilled in the art.

25 The invention further relates to the use of a modulator for the TRPM8 receptor, where the modulator is as defined above, for inducing a sensation of coldness in textiles. In this connection, the substances can be associated in very diverse ways with the textile: e.g. by spin-coating, imprinting, in the form of microencapsulation, direct incorporation
30 into the textile material (e.g. extruding), covalent coupling of suitable derivatives of the modulators (via suitable spacer/linker groups, with the help of which the molecule is reversibly or irreversibly bonded to the packaging material). Suitable methods are known to the person skilled in the art.

35 The invention further relates to substances per se according to the above definition for use as mediator, in particular agonists and/or antagonists, of the TRMP8 receptor.

The invention further relates to compositions comprising at least one compound

according to the above definition. In particular, such compositions are selected from

- a) pharmaceutical compositions, such as antitumor compositions, compositions for the treatment of diseases of the bladder, painkillers;
- b) foods, such as ice cream, mousse, cream, beverages, confectionery,
- 5 c) mouthcare compositions, such as toothpaste, mouthwash, chewing gum, breath fresheners
- d) skincare or haircare compositions, such as suncream, sunburn cream, lotions, shampoos, plasters, mouthwash, lotions, shaving cream, conditioners, face cleansers, soaps, bath oils and bath foams, antiperspirants, deodorants,
- 10 e) insect repellents, insecticides.

Besides constituents customary in each case for the particular composition, such compositions comprise an effective amount of at least one modulator according to the invention. In this connection, "effective" means a concentration of the modulator which
15 suffices to bring about the desired effect, such as e.g. pharmacological effect, or sensory effect, such as the olfactory effect of coldness, upon application of the composition (e.g. application to the skin).

Optionally, the compounds according to the invention can be combined with further
20 known active ingredients, in particular also those with a comparable effect. For example, these can be combined with known cooling compounds, such as e.g. menthol, menthone, N-ethyl-p-menthanecarboxamide (WS-3), N-2,3-trimethyl-2-isopropylbutanamide (WS-23), menthyl lactate (Frescolat® ML), menthone glycerol acetal (Frescolat® MGA), monomenthyl succinate (Physcool ®), monomenthyl
25 glutarate, O-menthylglycerol, menthyl N,N-dimethylsuccinamate.

The invention furthermore relates to textile products, such as e.g. shirts, trousers, socks, towels, finished (in particular on the surface) with at least one compound according to the above definition.

30

The invention furthermore relates to packaging materials which are associated with at least one compound according to the above definition.

The invention will now be described with reference to the following nonlimiting working
35 examples.

Experimental section:**Example 1 - Cloning of human TRPM8**

- 5 The starting point for the cloning of the human TRPM8 receptor is an LnCaP cDNA library. This is, for example, commercially available (e.g. BioChain, Hayward, USA) or can be produced from the androgen-sensitive human prostate adenocarcinoma cell line LnCaP (e.g. ATCC, CRL1740 or ECACC, 89110211) using standard kits.
- 10 The coding TRPM8 sequence (SEQ ID NO: 1) can be PCR-amplified and cloned using standard methods. The human TRPM8 gene isolated in this way was used for producing the plasmid pInd_M8, the construction of which is illustrated by the plasmid map according to figure 1.

Alternatively to this, the TRPM8 gene can also be produced synthetically.

15

Example 2 - Generation of the HEK293 test cells

- As test cell system, HEK293 cell line stably transfected with the human TRPM8 DNA (cf. above plasmid pInd-M8) are produced. Preference here is given to HEK293 which offers the option, via
- 20 the introduced plasmid, of inducing the TRPM8 expression by means of tetracycline.

- Methods for producing suitable test cell systems are known to the person skilled in the art. For example, the details of the preparation of the cells used according to the invention can be found in Behrendt H.J. et al., *Br. J. Pharmacol.* 141, 2004, 737-745 or the dissertation by Behrendt
- 25 "Comparative functional investigations of the heat capsaicin receptor (TRPV1) and of the cold menthol receptor (TRPM8) in recombinant and native cell systems".

Example 3- Assay on TRPM8 modulators

30

A test comparable with the test already described in the literature by Behrendt H.J. et

al., *Br. J. Pharmacol.* 141, 2004, 737-745 is carried out. The agonization or antagonization of the receptor can be quantified by means of a Ca^{2+} -sensitive dye (e.g. FURA, Fluo-4 etc.). On their own, agonists bring about an increase in the Ca^{2+} signal; antagonists bring about, in the presence of e.g. menthol, a reduction in the Ca^{2+} signal
5 (in each case detected via the dye Fluo-4, which has different fluorescent properties as the result of Ca^{2+}).

a) Test procedure:

10 Firstly, a fresh culture of transformed HEK cells is prepared in a manner known per se in cell culture flasks. The test cells HEK293-TRPM8 are detached from the cell culture flasks by means of trypsin and 40 000 cells/well are sown out with 100 μl of medium in 96-well plates (Greiner # 655948 poly-D-lysine-coated). To induce the receptor TRPM8, tetracycline is added to the growth medium (DMEM/HG, 10% FCS
15 tetracycline-free, 4 mM L-glutamine, 15 $\mu\text{g/ml}$ blasticidin, 100 $\mu\text{g/ml}$ hygromycin B, 1 $\mu\text{g/ml}$ tetracycline). On the following day, the cells are loaded with Fluo-4AM dye and the test is carried out. For this, the procedure is as follows:

- addition of in each case 100 μl /well of dye solution Ca-4 kit (RB 141, Molecular Devices) to in each case 100 μl of medium (DMEM/HG, 10% FCS tetracycline-free, 4 mM L-glutamine, 15 $\mu\text{g/ml}$ blasticidin, 100 $\mu\text{g/ml}$ hygromycin B, 1 $\mu\text{g/ml}$ tetracycline)
20
- incubation in the hatching cabinet, 30 minutes / 37°C / 5% CO_2 , 30 minutes / RT
- preparation of the test substances (various concentrations in 200 μl of HBSS buffer), and also of positive controls (various concentrations of menthol, icilin and ionomycin in 200 μl of HBSS buffer) and negative controls (only 200 μl of HBSS buffer)
25
- addition of the test substances in amounts of 50 μl /well and measurement of the change in fluorescence (e.g. in the assay instrument FLIPR, Molecular Devices or NovoStar, BMG) at 485 nm excitation, 520 nm emission, and evaluation of
30 the effectiveness of the various substances/concentrations and determination of the EC_{50} values.

The test substances are used in the assay in triplicate in concentrations of 0.1 -
35 200 μM . Normally, the compounds are kept ready in DMSO solutions and are diluted down to a maximum DMSO concentration of 2% for the assay.

b) Test result

The EC50 values determined for modulators according to the invention are summarized in table 2 below

5 **Table 2:** Activity of test substances on the human receptor TRPM8

#	Activity TRPM8 EC50
1	0.4
2	2
3	2
4	2.5
5	2.5
6	3.5
7	4
8	5
9	10
10	10
11	10
12	10
13	10
14	20
15	20
16	25
17	50
18	100
19	100

10 The evaluation surprisingly reveals that, according to the invention, it was possible for the first time to prepare agonists of TRPM8 which differ significantly in structural terms from agonists known hitherto, such as (-) menthol, icilin and other modulators described by Behrendt H.J. et al., in *Br. J. Pharmacol.* 141, 2004, 737-745 (cf. table 1 therein), and, moreover, in some cases exhibit better activities than (-) menthol, or are as comparably effective as icilin.

14

Example 4 - Preparation of mouthwash

A mouthwash of the following composition is prepared:

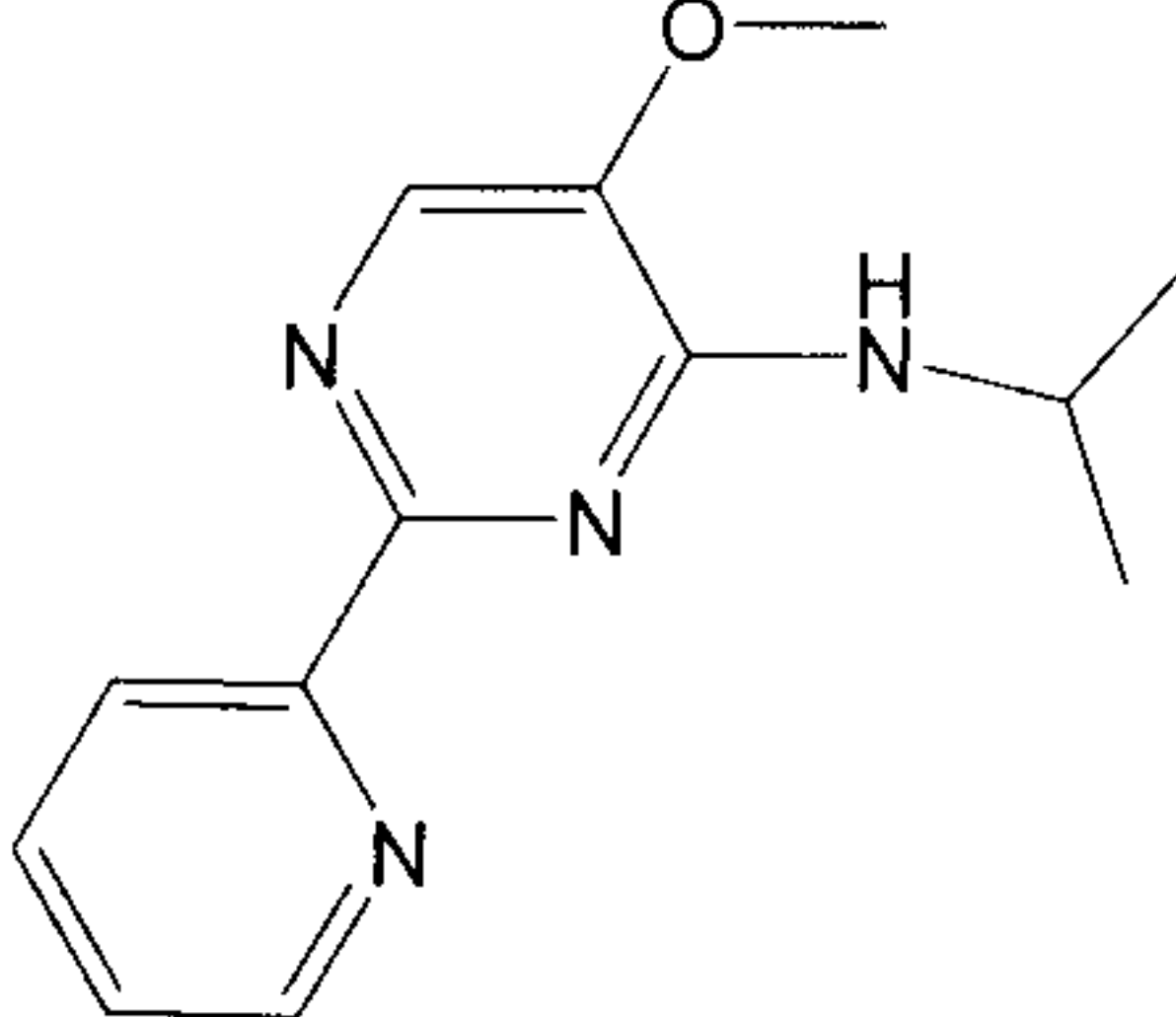
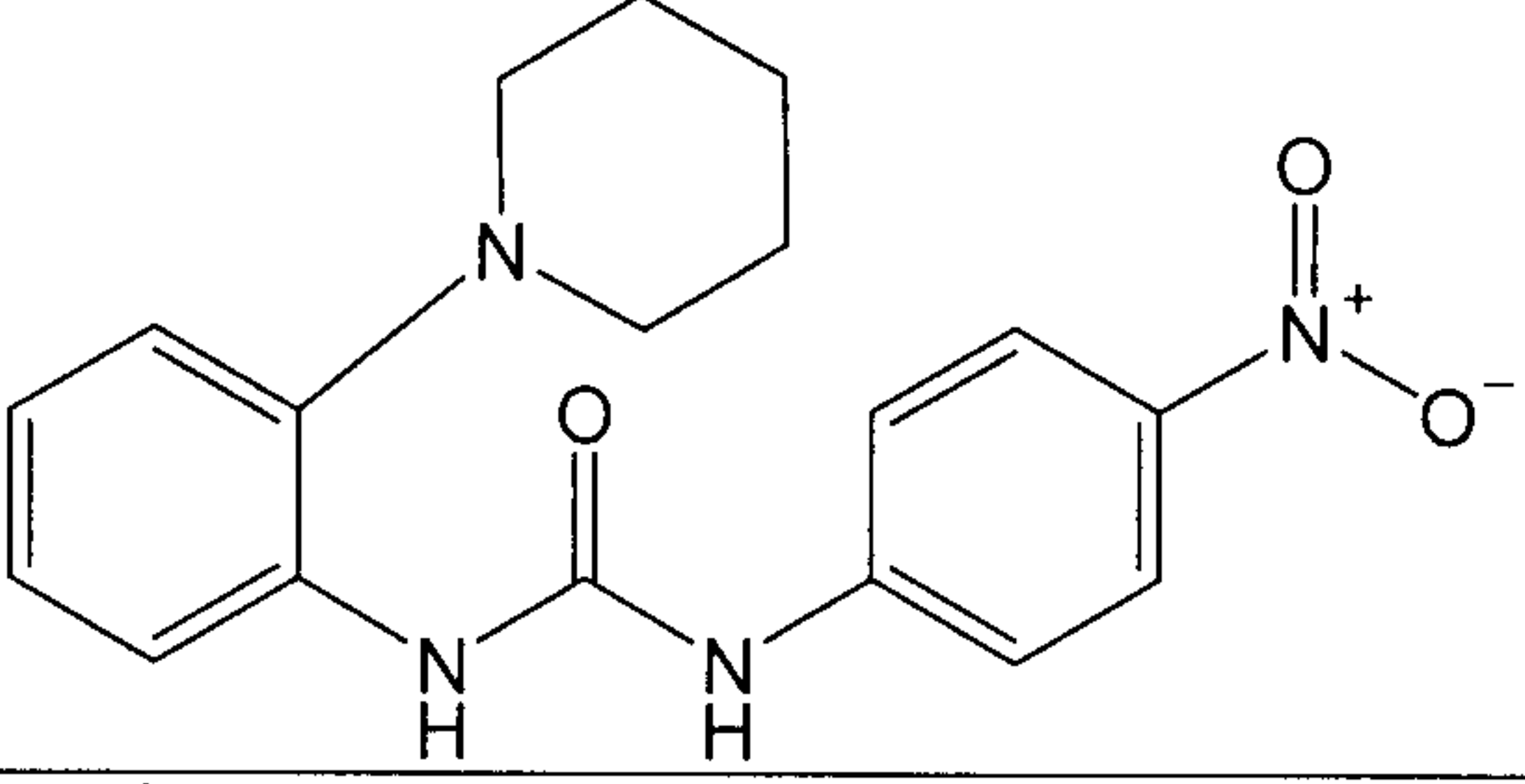
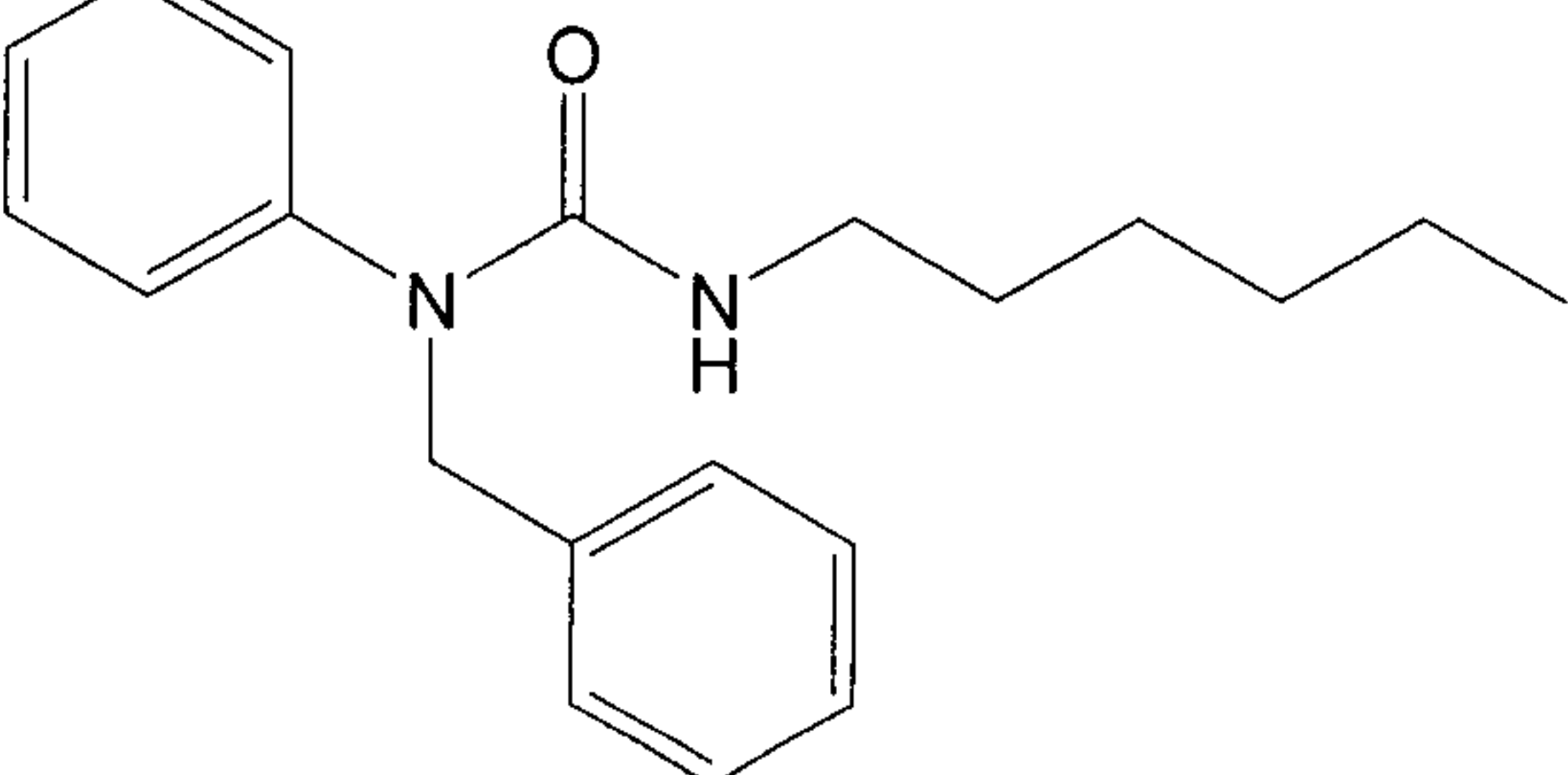
5	Ethanol 95%	177 ml
	Sorbitol 70%	250 g
10	TRPM8 agonist according to tab. 2 as 1% solution in the ethanol	50 ml
	Peppermint oil	0.30 g
15	Methyl salicylate	0.64 g
	Eucalyptol	0.922 g
	Thymol	0.639 g
20	Benzoic acid	1.50 g
	Pluronic ® F127 nonionic surfactant	5.00 g
25	Sodium saccharin	0.60 g
	Sodium citrate	0.30 g
30	Citric acid	0.10 g
	Water	q.s. 1 liter

To prepare a mouthwash, the above-described components are mixed together in the stated amounts.

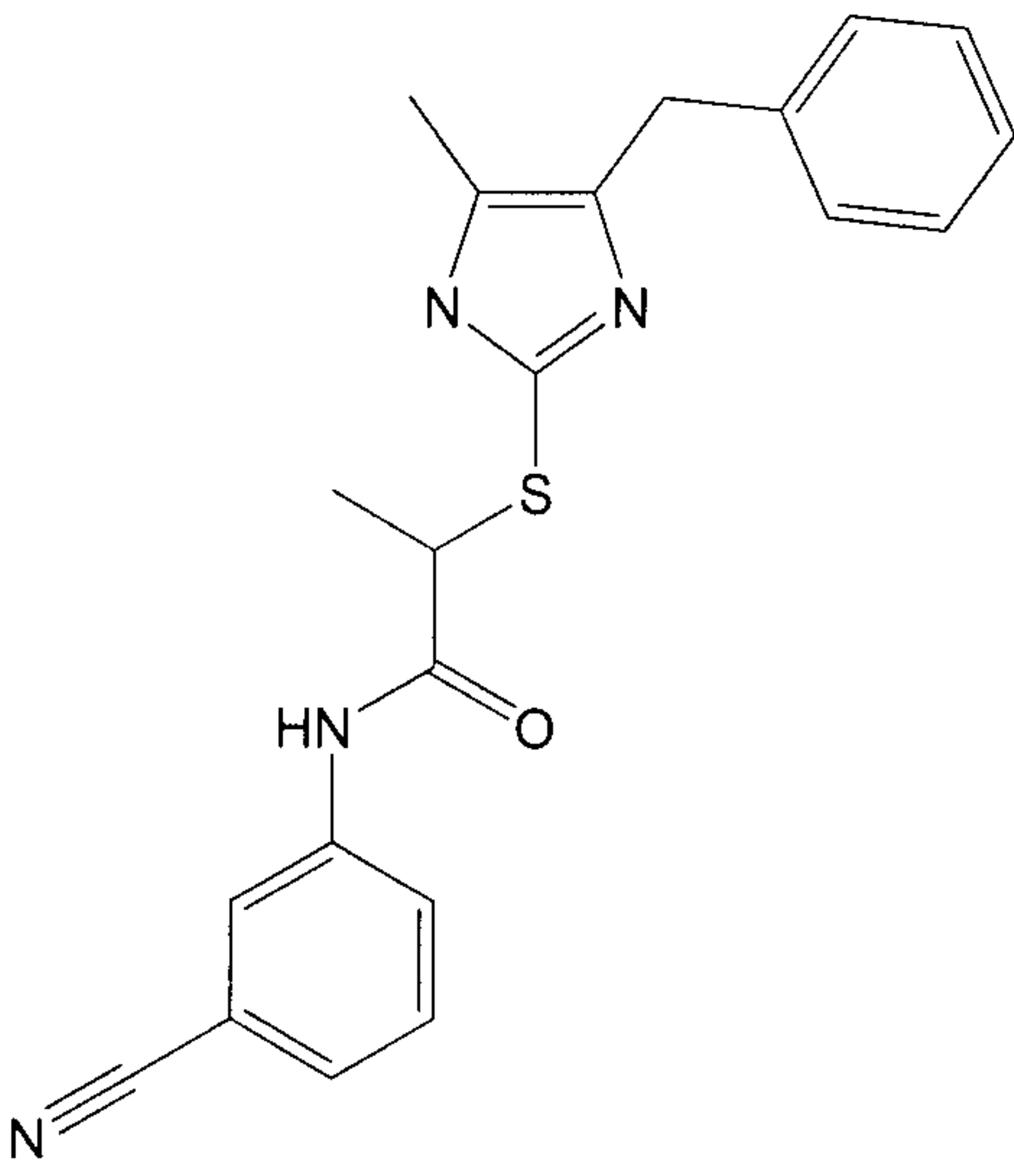
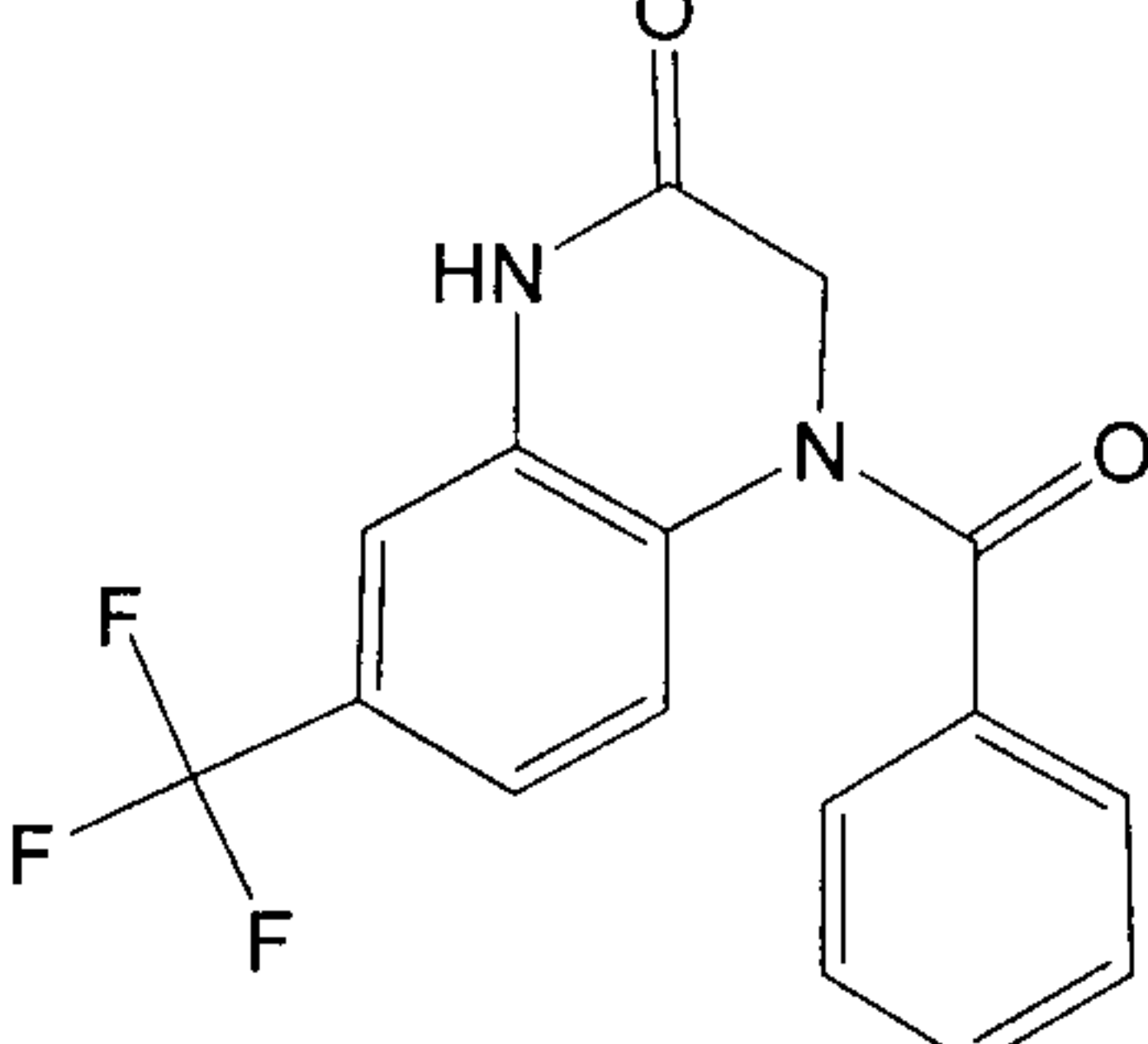
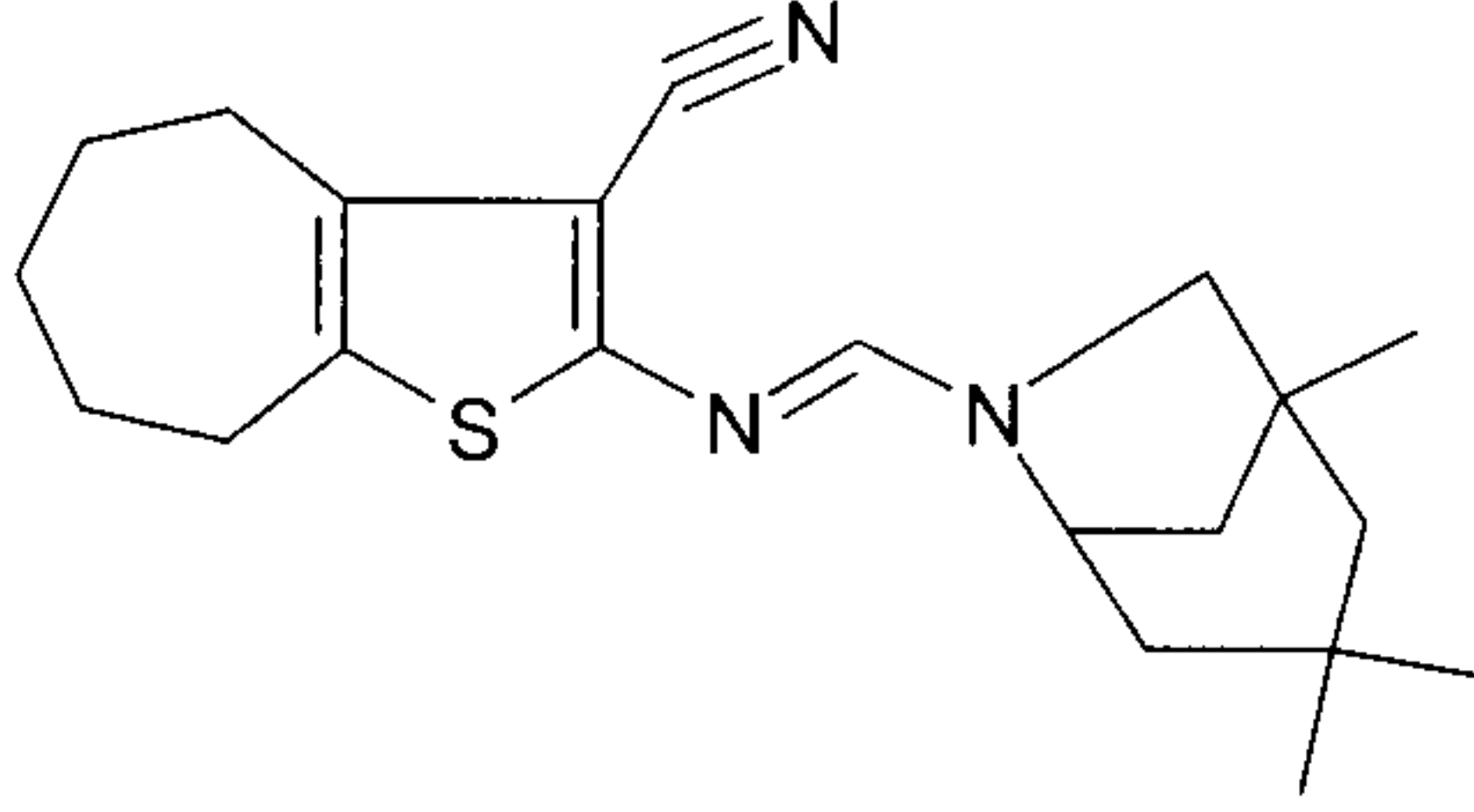
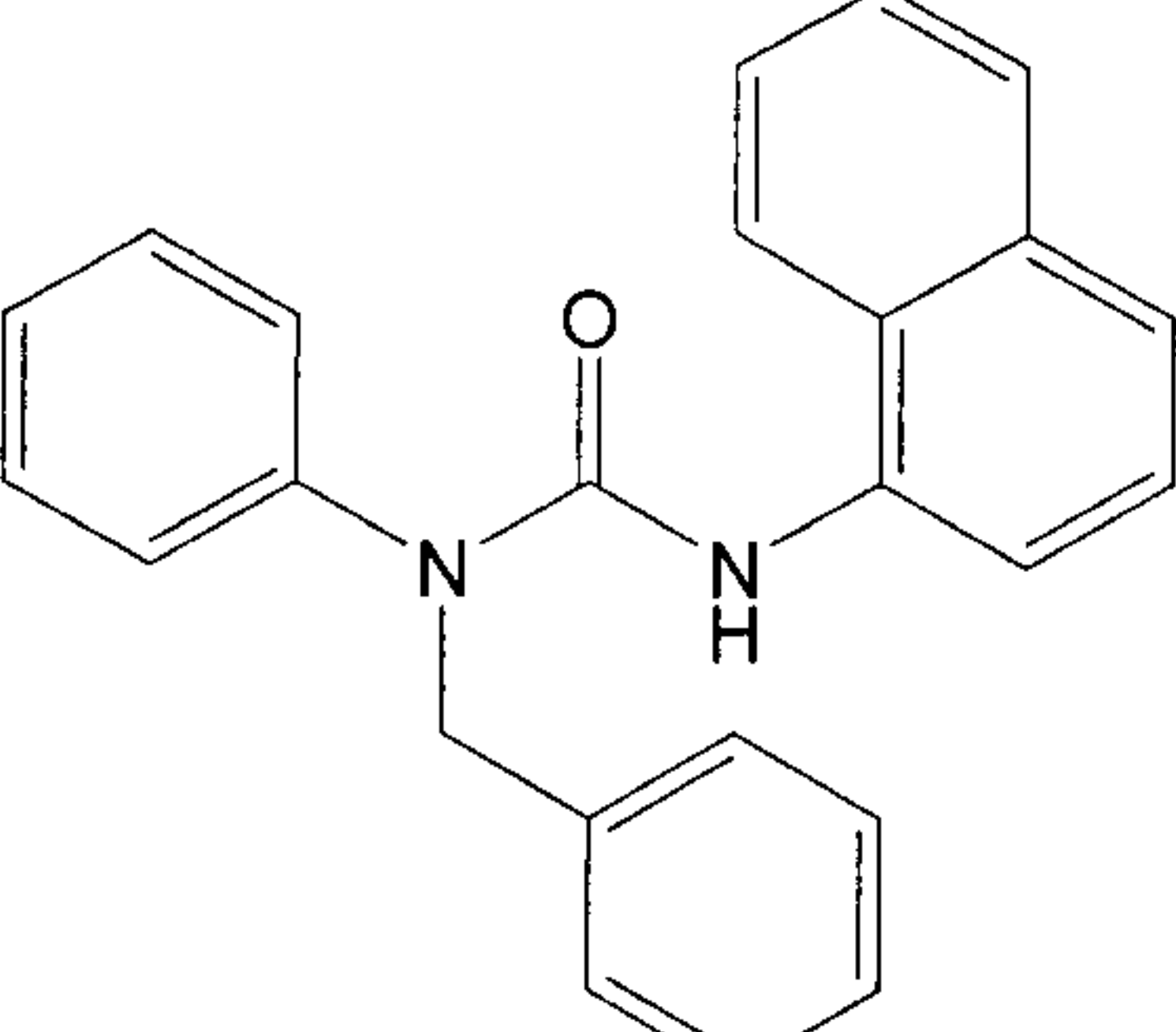
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Claims

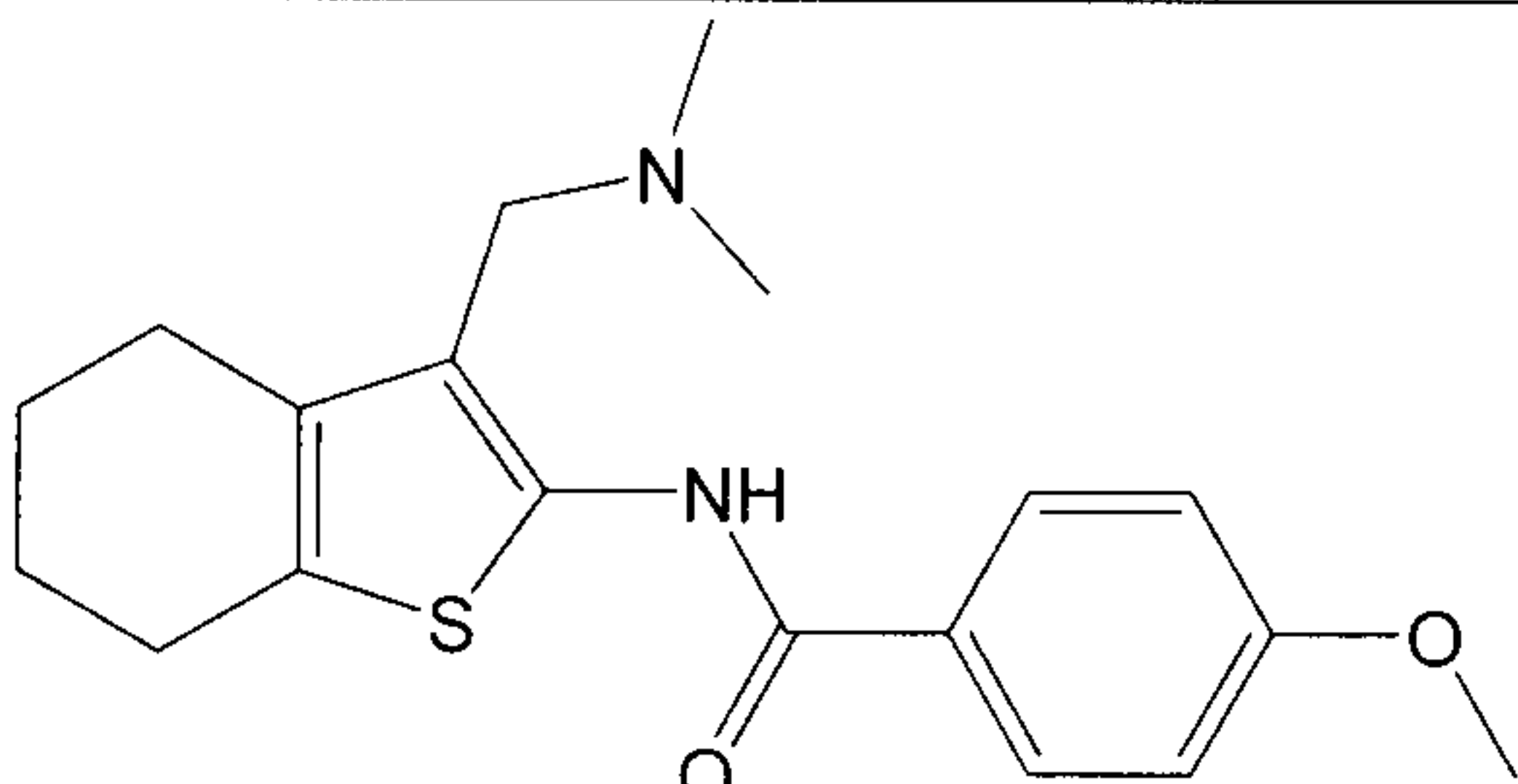
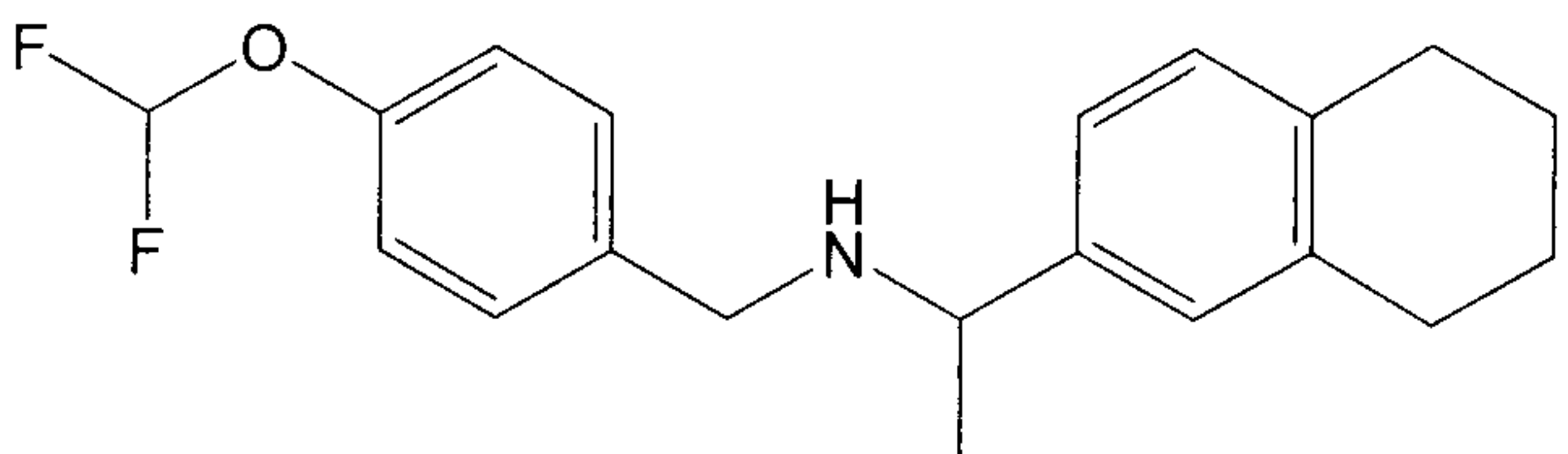
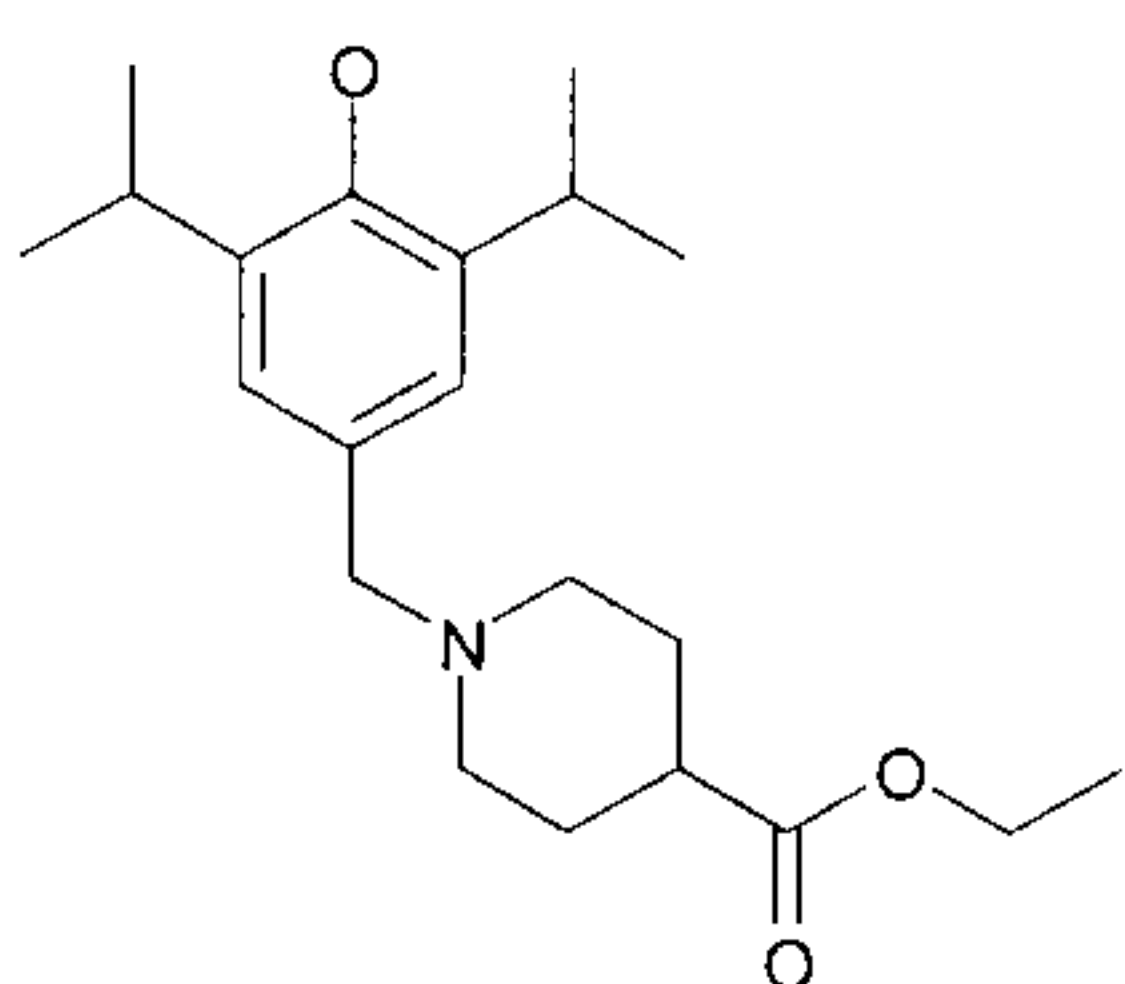
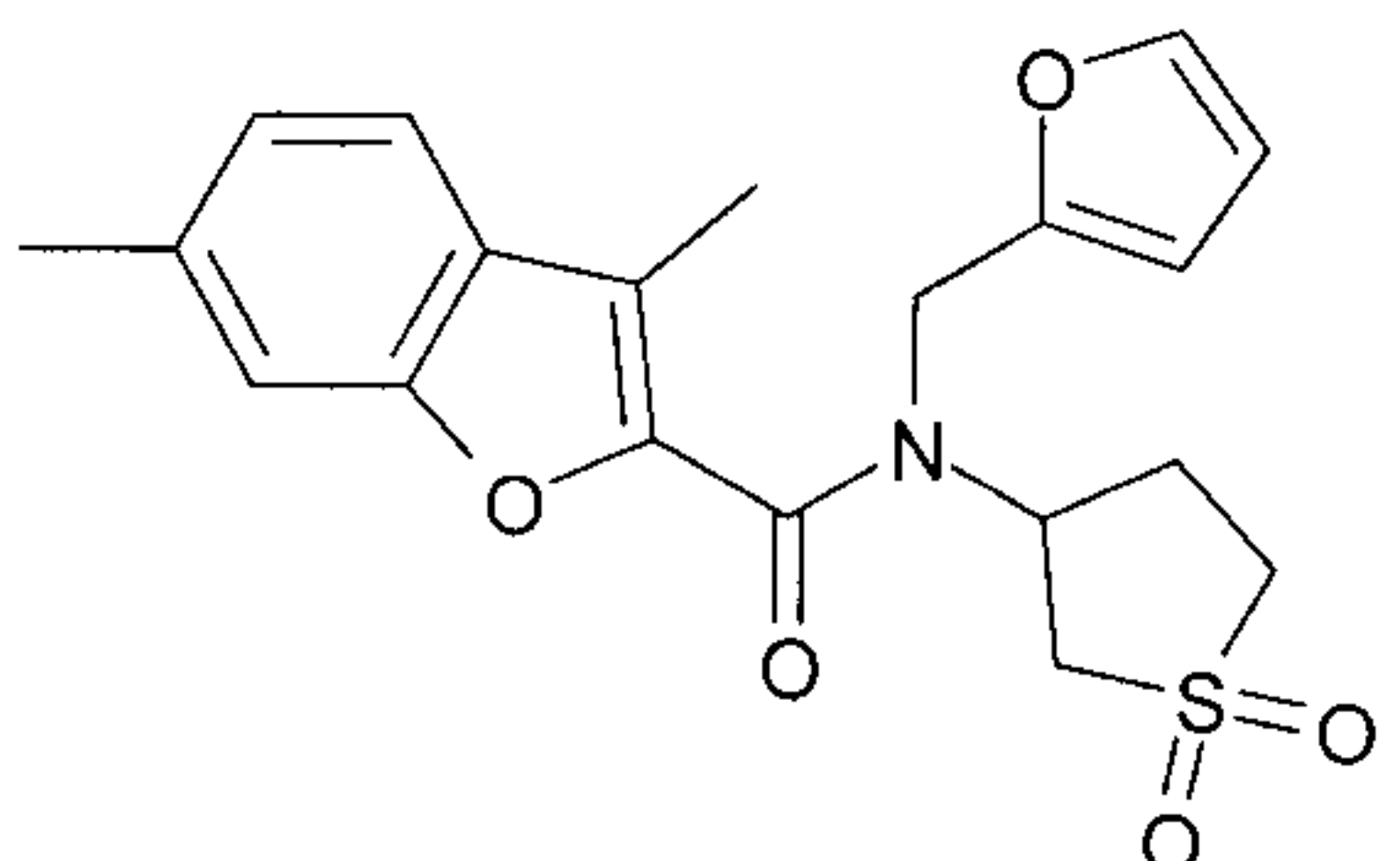
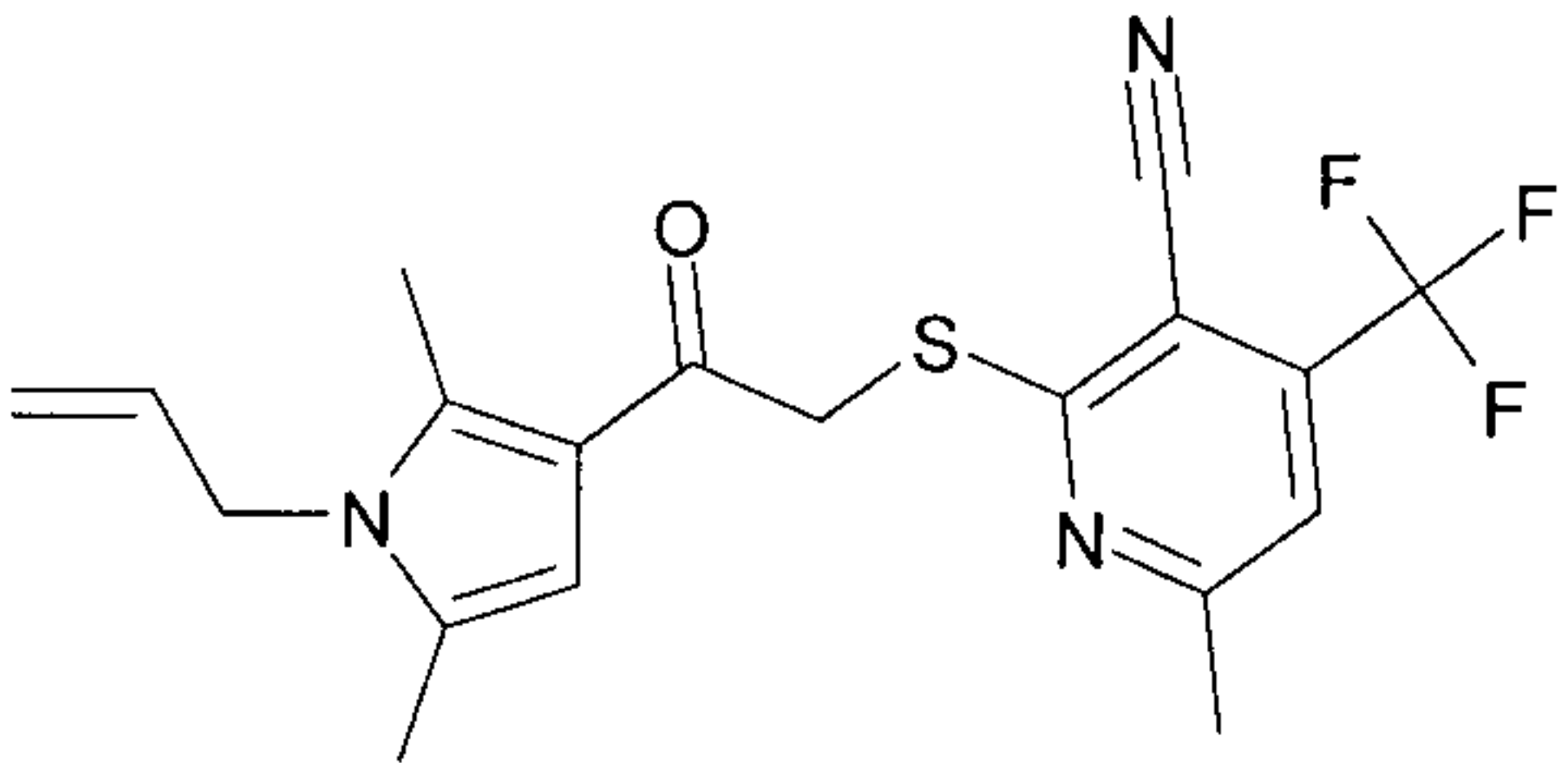
- 5 1. A method for in-vitro modulation of cold menthol receptor TRPM8 comprising contacting the receptor with a polynuclear organic compound, wherein in a cellular activity test, the compound is a modulator of the Ca^{2+} ion permeability of a cell that recombinantly expresses a human TRPM8 receptor, and wherein the modulator is a compound of formula:

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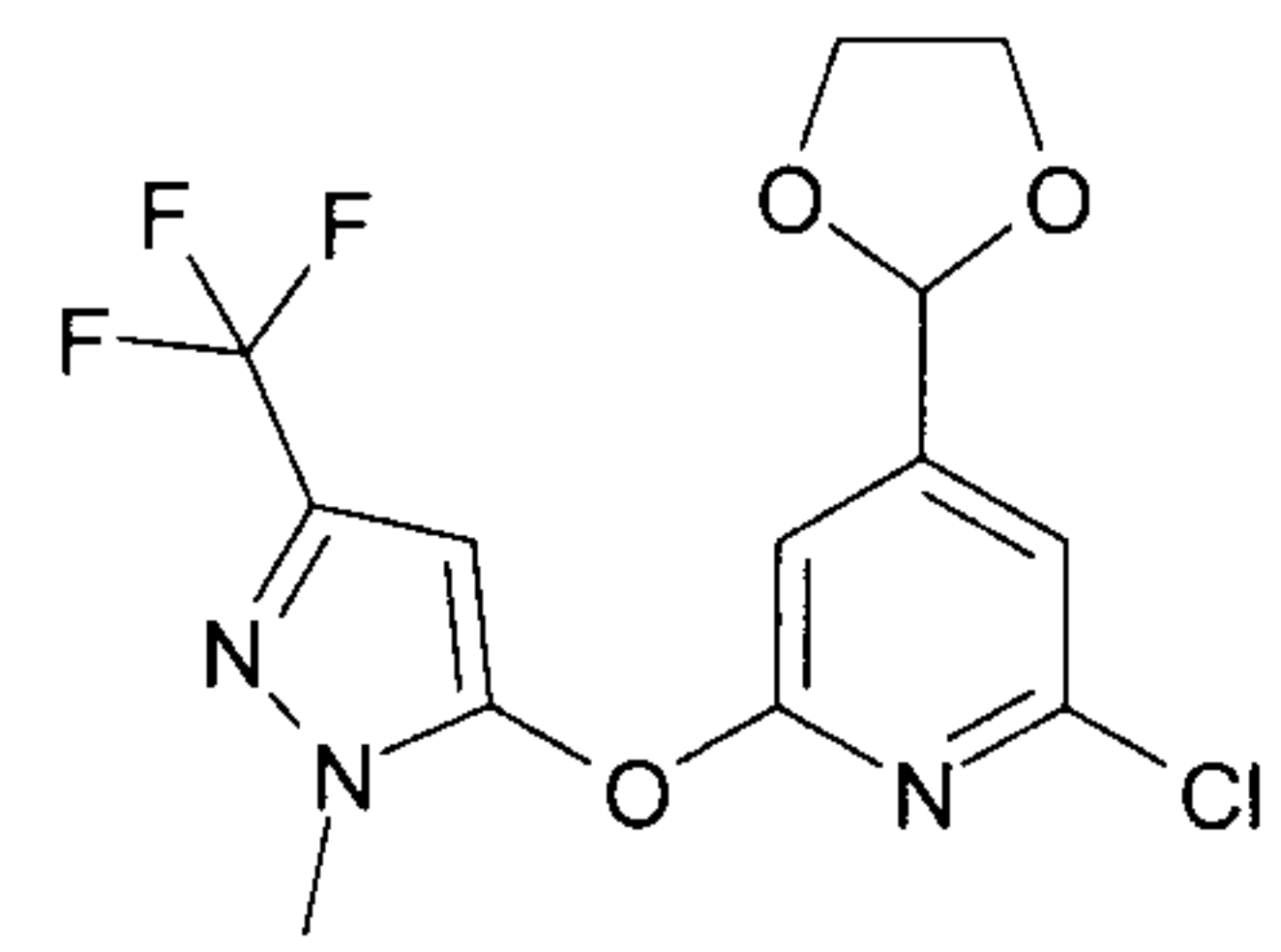
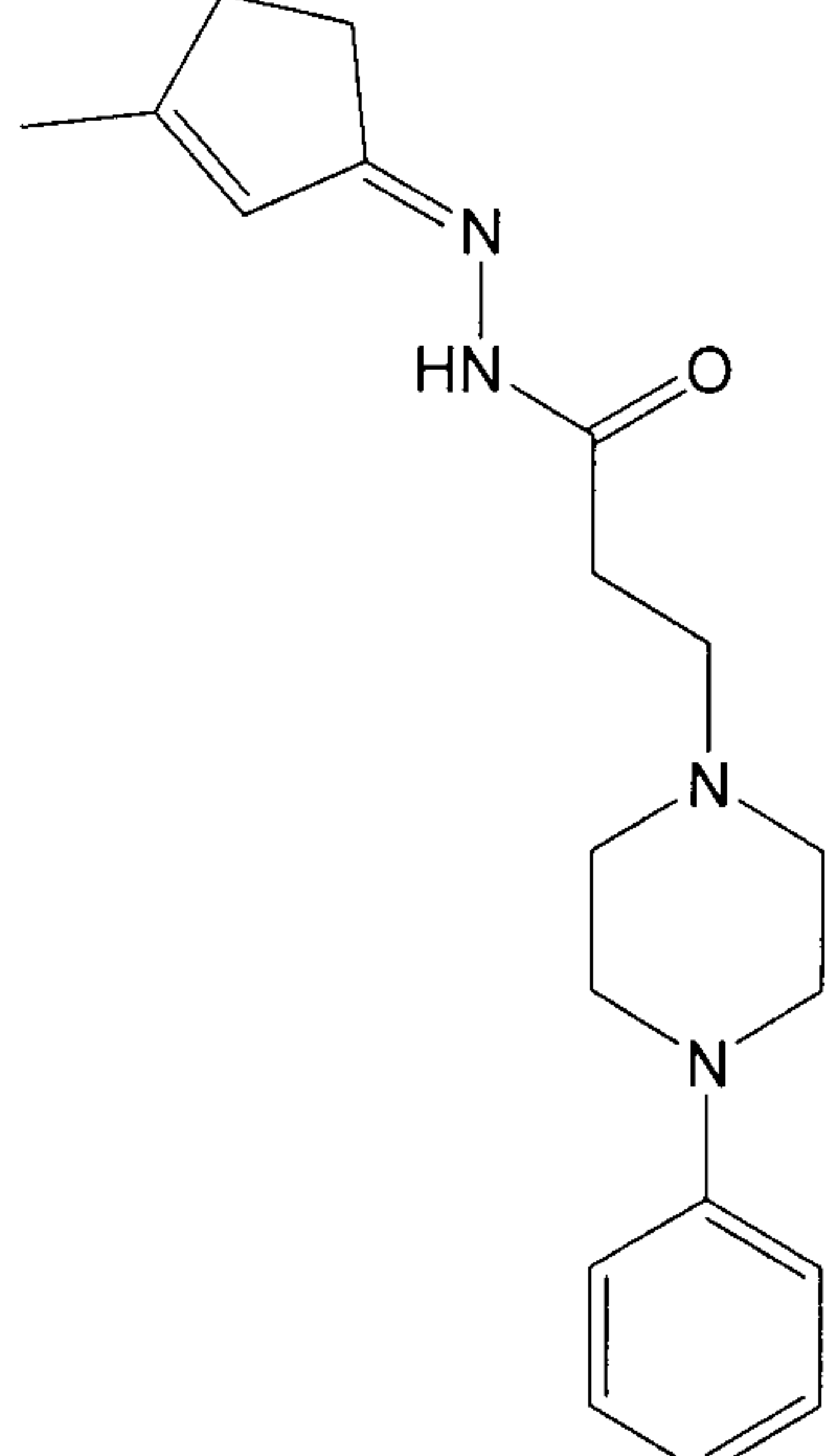
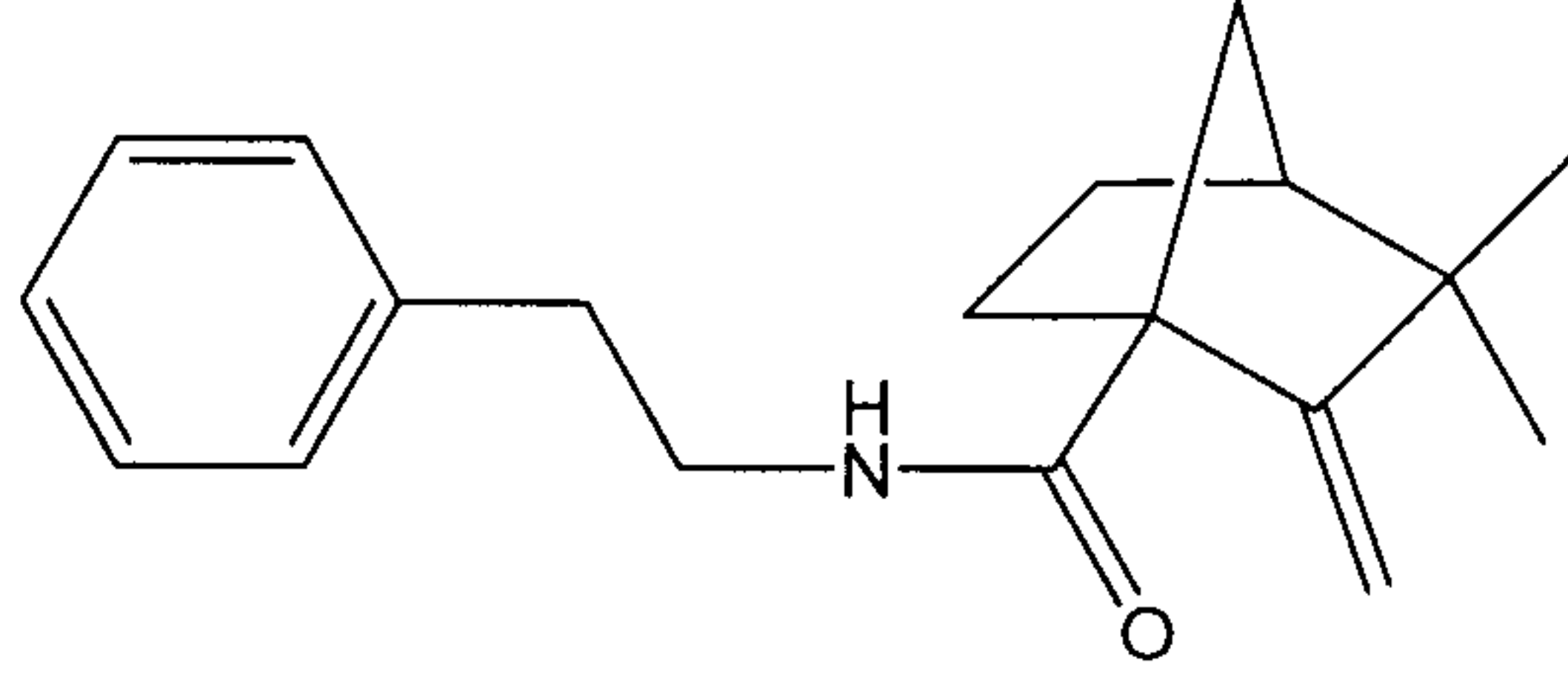
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8	 <chem>N#Cc1ccc(NC(=O)C(C)Sc2nc(C)c(Cc3ccccc3)n2)cc1</chem>
9	 <chem>O=C1NC(=O)N(C1c2ccccc2)c3cc(C(F)(F)F)ccc3</chem>
10	 <chem>CN1CCC2(C1)C(=CN2C#N)c3sc4c(c3)CCCCC4</chem>
11	 <chem>O=C(Nc1ccccc1)N(Cc2ccccc2)c3cc4ccccc4cc3</chem>

17

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18

17	
18	
	or
19	

2. The method of claim 1, wherein the compound is of formula 14.
3. The method of claim 1, wherein the compound is of formula 15.
4. The method of claim 1, wherein the compound is of formula 16.
5. The method of claim 1, wherein the compound is of formula 17.

19

6. The method of claim 1, wherein the compound is of formula 18.

7. The method of claim 1, wherein the compound is of formula 19.

8. An *in vitro* method for inducing a sensation of coldness in at least one of a human or an animal, the method comprising contacting the human or animal with a polynuclear organic compound, wherein in a cellular activity test, the compound is a modulator of the Ca^{2+} ion permeability of a cell that recombinantly expresses a human TRPM8 receptor and wherein the modulator is a compound as defined in any one of claims 1 to 7.

9. The method of claim 8, wherein the method is used in the treatment of prostate carcinoma, bladder weakness or pain.

10. A modulator for a TRPM8 receptor, wherein the modulator is a compound as defined in any one of claims 1 to 7.

11. A method for inducing a sensation of coldness in at least one of a human or an animal comprising contacting a packaging material comprising the modulator of claim 10.

12. A method for inducing a sensation of coldness in at least one of a human or an animal comprising contacting a textile comprising the modulator of claim 10.

13. A composition comprising the modulator of claim 10, and an acceptable excipient, wherein the composition is

- a) a pharmaceutical composition,
- b) a food,
- c) a mouthcare composition,
- d) a skincare or haircare composition, or
- e) an insect repellent and insecticide.

14. The composition of claim 13, wherein the composition is a pharmaceutical composition.

20

15. The composition of claim 13, wherein the food is an ice cream, a mousse, a cream, a beverage or a confection.

16. The composition of claim 13, wherein the mouthcare composition is a toothpaste, a mouthwash or a chewing gum.

17. The composition of claim 13, wherein the skincare or haircare composition is a suncream, a sunburn cream, a lotion, a shampoo or a plaster.

18. A textile product comprising the modulator of claim 10.

19. The textile product of claim 18, wherein the textile product is a shirt, a trouser, a sock or a towel.

20. A packaging material comprising the modulator of claim 10.

21. Use of one of the compound as defined in any one of claims 1 to 7, for the manufacture of a medicament useful for modulating the TRPM8 receptor.

22. Use of one of the compound as defined in any one of claims 1 to 7, for modulating the TRPM8 receptor.

23. Use of one of the compound as defined in any one of claims 1 to 7, for the manufacture of a medicament useful for inducing a sensation of coldness in a human or animal.

24. Use of one of the compound as defined in any one of claims 1 to 7, for inducing a sensation of coldness in a human or animal.

25. Use of one of the compound as defined in any one of claims 1 to 7, for the manufacture of a medicament for the treatment of prostate carcinoma, bladder weakness or pain.

26. Use of one of the compound as defined in any one of claims 1 to 7, for the treatment of

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prostate carcinoma, bladder weakness or pain.

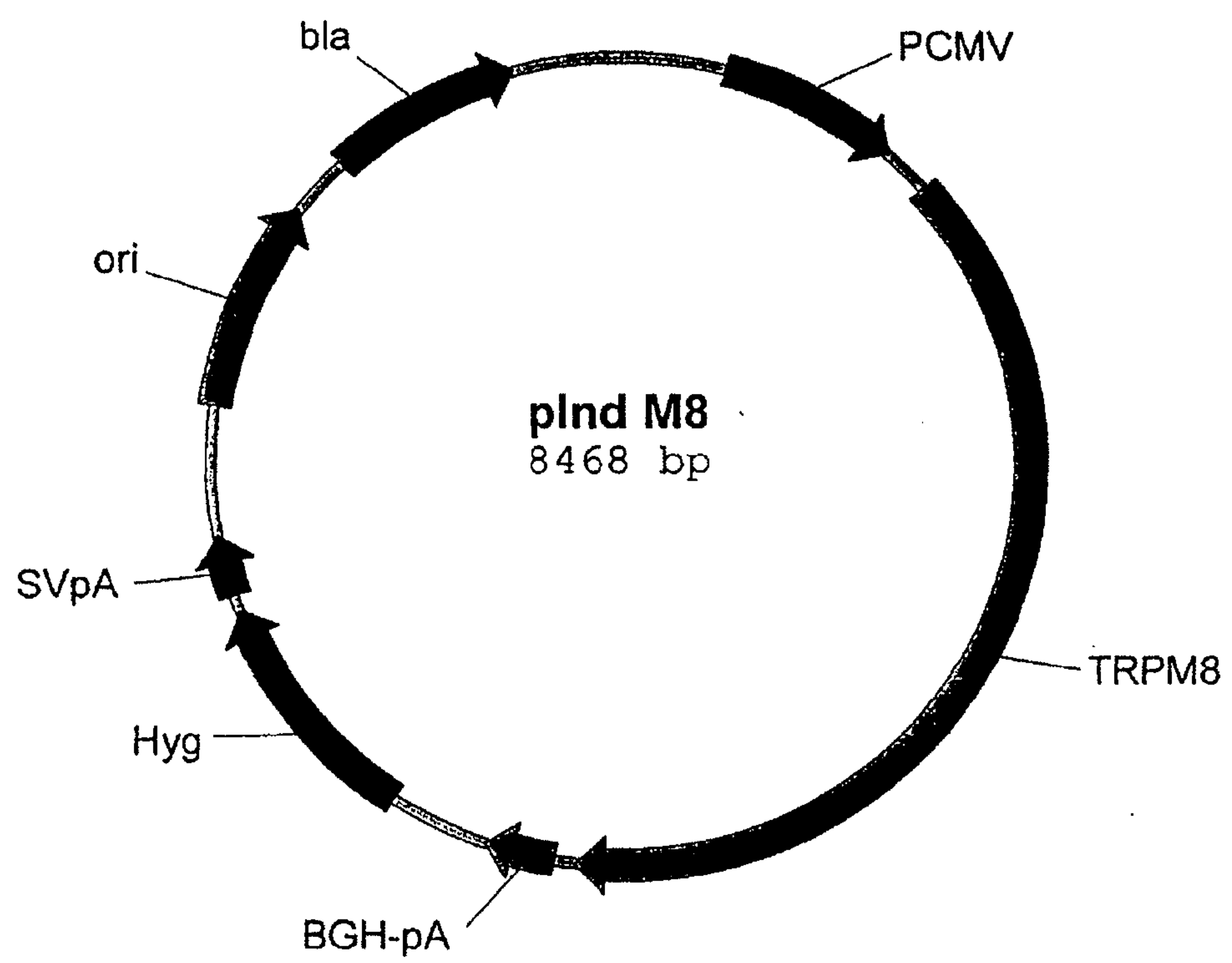


Fig. 1