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(54) Titre : NOUVEAU RECEPTEUR D'ERYTHROPOIETINE PROTECTEUR DE TISSU (NEPOR) ET PROCEDES D'UTILISATION

(54) Title: USE OF EPH-B4 AND EPHRIN-A1 FOR PREDICTING NEGATIVE PHYSIOLOGICAL RESPONSE TO THE TREATMENT WITH ERYTHROPOIETIN

(57) **Abrégé/Abstract:**

There is disclosed a use and a composition of a tissue protective erythropoietin (EPO) binding receptor protein complex, termed NEPOR. Presence of NEPOR components on a tumour allows EPO to impinge on the survival of associated cells thereby enhancing tumour progression and negatively effecting patient survival. By disclosing the molecular compositions of NEPOR species, there are disclosed methods for rationally identifying/designing NEPOR modulating therapeutics. Thus, the present disclosure provides methods for treating neurological insults such as stroke (via enhancement of NEPOR activity) and cancer (via down-regulation of cyto-protective signaling from NEPOR). Furthermore, there is disclosed herein the use of EPO with an inhibitor of NEPOR activity for treating negative patient outcomes associated with EPO stimulated NEPOR function.

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ABSTRACT

There is disclosed a use and a composition of a tissue protective erythropoietin (EPO) binding receptor protein complex, termed NEPOR. Presence of NEPOR components on a tumour allows EPO to impinge on the survival of associated cells thereby enhancing tumour progression and negatively effecting patient survival. By disclosing the molecular compositions of NEPOR species, there are disclosed methods for rationally identifying/designing NEPOR modulating therapeutics. Thus, the present disclosure provides methods for treating neurological insults such as stroke (via enhancement of NEPOR activity) and cancer (via down-regulation of cyto-protective signaling from NEPOR). Furthermore, there is disclosed herein the use of EPO with an inhibitor of NEPOR activity for treating negative patient outcomes associated with EPO stimulated NEPOR function.

USE OF EPH-B4 AND EPHRIN-A1 FOR PREDICTING NEGATIVE PHYSIOLOGICAL RESPONSE TO THE TREATMENT WITH ERYTHROPOIETIN

This application is a divisional application of co-pending application Serial No. 2,706,994, filed November 28, 2008.

Technical Field

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The present disclosure provides a novel tissue protective erythropoietin (EPO) binding receptor protein complex, here termed NEPOR. NEPOR is proposed to mediate EPO's tissue protective properties. Thus, presence of NEPOR on a tumour allows EPO to impinge on the survival of associated cells thereby enhancing tumour progression and negatively effecting patient survival.

10 In this circumstance, presence of NEPOR represents a prognostic biomarker for poorer patient outcome, while also representing a unique clinically tractable anti-cancer target protein. Likewise, NEPOR mediates EPO's neuroprotective activity and thus represents a unique target for treatment of diseases associated with neuronal insults, such as stroke.

15 In the first instance, the present disclosure provides a method for assessing a tumour for expression of this protein. The present disclosure further provides a method to stratify patients having a tumour as suitable (*i.e.* NEPOR not present) or non-suitable (*i.e.*, NEPOR present) for EPO treatment. The method disclosed comprises: (a) isolating a tissue sample from an individual who is receiving or is a candidate for receiving erythropoietin, (b) determining the level of
20 expression of the NEPOR gene(s) (mRNA) and/or the presence of the NEPOR gene product (protein) from the isolated tissue, and (c) correlating the presence of an NEPOR gene expression product or the presence of NEPOR protein to a physiological response to the treatment with erythropoietin. In a second instance, the present disclosure provides a method for treating patients with NEPOR positive tumors. Furthermore, the present disclosure provides a method for
25 treating stroke. Finally, the present disclosure provides a method for screening for NEPOR directed therapeutics (both antagonistic therapeutics for cancer, and agonistic therapeutics for treatment of hypoxia associated tissue damage, such as stroke).

Background

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Approved by the FDA in 1993 for treatment of anemia, Erythropoietin (EPO) is a 193 amino acid glycoprotein hormone, produced by the kidneys to regulate red blood cell (RBC) production; a process commonly termed erythropoiesis. EPO was originally identified as a cytokine that promotes erythrocyte progenitor survival and differentiation, but has also been
35 shown to possess neuroprotective functions, particularly in response to ischemic injury in the central nervous system, (CNS). Clinical use of EPO has been prevalent in the treatment of anemic cancer patients, while ongoing studies are exploring EPO's potential in the treatment of neurological diseases (*e.g.* stroke). Notwithstanding, recent clinical studies in cancer patients have begun to uncover highly worrying adverse events, suggesting that administration of

recombinant human EPO (rHuEPO) can adversely effect overall patient survival. An urgent need thus exists in medical oncology to better understand and predict the prevalence or susceptibility to this effect, so that administration of rHuEPO can be contra-indicated, continued or stopped.

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EPO: Biological function

Erythropoietin (EPO) is a 193 amino acid type I cytokine, produced by cells of the renal cortex to regulate red blood cell (RBC) production in a process termed erythropoiesis. Erythropoiesis is multistage in nature, involving the differentiation of pluripotent hematopoietic stem cells through the lineage-committed burst-forming unit-erythroid (BFU-E) and colony-forming unit-erythroid (CFU-E) progenitor cells, which give rise to a series of early and late erythroblasts, eventually leading to the formation of reticulocytes and mature erythrocytes. During this process, the sequential formation of pro-erythroblasts, basophilic, polychromatophilic, and orthochromatic erythroblasts is positively regulated by EPO. EPO induces multiple positive effects on early erythroblasts, including increased proliferation, progression through maturation, and protection from programmed cell death.

In terms of molecular mechanism, EPO binds to two identical receptors (EpoR), an event which activates several intracellular signaling pathways. These include Janus kinase 2-signal transducer and activator of transcription 5 (JAK2-STAT5), phosphatidylinositol 3-kinase (PI3K), protein kinase C (PKC), and Ras-Raf-MEK (mitogen-activated or extracellular signal-regulated protein kinase kinase)-ERK (extracellular signal-regulated protein kinase). The JAK2-STAT5 and RAS-RAF-MEK-ERK pathways are thought to be associated with Epo's mitogenic action, while the PI3K pathway, acting through Akt (PI3K-Akt), is viewed as a mediator of EPO's anti-apoptotic activities.

EPO: Clinical use

Anemia (AmE) or anæmia/anaemia (BrE), from the Greek (ἀναιμία)(an-haîma) meaning "without blood", is a deficiency of red blood cells (RBCs) and/or hemoglobin. The condition is commonly observed in patients with chronic diseases, and is particularly common in cancer where about 50% of patients are anaemic at presentation and some 70-90% developing the condition during the course of treatment (typically termed chemotherapy induced anemia (CIA)). In a recent review of the European Cancer Anemia Survey (ECAS), Ludwig et al. cited a 50% baseline anemia rate (hemoglobin [Hb] < 12 g/dL) among 3010 patients with hematological malignancies and a 41% baseline anemia rate among 11,453 patients with solid tumours (*Blood*, 2002;100:234a-235a. Abstract 884). Further longitudinal analysis revealed that 72% of 2780 patients with haematologic malignancies and 66% of 10,067 patients with solid tumours

succumbed to CLA. Other published studies have reported varying high rates in patients at different phases and with different types of treatment (Table 1). Notwithstanding, all studies demonstrate the extremely high prevalence of anemia amongst cancer patients.

Table 1. Prevalence of Anemia in Cancer Patients Undergoing Treatment

Type of Cancer	Prevalence of Anemia (Hb < 12 g/dL)
Cervical cancer ^[3]	82%
Solid tumors ^[1]	66%
Colorectal cancer ^[3]	67%
Lung cancer ^[3]	63%
Haematological malignancies	72%

A number of factors contribute to the high incidence of anemia among cancer patients, including not only chemotherapy and radiation-induced myelosuppression, but also cytokine-mediated anemia of chronic disease, bleeding, marrow infiltration by tumour, hemolysis, and nutritional deficiencies. Whatever the source, anemia results in a reduced ability of blood to transfer oxygen to the tissues, leading to tissue hypoxia and an associated range of clinical consequences, affecting all realms of patient health: physiologic status, psychosocial well-being and quality of life. Not surprising, anemia can negatively affect a patient's response to cancer therapy, a fact which highlights the important supportive role of rHuEPO in restoring normal RBC counts.

EPO: Clinical Safety signals

ESA's were for many years considered to be extremely safe in their labelled indications of chronic kidney disease and chemotherapy-induced anemia. The first hints of safety issues came in 2003 when results from a pair of studies examining EPO's potentiation of radiation and chemotherapy prompted an FDA meeting in May 2004. This first study (the ENHANCE study: *Lancet* 2003;362:1255-1260) suggested the relative risk of progression-free survival was worse for patients who received radiotherapy plus NeoRecormon epoetin beta from Roche than for patients receiving placebo plus radiotherapy. A randomized, double-blind, multi-institutional trial that included a study population of 351 patients who were receiving radiotherapy was performed. The patients were treated 3 times per week with either placebo or EPO in the form of epoetin beta starting 10 to 14 days before and continuing through radiation therapy. Although haemoglobin levels increased in 82% of patients receiving EPO, compared with 15% in patients receiving placebo, the rate of loco-regional progression-free survival was significantly lower. In addition, the EPO group had a higher relative risk for loco-regional progression and death.

In the second trial involving 939 breast cancer patients receiving chemotherapy (the BEST study: *J. Clin. Oncol.* 2005;23:5960-5972; see table 2), those given Eprex epoetin alfa from Johnson &

Johnson had a higher 4-month mortality rate and a lower 12-month survival rate than those on placebo. Both studies attempted to push the limits of hemoglobin levels beyond that permitted for marketing by the FDA - the recommended haemoglobin target for Aranesp was at the time up to 12 g/dL, while the labels for Epogen and Procrit recommended 10-12 g/dL. Henke treated
 5 men to target levels of at least 15 g/dL, while women were treated to at least 14 g/dL. The target level in the BEST study was 12- 14 g/dL.

Table 2: Summary of the results from Leyland-Jones et al. (*J. Clin. Oncol.* 2005;23:5960-5972) showing that 8.7% of patients from the EPO treatment arm died within 4 months of treatment,
 10 compared to 3.4% in the non-treated arm. ITT = Intention to treat.

Tab 2 4. Causes of Death Among Patients Who Died Within 4 Months of Random Assignment (ITT population, N = 939)				
Outcome	Epoetin Alfa (n = 469)		Placebo (n = 470)	
	No. of Patients	%	No. of Patients	%
Alive at 4 months	428	91.3	454	96.6
Died within 4 months	41	8.7	16	3.4

Johnson & Johnson (JNJ, New Brunswick, N.J.) have since reported data from the Phase IV
 15 CHOIR trial (*N. Engl. J. Med.* 2006 Nov 16;355(20):2085-98.) that tested whether using Procrit epoetin alfa to get hemoglobin levels to 13.5 g/dL would improve outcomes vs. treating to 11.3 g/dL (within the 10-12 g/ dL range on the drug's label). Patients in the higher haemoglobin group had a significantly increased incidence of mortality and cardiovascular events. While this study was carried out in the renal disease space, the safety implications were further emphasized
 20 in a more recent study - DAHANCA10. In February 2007, Amgen disclosed that this independent study had been halted three months earlier after interim data showed that Aranesp plus radiation missed the primary endpoint of 3-year loco-regional control vs. radiation alone. The study also showed a non-significant increase in death in the Aranesp arm. DAHANCA10 explored whether the use of Aranesp to maintain a hemoglobin level of 14-15.5 g/dL during
 25 radiotherapy could improve loco-regional disease control in patients with primary head and neck squamous cell carcinoma (HNSCC).

Safety signals also emerged from the use of Aranesp in the AoC space (study 103). In January 2007, Amgen reported that the risk/benefit profile of Aranesp was "at best neutral" in a Phase III
 30 trial in patients who had AoC and who were not receiving chemo- or radio-therapy. Here the data revealed significantly more deaths in Aranesp patients than in placebo patients. The trial, which treated patients to a haemoglobin level of 12-13 g/dL, also missed its primary endpoint of a significant reduction in transfusion frequency at 16 weeks. Study 103 enrolled patients with

various cancers, including non-small cell lung cancer (NSCLC), breast cancer and prostate cancer. Canadian researchers have published similar findings (*J. Clin. Oncol.* 2007 Mar 20; 25(9):1027-32). Here the authors showed that of the 70 advanced NSCLC patients with AoC, those receiving Procrit, had a significantly higher mortality rate than those receiving placebo. A synopsis of each of these studies is provided in Table 3 below:

Table 3: Summary of results from EPO safety studies highlighting survival issues.

STUDY	EPO type	POPULATION	DESIGN	STATUS
DAHANCA (SE20029001)	Aranesp	HNSCC; Baseline Hb $\leq$ 14.5	Multicenter, open-label trial of radiotherapy +/- Aranesp	Terminated early by DMC (after 522 of 600 planned patients enrolled) based on lower LRC rates and increased deaths in the ESA arm at planned interim analysis; 522 of 600 planned pts; summary results 12/06; CSR anticipated 9/08
EPO-CAN-20	Eprex/Procrit	NSCLC not receiving chemo; baseline Hb $\leq$ 12	Double-blind, placebo controlled, randomized (1:1) +/- Eprex	Terminated early by DSMB for increased deaths in ESA arm; 70 of 300 patients enrolled; results published in abstract in 2004 and in the journal of clinical oncology 3/07
BEST (EPO-INT-76)	Eprex/Procrit	Metastatic breast cancer	Randomised, double blind, placebo controlled	Terminated in April 2002, after review of data in the first 938 pts by the DMC, due to evidence of excess mortality in the Eprex arm
RTOG 9903	Eprex/Procrit	HNSCC; baseline Hb 9-12.5 (female), 9-13.5 (male)	Open-label, randomized (1:1), chemo/radiation +/- procrit	Terminated early by DSMB for trend to poorer LRC and OS in EPO arm. 148 of 372 patients enrolled. Results published in abstract 2004
Study 103 (Amgen)	Aranesp	NSCLC, prostate, breast cancer		

EPO clinical safety; a role for EPOR?

These clinical findings have led many investigators to suggest a possible role for ESA's in promoting tumour growth through stimulation of EPO receptor survival signalling in tumour cells, and via the stimulation of angiogenesis. Implicit in these proposed activities is the notion that the EPO receptor can somehow confer survival advantage to cancer cells, a negative side effect. This, in turn, suggests that EPO receptor is both present and activated by EPO binding in such cells. Using real-time, quantitative RT-PCR, the EPOR gene has not only been shown to be strongly expressed in bone marrow (containing the EPO-responsive erythroid progenitors), but also at significant levels in normal tissues (e.g. kidney, heart, brain, endothelium, and smooth muscle). Moreover, EPOR transcript levels in breast, colon, ovary, prostate, lung, lymphoma, ileum, stomach, and kidney tumour tissues and tumour cell lines were no higher than those levels observed in normal tissue counterparts. These findings are in concordance other reports which demonstrated that EPOR transcript levels are basically equivalent in matched tumour and non-

tumour samples from patients with lung, colon and prostate cancer. From the perspective of these data, it is questionable whether the EPOR gene might somehow provide selective advantage to tumour cells, at least via abnormal expression levels.

5 Therefore, there is a possible role for EPOR in mediating tumour cell survival in response to EPO. From a molecular perspective, the ability of cancer cells to subvert the EPO/EPOR system would not be surprising. A number of preclinical studies have demonstrated EPO-mediated activation of the mitogen-activated protein kinase (MAPK), phosphatidylinositol 3-kinase (PI₃K)-Akt, JAK-STAT (Janus kinase-Signal Transducer and Activator of Transcription), and
 10 nuclear factor-kappa B (NFκB) signalling pathways in a variety of human cancers. Each of these signalling cascades has been associated with cellular functions that promote tumour progression. EPO stimulated not only chemotaxis of endothelial cells, together with migration and invasion of breast cancer and HNSCC cells, but also appears to induce cancer cell proliferation and inhibit apoptosis. Moreover, pretreatment with rHuEPO protects some cancer cell lines from the
 15 cytotoxic effects of the chemotherapeutic agent, cisplatin. Thus, EPO/EPOR signalling appears to contribute to a wide variety of tumour-promoting functions in different cancer types.

Despite this evidence, the possible contribution of EPO/EPOR signalling to cancer progression is anything but straightforward. The influence of EPO/EPOR on different cancer types appears to
 20 be quite variable and remains incompletely understood. Studies have shown that EPO does not influence the proliferation of cancer cell lines. Rosti et al. (*Haematologica* 1993 Jul-Aug; 78(4):208-12.), for example, investigated the proliferative potential of rHuEPO by testing the effects of this factor on clonogenic growth and DNA synthesis in 10 different cell lines derived from haematologic malignancies and solid tumours. The cell lines K-562 and HEL were
 25 included in this study, both of which express EPO receptors. Results showed that rHuEPO had no effect on either colony growth or DNA synthesis (see Table 4).

Table 4. Showing the lack of effect of rHuEPO on the percentage of cells in S phase in human cell lines.

Cell line	EPO (IU/ml)		
	0	1.0	5.0
K-562	37.0 ± 2.0	37.1 ± 2.1	36.8 ± 1.7
HEL	27.3 ± 1.9	26.2 ± 1.3	25.8 ± 1.4
HL-60	26.4 ± 1.8	24.8 ± 2.1	25.6 ± 2.0
PLB 985	30.0 ± 1.7	27.8 ± 2.3	28.2 ± 2.5
KG-1	14.2 ± 1.3	14.0 ± 1.7	15.5 ± 1.8
H69	15.3 ± 1.5	15.8 ± 1.3	14.9 ± 1.6
N417	16.6 ± 1.8	17.0 ± 1.4	16.3 ± 2.2
MCF-7	20.0 ± 0.9	21.1 ± 1.2	19.7 ± 1.0

OCUM-1	16.1 ± 2.1	17.3 ± 2.4	15.3 ± 2.3
GBL-HU12	19.2 ± 1.5	20.9 ± 1.6	19.1 ± 2.0

In a similar study, Westphal et al. (*Tumori* 2002 Mar-Apr; 88(2):150-9.) investigated the effects of EPO on more than 25 different benign and malignant human cell lines. Expression of EPO receptor mRNA and protein was analyzed with RT-PCR, Western blot, and immunocytochemistry. Cellular responses to various concentrations of EPO were evaluated using tritiated thymidine uptake, Northern blot analysis of c-fos expression, and tyrosine-kinase activity assay. EPO receptor mRNA and protein were identified in the majority of the tumour cell lines evaluated. Despite these findings, treatment with rHuEPO did not significantly influence the proliferation rate of EPO-receptor-positive tumour cell lines. Moreover, treatment with EPO neither affected the gene c-fos mRNA of those cell lines nor stimulated tyrosine-kinase activation. Based on their findings, the authors concluded that expression of the EPO receptor in tumour cells does not appear to be essential for growth and therefore should not have a deleterious effect in cancer patients.

15 Might a novel EPO receptor explain these clinical and molecular findings?

Results by Lu et al. (*J. Biol. Chem.*, Vol. 281, Issue 11, 7002-7011, 2006) establish that receptor activation is not simply accomplished by bringing two receptors into close proximity through disulfide linkages in the transmembrane or extracellular domains. Instead, the relative orientation of the two transmembrane domains of an EpoR dimer, rather than their proximity, determines the extent of receptor activation. More specifically, these authors propose that Epo binding to the inactive, symmetric EpoR dimer causes the repositioning of the two fibronectinIII domains to an asymmetric 120° relative orientation, which in turn changes the orientation of the transmembrane domains and intracellular domains, and juxtaposes the appended JAK2s to initiate the phosphorylation cascade. EPO mutants would not necessarily be expected to be capable of initiating EPOR-signalling, due to their inability to induce the correct relative conformation of the fibronectinIII domains. Interestingly, it appears that certain aspects of EPO function can be decoupled from EPOR activity. Leist et al. (*Science* 305, 239-242.) have shown that the haematopoietic and tissue-protective activities of Epo are distinct and separate, demonstrating for example that carbamylated Epo (CEpo) does not stimulate erythropoiesis, yet prevents tissue injury in a wide variety of *in vivo* and *in vitro* models.

EPO and neuronal protection:

35 EPO's efficacy in treating nervous system disease has been demonstrated in several experimental models of brain and spinal cord injury. As such, EPO has become a candidate for therapeutic neuro-protection. Notwithstanding, the use of EPO as a neuro-protectant raises several safety

issues. Although recombinant EPO seems to be potentially safe at neuroprotective proven doses, cardiovascular or cerebrovascular events can occur as a result of its bone marrow stimulating activities. Interestingly, as highlighted above, EPO's neuronal protective function appears molecularly separable from the haematopoietic activity, as carbamylated EPO and certain EPO mutants are neuroprotective but fail to induce haematopoiesis. Such mutants fail to bind EPOR (Leist et al. *Science* 305, 239-242).

Synopsis:

EPO was for a long time considered to act solely on haematopoietic cells, a fact which led to its emergence as a leading treatment for chemotherapy-induced anemia. However, emerging evidence has shown that EPO is expressed in a variety of tissue and cell types, including cancer, vascular endothelial, and neuronal cells. Expression of EPO is induced in response to hypoxia, an event mediated by the HIF-1 transcription factor. EPO is prototypically thought to exert its biological effects via binding to its cell surface receptor EPOR, resulting in tyrosine phosphorylation of the receptor and other intracellular proteins, including JAK2 and STAT5. The JAK/STAT pathway is utilized both in haematopoietic and non-haematopoietic cells (including brain cells) following binding of EPO to the EPO receptor. The recent findings of EPO-receptor expression in human breast and renal cancer cells, as well as in several tumour cell lines, have raised important questions in the oncology setting about a possible tumour-growth-promoting effect of rHuEPO on EPO-receptor-bearing tumours. This possibility has been borne out in several clinical trials. Interestingly, other studies have shown that certain EPO mutants which are cytoprotective but not longer able to induce haematopoiesis, function independently of EPOR. This suggests that another EPO receptor may exist which lacks EPOR's strict binding conformation requirements.

In view of the disclosure provided herein and its related discovery, a brief description of ephrin receptors and ephrin biology is provided as follows.

Ephrin and Ephrin Receptor Biology

Erythropoietin-producing hepatocellular carcinoma (Eph) receptors form the largest family of receptor tyrosine kinases. Eph receptors are divided into two groups (Eph-A's and Eph-B's) based on the similarity of their extracellular domain sequences and the distinct structural properties of the ephrin ligands (Eph Nomenclature Committee, 1997). About 16 ephrin receptor genes (EphA1-10, EphB1-6) have been identified in the vertebrate genome (Pasquale, *Nat. Rev., Mol. Cell Biol.* 6 (2005), pp. 462-475.), 14 of which are present in humans (Figure 1) and other mammals (EphA1-8, EphA10, EphB1-4, EphB6).

Eph receptors are single-pass transmembrane proteins with highly conserved extracellular and intracellular domains. The former domains consists of an N-terminal ligand binding domain, a cysteine-rich EGF-like region and two fibronectin type III repeats (Yamaguchi and Pasquale, Curr. Opin. Neurobiol. 14 (2004), pp. 288–296.). Intracellularly, the juxtamembrane region is followed by a tyrosine kinase domain, followed by a sterile- α -motif (SAM), and a type-II PSD-95/Disc large/ZO-1 (PDZ) binding motif at the carboxyl terminus (Kullander and Klein, Nat. Rev., Mol. Cell Biol. 3 (2002), pp. 475–486.). The tyrosine kinase domain of one receptor from each class (EphA10 and EphB6) lacks residues that are essential for catalytic activity. Eph receptor variants are generated by alternative splicing and their structures differ from the prototypical domain structure. The domain architecture of Eph receptors and Ephrins (A and B subclasses) are shown in Figure 2.

Eph receptors can undergo *cis*-oriented homo- as well as heterodimerization (Freywald et al., J. Biol. Chem. 277 (2002), pp. 3823–3828.), which is mediated directly by the extracellular cysteine-rich region, the fibronectin type III repeats (Lackmann et al., J. Biol. Chem. 273 (1998), pp. 20228–20237.) and the SAM motif (Stapleton et al., Nat. Struct. Biol. 6 (1999), pp. 44–49. and Thanos et al., Science 283 (1999), pp. 833–836.) or indirectly through PDZ protein interactions (Fanning and Anderson, J. Clin. Invest. 103 (1999), pp. 767–772). *Trans*-oriented interactions typically occur with select ephrin molecules on opposing cells. In common with their receptors, the ephrins (named derived from Eph family receptor interacting proteins or *ephros*) are divided into two distinct subclasses A and B. Ephrin-A ligands are GPI-anchored peripheral membrane molecules. In contrast, ephrin-B ligands are transmembrane molecules whose short cytoplasmic domain is capable of participating in various signalling events. The ephrin-A and ephrin-B molecules were initially described as selectively interacting with EphA and EphB receptors, respectively. However, there may be crosstalk between A and B family members. For example, ephrin-A5 is capable of binding EphB2, while EphA4 binds to ephrin-A and ephrin-B family members. Although interactions across classes are limited, within a class they are promiscuous, with multiple EphA receptors binding to a given ephrinA and vice versa.

While neither class of ephrins possesses a catalytic activity, both can activate signal transduction pathways after interaction with Eph receptors (reverse signalling). Reverse signalling activated by transmembrane ephrins includes tyrosine phosphorylation of their cytoplasmic tail and interaction with various signalling molecules. The mechanism by which GPI-linked ephrins stimulate downstream signalling is still unclear.

Signalling sometimes involves formation of signalling assemblies, a process that begins with a monovalent interaction (nanomolar affinity) between an Eph receptor and an ephrin on a juxtaposed cell. Crystallographic work has shown that the globular ephrin-binding domain of EphB2 contains a cavity that accommodates a hydrophobic protrusion from the ephrins.

Structural changes occur upon binding. For example, EphB2 undergoes different structural rearrangements upon binding to ephrin-B2 or ephrin-A5.

A lower affinity binding interface is also present on the opposite side of the EphB2 ligand binding domain (Eph_lb), with complementary interfaces also present in the Eph-receptor-binding domain of ephrin-B2. While only of micromolar binding affinity, the second interface can mediate the dimerization of two Eph-ephrin dimers into a tetramer that comprises two receptor and two ephrin molecules extending from adjacent cell surfaces. The lower-affinity interface contains important determinants of subclass specificity and is not engaged in the EphB2-ephrin-A5 complex.

Signalling is initiated upon transphosphorylation via correctly orientated kinase domains. Eph receptors become extensively phosphorylated upon activation by ephrins and via src-kinase association. Phosphorylation promotes conformational order on the activation segment of the kinase domain that favours substrate binding and also disrupts intra-molecular inhibitory interactions that occur between the juxtamembrane segment and the kinase domain. Src-family mediated phosphorylation of Eph receptors has also been shown to act in a similar manner.

Summary

The present invention discloses members of the ephrin family (ephrinA1 and EPH-B4) as mediators of cytoprotective EPO signalling, either as homodimers and/or as heterodimeric partners of EPOR and/or each other. Our data emphasize the importance of EPH-B4 and EphrinA1 in mediating this function. As such, NEPOR represents a novel EPO receptor derived from a unique combination (*i.e.* via homo- and/or hetero-dimerization) of components derived from ephrin biology and possibly the EPO receptor. See figure 3 for summary.

The present disclosure is based upon the data that EPH-B4 and EphrinA1 are the components of a novel EPO receptor (NEPOR). We are able to show that EPO stimulates enhanced tumor growth in a mouse tumor model system. EPO stimulates the Akt signalling pathway in cell lines lacking EPO receptor expression. These cells express EPH-B4 which is a receptor that stimulates signalling via the Akt pathway. Furthermore in a mouse tumor model it can be shown that EPO is capable of stimulating significant tumor growth. Such activity is inhibited via knock-down of the EPH-B4 receptor highlighting the EPH-B4 dependant nature of a EPO mediated tumor genesis. As such, NEPOR is primarily composed of EPH-B4 as a homodimer and/or in heterodimeric association with EPOR or an Ephrin. Furthermore, *in silico* analyses points to structural complementarity between EPO and Ephrin molecules, particularly Ephrin A1. Thus, NEPOR may also be composed of EphrinA1 as a homodimer and/or in heterodimeric association EPH-B4. A summary of these putative NEPOR species is provided in Figure 3 and Table 5.

The present disclosure provides a method for assessing a tissue for expression of the tissue protective NEPOR receptor complex and/or EPH-B4 and/or Ephrin A1. In so doing, the present disclosure provides a prognostic method to stratify patients having a tumour as suitable (NEPOR not present on the tumour; NEPOR-) or non-suitable (NEPOR present on the tumour; NEPOR+) for EPO treatment. Specifically, the method for assessing tumour tissue NEPOR and/or gene expression components comprises:

- (a) isolating a tissue sample from an individual who is receiving or shall receive erythropoietin,
- (b) determining the level of expression of the NEPOR gene transcript(s) (*i.e.* EPH-B4, and/or Ephrin A1 mRNA) and/or the presence of the NEPOR gene products (*i.e.* EPH-B4, and/or Ephrin A1 proteins) from the isolated tissue, and
- (c) correlating the presence of these NEPOR component gene expression products to a negative physiological response to the treatment with erythropoietin.

Preferably, the expression of the NEPOR component genes (*i.e.* EPH-B4, and/or Ephrin A1 mRNA) is determined by a molecular biological technique selected from the group consisting of PCR, QPCR, R-PCR, gene expression microarray analysis, northern-blot analysis, reverse transcription and amplification, zymography, ligase-chain-reaction, NASBA, RNase Protection Assay (RPA), capillary electrophoresis with laser induced fluorescence (CE-LIF) and combinations thereof.

Preferably, the determination of the presence of the NEPOR gene products is done by detecting the respective proteins with an immunoassay procedure, where the immunoassay procedure is selected from the group of immunoprecipitation, enzyme immunoassay (EIA), radioimmunoassay (RIA) or fluorescent immunoassay, a chemiluminescent assay, an agglutination assay, nephelometric assay, turbidimetric assay, a Western blot, a competitive immunoassay, a noncompetitive immunoassay, a homogeneous immunoassay a heterogeneous immunoassay, a bioassay and a reporter-assay such as a luciferase-assay. The immunoassay procedure is most preferably based on ELISA.

Preferably, the method for detection of NEPOR and/or EPH-B4, and/or Ephrin A1 on tumour tissue can also be an *in situ* imaging method, comprising administering an anti-NEPOR antibody or NEPOR binding peptide linked to a radio-ligand or other imaging agent, and measuring for tissue distribution and location of the radio-ligand or other imaging agent. Preferably, the tissue sample is selected from the cancerous tissue or circulating cells derived from same, or from a group of biological tissues and fluids such as blood, lymph, urine, cerebral fluid. Specifically, the individual is a cancer patient who is to be treated with erythropoietin or is being treated with erythropoietin. Preferably, the negative physiological effect is increased tumor progression and/or poorer patient survival. Preferably, the presence of NEPOR gene products and/or EPH-

B4, and/or Ephrin A1 is indicative of increased tumor progression and/or poorer patient survival upon treatment with erythropoietin. Preferably the cancer is one of head and neck cancer, breast cancer, liver cancer, colorectal cancer, small intestine cancer, leukemia, prostate cancer, lung cancer, ovarian cancer, pancreatic cancer, endometrial cancer, stomach cancer, non-Hodgkin lymphoma, kidney cancer, Renal cell carcinoma (RCC), malignant melanoma, gallbladder cancer, bladder cancer, vulvar cancer, Penile cancer, testicular cancer, thymus cancer, Kaposi's sarcoma, eye cancer, adrenal gland cancer, brain cancer, cervical cancer, appendix cancer, adenoid cancer, bile duct cancer, urethral cancer, spinal cancer, Ewing's family of tumors, extragonal germ cell cancer, extra hepatic bile duct cancer, fallopian tube cancer, soft tissue cancers, bone cancer, Hodgkin's lymphoma, anal cancer, malignant mesothelioma, vaginal cancer skin cancer, central nervous system cancer (craniopharyngioma), pleuropulmonary blastoma, nasal cavity and paranasal sinus cancer transitional cell cancer of renal pelvis and ureter, pituitary gland cancer, squamous cell carcinoma of the head and neck (HNSCC), prostate cancer, colorectal cancer, lung cancer, brain cancer, bladder cancer, and salivary gland cancer. It is particularly preferred that the cancer is selected from the group of squamous cell carcinoma of the head and neck (HNSCC), prostate cancer, colorectal cancer, lung cancer, kidney cancer, brain cancer, bladder cancer and breast cancer.

The present disclosure further provides a method for designing a therapy which modulates the activity of NEPOR and/or EPH-B4, and/or Ephrin A1, comprising:

- 1) performing an *in vitro* screening assay for NEPOR and/or EPH-B4, and/or Ephrin A1 specific therapies; by measuring the binding of test compounds to a tissue protective NEPOR receptor complex and/or EPH-B4, and/or Ephrin A1 (also in comparison to EPOR homodimer complexes), wherein the test compound is labelled (binding of the labelled test compound to the receptor complexes detailed in figure 9) and is measured by detecting the label attached to the test compound;
- 2) performing a label-free screening approach such as surface plasmon resonance. In this case the test compound is not labelled and its binding to NEPOR receptor complexes (as detailed in figure 9) is measured by a label independent (optical) method.
- 3) testing NEPOR and/or EPH-B4, and/or Ephrin A1 activity by (a) contacting a test compound with a tissue protective NEPOR receptor complex (N) or tissue protective NEPOR receptor complex-expressing cell; measuring the level of the activity of (N) in the cell; identifying a test compound that increases or decreases the level of activity of (N) as compared to the level of activity of (N) measured in the absence of the test compound; and assaying the identified test compound for tissue protective activity;
- 4) testing the modulation of NEPOR/ligand binding and/or EPH-B4, and/or Ephrin A1 ligand binding by (a) contacting (N) with a tissue protective NEPOR receptor complex ligand and/or EPH-B4, and/or Ephrin A1 ligand attached to a first label, and an equivalent amount of a test compound attached to a second label under conditions conducive to binding, removing

unbound material from (N), and detecting the level of the first and second labels, where if the second label is present the compound binds (N) and if the level of the first label decreases relative to the level of the first label when the labelled ligand is contacted with (N) under conditions conducive to binding in the absence of a test compound after removal of unbound material, then a compound that binds to (N) is identified.

5) identifying a compound that modulates a tissue protective activity in a mammal, comprising: (a) administering the compound to a first animal immediately following infliction of an injury, wherein the first animal endogenously expresses a tissue protective NEPOR receptor complex; and (b) administering the compound to a second animal immediately following infliction of the same injury as in step (a), wherein the second animal is deficient in expression of a tissue protective NEPOR receptor complex and/or EPH-B4, and/or Ephrin A1 or components thereof; such that if recovery from the injury differs in the animal of step (a) as compared to the animal of step (b), a compound that modulates a tissue protective activity is identified.

The present disclosure further provides methods for treating or preventing a disease or disorder in a human comprising administering a therapeutically effective amount of a compound that modulates the activity of a tissue protective NEPOR receptor complex to a human in need of such treatment or prevention, with the proviso that the compound is not EPO. The compound is selected from the group consisting of an antibody specific for the tissue protective NEPOR receptor complex, an antibody is specific for a tissue protective NEPOR receptor complex ligand, a small molecule, a peptide, an EPO mutant, an EPO:Ephrin_ligand_binding domain chimera, a member of a library, and a combination thereof. Preferably, such compounds negatively modulate the tissue protective function of the NEPOR receptor complex in the aforementioned mentioned cancers. Preferably such compounds positively modulate the tissue protective function of the NEPOR receptor complex wherein the disease or disorder is caused by hypoxia, seizure disorders, neurodegenerative diseases, neurotoxin poisoning, multiple sclerosis, hypotension, cardiac arrest, radiation, or hypoglycemia.

The present disclosure further provides a method for identifying compounds that modulate NEPOR's tissue protective signalling activity, comprising (a) contacting a test compound with the NEPOR receptor complex expressing cell; (b) measuring the level of tissue protective activity initiated by NEPOR activation in the cell; (c) identifying a test compound which increases or decreases the level of tissue protective NEPOR complex activity in a cell; (d) assaying the identified compounds for tissue protective activity mediated via NEPOR; and (e) assaying the identified therapeutics for NEPOR inhibitory activity. Preferably, the assay in step (d) is a tissue protective NEPOR receptor complex activity is measured by a cell proliferation/differentiation assay. More preferably, the cells in the cell proliferation/differentiation assay are recombinantly engineered to express EPH-B4, and/or

EPOR, and/or Ephrin A1. More preferably, the cells endogenously express an EPO receptor and are transformed with a nucleic acid comprising a nucleotide sequence that (i) is operably linked to a promoter, and (ii) encodes either EPH-B4 and/or Ephrin A1. Most preferably, the cells endogenously express EPH-B4 and/or Ephrin A1 and are transformed with a nucleic acid
 5 comprising a nucleotide sequence that (i) is operably linked to a promoter, and (ii) encodes an EPO receptor polypeptide.

The present disclosure further provides a method for identifying a compound that modulates the interaction between a tissue protective NEPOR receptor complex and a tissue protective NEPOR
 10 receptor complex ligand, comprising: (a) contacting a tissue protective NEPOR receptor complex with one or more test compounds; and (b) measuring the tissue protective NEPOR receptor complex activity, whereby if the activity measured in (b) differs from the tissue protective NEPOR receptor complex activity in the absence of the one or more test compounds, then a compound that modulates the interaction between the tissue protective NEPOR receptor
 15 complex and the tissue protective NEPOR receptor complex ligand is identified. Preferably, the tissue protective NEPOR receptor complex activity is measured by cell proliferation or cell differentiation. Preferably, the tissue protective NEPOR receptor complex activity measured is the ability of the tissue protective NEPOR receptor complex to interact with a tissue protective NEPOR receptor complex ligand. Preferably, the step of assaying the identified compound for
 20 tissue protective activity comprises detecting the presence of nucleolin in the cell. Preferably, the step of assaying the identified compound for tissue protective activity comprises detecting or measuring an increased level of activity of neuroglobin or cytoglobin in a cell. Preferably, the tissue protective NEPOR receptor complex is in solution. Preferably, the tissue protective NEPOR receptor complex is in a cell. Preferably, the compound inhibits the binding of a tissue
 25 protective NEPOR receptor complex ligand to a tissue protective NEPOR receptor complex. Preferably, the compound enhances the binding of a tissue protective NEPOR receptor complex ligand to a tissue protective NEPOR receptor complex. Preferably, the tissue protective NEPOR receptor complex contacted in step (a) is on a cell surface. Preferably, the tissue protective NEPOR receptor complex is on an isolated cell membrane. Preferably, the tissue protective
 30 NEPOR receptor complex activity is compared to EPOR receptor activation to identify NEPOR specific compounds. Preferably, the tissue protective NEPOR receptor complex is immobilized to a solid surface and more preferably, the solid surface is a microtiter dish or a chip.

The present disclosure further provides a method for identifying a compound that binds a tissue
 35 protective NEPOR receptor complex, comprising: (a) contacting a test compound with a ligand-binding tissue protective NEPOR receptor complex fragment comprising at least one EPO receptor or EPH-B4 receptor or Ephrin A1 receptor extracellular domain and at least one EPO receptor or EPH-B4 receptor or Ephrin A1 receptor, extracellular domain fused to an Fc fragment attached to a solid support; and (b) contacting a test compound with a ligand-binding

EPOR receptor complex fragment comprising at least two EPO receptor extracellular domains fused to an Fc fragment attached to a solid support (c) removing unbound test compounds from the solid supports; (d) identifying the compound attached to the tissue protective NEPOR receptor complex fragment, but not the EPOR receptor complex (and vice versa), whereby a
 5 compound bound to the solid support is identified as a compound that binds specifically to a tissue protective NEPOR receptor complex or a compound that binds specifically to an EPOR receptor complex.

The present disclosure further provides a method for identifying a compound that binds a tissue
 10 protective NEPOR receptor complex, comprising: (a) contacting a test compound with a ligand-binding tissue protective NEPOR receptor complex fragment comprising at least one EPO receptor or EPH-B4 receptor or Ephrin A1 receptor, extracellular domain fused to an Fc fragment attached to a solid support; (b) removing unbound test compounds from the solid supports; (c) identifying the compound attached to the tissue protective NEPOR receptor
 15 complex fragment, whereby a compound bound to the solid support is identified as a compound that binds specifically to a tissue protective NEPOR receptor complex.

The present disclosure further provides a method for identifying a compound that binds to a tissue protective NEPOR receptor complex, comprising: (a) contacting a tissue protective
 20 NEPOR receptor complex fragment comprising at least one EPO receptor or EPH-B4 receptor or Ephrin A1 receptor extracellular domain and at least one EPO receptor or EPH-B4 receptor or Ephrin A1 receptor, extracellular domain fused to an Fc fragment attached to a solid support with (i) a tissue protective NEPOR receptor complex ligand attached to a first label and (ii) an equivalent amount of a test compound attached to a second label under conditions conducive to
 25 binding; (b) removing unbound material from the tissue protective NEPOR receptor complex; and (c) detecting the level of the first and second labels wherein if the second label is present the compound binds the complex and if the level of the first label decreases relative to the level of the first label where the labelled ligand is contacted with a tissue protective NEPOR receptor complex under conditions conducive to binding in the absence of a test compound after removal
 30 of unbound material, then a compound that binds to a tissue protective NEPOR receptor complex is identified.

The present disclosure further provides a method for identifying a compound that modulates the binding of a tissue protective NEPOR receptor complex ligand to a tissue protective NEPOR
 35 receptor complex, comprising: (a) contacting a tissue protective NEPOR receptor complex ligand with a tissue protective NEPOR receptor complex fragment comprising at least one EPO receptor or EPH-B4 receptor or Ephrin A1 receptor extracellular domain and at least one EPO receptor or EPH-B4 receptor or Ephrin A1 receptor, extracellular domain fused to an Fc fragment attached to a solid support; in the presence of one or more test compounds under

conditions conducive to binding; and (b) measuring the amount of tissue protective NEPOR receptor complex ligated bound to the tissue protective NEPOR receptor complex; whereby if the amount of bound tissue protective NEPOR receptor complex ligand measured in (b) differs from the amount of bound tissue protective NEPOR receptor complex ligand measured in the absence of the one or more test compounds, then a compound that modulates the binding of a tissue protective NEPOR receptor complex ligand to the tissue protective NEPOR receptor complex is identified.

Preferably, the amount of bound tissue protective NEPOR receptor complex ligand is measured using a tissue protective NEPOR receptor complex ligand-specific antibody. Preferably, the tissue protective NEPOR receptor complex ligand is labelled and binding of the tissue protective NEPOR receptor complex ligand to the tissue protective NEPOR receptor complex is measured by detecting the label attached to the tissue protective NEPOR receptor complex ligand. Preferably, the tissue protective NEPOR receptor complex ligand is labelled and binding of the labelled ligand to the tissue protective NEPOR receptor complex is measured by detecting the label attached to the tissue protective NEPOR receptor complex ligand. Preferably, the label is fluorescent. Preferably, the test compound is an antibody specific for the tissue protective NEPOR receptor complex. Preferably, the test compound is a small molecule. Preferably, the test compound is a peptide or a member of a library. Preferably, the tissue protective NEPOR receptor complex ligand is EPO, or derivatives thereof. Preferably, the compound binds the tissue protective NEPOR receptor complex or ligand thereof. Preferably, the tissue protective NEPOR receptor complex activity is compared to EPOR receptor activation to identify NEPOR specific compounds.

The present disclosure further provides a method for identifying a compound that modulates a tissue protective activity in a mammal, comprising: (a) administering the compound to a first animal immediately following infliction of an injury, wherein the first animal endogenously expresses a tissue protective NEPOR receptor complex; and (b) administering the compound to a second animal immediately following infliction of the same injury as in step (a), wherein the second animal is deficient in expression of a tissue protective NEPOR receptor complex or components thereof; such that if recovery from the injury differs in the animal of step (a) as compared to the animal of step (b), a compound that modulates a tissue protective activity is identified.

The present disclosure further provides a method for designing a compound which interferes with NEPOR's survival promoting activity, comprising:

(a) providing the molecular makeup of the NEPOR species and providing amino acid sequences of a component NEPOR polypeptides;

(b) using software comprised by the digital computer to design a chemical compound/protein construct which is predicted to bind to NEPOR; and

(c) optionally designing protein constructs which mimic NEPOR in its dimerised/multimerised state (*e.g.* Fc constructs).

5

The present disclosure further provides a method for identifying compounds that modulate NEPOR's tissue protective signalling activity, comprising (a) contacting a test compound with the NEPOR receptor complex; (b) measuring the level of tissue protective activity initiated by NEPOR activation; (c) identifying a test compound which increases or decreases the level of
 10 tissue protective NEPOR complex activity; (d) assaying the identified therapeutics for tissue protective activity mediated via NEPOR; and (e) assaying the identified therapeutics for NEPOR inhibitory activity. Preferably, the tissue protective NEPOR receptor complex activity is measured by measuring the binding of the test compound to the NEPOR receptor complex. More preferably, the test compound is labelled and binding of the labelled test compound to the tissue
 15 protective NEPOR receptor complex is measured by detecting the label attached to the test compound. Most preferably, the tissue protective NEPOR receptor complex activity is measured by measuring the binding of the test compound to the tissue protective NEPOR receptor complex.

20 The present disclosure further provides a method for imaging tumour tissue that is susceptible to enhanced survival in response to EPO treatment, comprising administering an anti-NEPOR antibody or NEPOR binding peptide linked to a radio-ligand or other imaging agent, and measuring for tissue distribution and location of the radio-ligand or other imaging agent. Preferably, the anti-NEPOR antibody is a monoclonal or polyclonal antibody selected from the
 25 group of antibodies listed in Table 6.

The present disclosure further provides a method for modulating cell survival in NEPOR positive tissue comprising administering an EPO mutants and peptides selected from the group consisting of peptides from SEQ ID NO. 17 through SEQ ID NO. 212.

30

The present disclosure further provides a method for modulating cell survival in NEPOR positive tissue comprising administering an effective amount of an EPO chimera, comprising an ephrin receptor ligand binding domain selected from the group consisting of SEQ ID NO. 215, and SEQ ID NO. 216.

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Brief Description of the Figures

Figure 1 shows the genomic localization of human Eph receptor (EPH) and ephrin (EFN) genes on human chromosomes.

Figure 2 shows the domain architecture of Eph receptors and Ephrins (A and B subclasses).

Figure 3 shows a process for identifying putative EPO binding transmembrane receptors. All
 5 proteins containing two membrane proximal FN3 domains were extracted (84 in all) and
 assessed for evidence of response to hypoxia. EPH-B4 was amongst one of four possible proteins
 extracted. Moreover, it is the only member of the Ephrin receptor family which is embryonic
 lethal, with death in embryo's preceding that of EPOR knock-outs.

10 Figure 4 shows the human EPO locus showing the neighbouring EPH-B4 gene.

Figure 5 shows a schematic of the results from analysis of the 5' and 3' UTR's (and an
 additional 500bp on either side) of the EPO, EPOR and EPH-B4 genes for the presence of
 hypoxia inducible transcription factor binding sites. This study was performed employing the
 15 "Match" algorithm from TRANSFAC (*Nucleic Acids Res.* 2003 Jan 1, 31(1):374-8) to analyse
 the composition of HIF1 binding sites. Strikingly, only the EPO and EPH-B4 genes were found
 to contain such sites, supporting the hypothesis that EPH-B4 is indeed hypoxia inducible.

Figure 6 shows a structural analysis of EphrinA5:EphB2 association in comparison with that of
 20 EPO:EPOR. This structural analysis reveals several commonalities consistent with a propensity
 for Ephrin A1 to bind EPO. The top panel shows homology of the EPO binding region of EPOR
 to the human Ephrin A molecules. The two lower panels compare the structural aspects of
 Ephrin A with EPOR.

25 Figure 7 shows staining of hippocampus with anti-EPH-B4 and anti-EpoR antibodies. It should
 be noted that there is a striking co-expression of both proteins restricted to certain cells only.
 These data suggest functional coupling of EPH-B4 and EPOR activity.

Figure 8 shows co-immunoprecipitation of EPH-B4 using flag-tagged EpoR. This finding is
 30 consistent with the notion that EPH-B4 and EPOR might heterodimerize.

Figure 9 shows the possible various species of NEPOR (without being bound by theory). In this
 representation, NEPOR homo/heterodimer species are shown as Fc constructs. This mimics the
 dimerization of separate receptor monomers. Any method which allows the production of such
 35 NEPOR dimers can be employed in screening for NEPOR specific agonists and antagonists,
 including small molecules, peptides, proteins and EPO variants.

Figure 10 shows an alignment of EPO protein mutants which are predicted to bind NEPOR more favourably than EPOR. Such mutants are predicted to be primarily tissue protective as opposed to haematopoietic, particularly those versions combining the described mutations.

5 Figure 11 shows mRNA levels of ovarian cancer cell lines. RNA was isolated from a panel ovarian cancer cell lines and was reverse transcribed into cDNA. PCR was done using primers specific for EPO receptor, EPH-B4, Ephrin A1 and actin.

10 Figure 12 shows protein expression in ovarian cancer cell lines. Protein extracts were isolated from a panel ovarian cancer cell lines. Samples were separated using SDS-Page gel electrophoresis. Immunoblots using antibodies for EPO Receptor (R&D biosystems), EPH-B4 (a gift from Prakash Gil), Ephrin A1 and actin (Sigma Aldrich) were used to compare protein expression.

15 Figure 13 shows ESA protection from chemotherapy induced apoptosis. Ovarian cancer cell lines Hey A8, SkoV3 ip1, and HeyA8-MDR (chemoresistant) were treated with 50 U erythropoietin (EPO), 50 nM docetaxel, or a combination of EPO and docetaxes for 48 hours. Cells were then fixed and DNA stained with propidium iodide. Percentage of sub G1 cells were then quantified using flow cytometer (BD).

20 Figure 14 shows signalling pathways activated in response to EPO in ovarian cancer cell lines. Cell lines previously characterized for expression levels of EPOR, EPH-B4, and Ephrin A1 were washed and grown in serum free media for two hours. Cells were then treated with 50 U EPO and collected and designated time points (0, 5 and 30 minutes). Protein extracts were isolated and analyzed by immunoblots using antibodies for phosphor-STAT5 (Invitrogen), phosphor-AKT, phosphor-ERK (Cell Signaling) and actin (Sigma Aldrich).

30 Figure 15 shows erythropoietin induced tumor growth in nude mice. Mice were injected i.p. with 1×10^6 Hey MDR ovarian cancer cells. Day eight following injections mice were injected with designated amounts of EPO (10, 50, 100 U, three mice per group) every second day. A) Mice were sacrificed at day 26 and tumor weight was measured. B) Protein extracts were isolated from tumors and analyzed by immunoblot using antibodies specific for phosphor AKT ser 473, phosphor ERK (Cell Signaling) and pSTAT5b (Invitrogen).

35 Figure 16 shows EPH-B4 expression effects tumor promoting effect of EPO. Female nude mice were injected i.p. with 1×10^6 HeyA8-MDR cells. Day eight following injection the cells were treated with control siRNA – DOPC, EPH-B4 siRNA-DOPC, EPO, or in EPO + control or EPH-B4 siRNA-DOPC (10 per group). (50 U EPO given 3 x week, 5 μ g siRNA 2 x week). Mice were

sacrificed on day 25 and tumor weights were measured. Statistics were done using students T-test. B) Distribution of tumor weight per group.

Figure 17 shows tumor weight distributions.

5

Detailed Description

The present disclosure results from the identification of a novel EPO receptor, henceforth referred to as NEPOR. NEPOR was identified using a bioinformatics workflow encompassing both a functional and sequence based analysis of the human genome/proteome. Homology analysis involving an extracellular protein database (termed XtraCellDB) was used in conjunction text-mining and genome context analysis. These *in silico* predictions were subsequently verified in lab-based experiments. Thus, the present disclosure provides genomic, proteomic and experiment evidence that the protein EPH-B4 (Erythropoietin Producing Hepatoma protein B4) and/or Ephrin A1 act as EPO receptors.

Working on the theory that the adverse effects of EPO seen in many cancer patients may be mediated by a receptor complex distinct from the prototypical EPO receptor (EPOR) homodimer, we initiated an *in silico* discovery project to try to identify a novel EPO receptor. Should such a novel EPO receptor species exist, we hypothesized that it will be responsible for mediating EPO-induced cell survival activity, as opposed to EPO mediated haematopoietic activity. Thus, we proposed the existence of at least two species of EPO receptor; the prototypical EPOR homodimer which is primarily responsible for EPO's haematopoietic activity, and a novel EPO receptor, termed NEPOR, which is primarily responsible for EPO's cytoprotective activities. The existence of such a novel EPO receptor is compelling for three main reasons. Firstly it allows the prediction of a cancer patients response to EPO. Presence of NEPOR on a tumour cell would imply a negative response to EPO, since binding of EPO by NEPOR would induce a cascade of survival signals within tumour cells and tissues, thus contributing to cancer progression and poorer patient survival. Thus, detection of NEPOR expression in a tumour provides a novel biomarker for stratify cancer patients as suitable (*i.e.* NEPOR not present) or unsuitable (*i.e.* NEPOR present) for EPO treatment. A corollary of this model is a second interesting perspective. If NEPOR is capable of initiating survival signals on cancer cells, then it represents an excellent therapeutic target for treatment of cancers expressing this receptor. Thus, therapeutic molecules targeting and antagonizing the tissue protective function of this receptor should be efficacious anti-cancer agents. Finally, under conditions where induction of cell survival is favourable, such as in response to ischemic stroke, therapeutic molecules capable of activating NEPOR-mediated survival signals provide an efficacious path to treating a variety of neurological diseases. Definition of NEPOR's molecular composition therefore provides the molecular basis for designing such therapies.

It had previously been proposed that rHuEPO can promote tumour growth through stimulation of Epo receptor (EPOR) signalling in tumour cells, and via the stimulation of angiogenesis. Binding of EPO to EPOR homodimers was assumed to somehow confer survival advantage to cancer cells, leading to increased loco-regional progression and poorer survival rates in patients having a form of cancer. However, aware of the binding promiscuity of exogenously administered therapeutics, we were anxious to address the possibility as to whether another receptor might be responsible for the observed negative outcomes, either alone or in functional interaction with EPOR.

In an effort to identify such a novel cytoprotective EPO receptor, we developed an *in silico* based analysis approach specifically designed to mine the human proteome for candidate molecules. Combining the power of text-mining and in-depth bioinformatics analysis, this multi-evidence based approach successfully identified a putative novel EPO receptor. Subsequent lab-based validation supports these findings. Given its established physiological role, we propose that by impinging on this receptors activity, EPO can confer survival advantage to certain cells, including cancer cells and neurons. As a consequence, the expression of this protein on cancer cells can be used to stratify the suitability of cancer patients for EPO treatment. Patients with cancer associated NEPOR expression should be contraindicated for EPO treatment. However, a corollary of this finding is that these same individuals represent excellent candidates for treatment with antagonistic anti-NEPOR therapies. In addition, we also propose that by mediating EPO's cyto-protective activity, NEPOR represents an excellent therapeutic target for a variety of diseases involving tissue ischaemia (*e.g.* stroke).

Thus, in the first instance, the present disclosure provides a method for assessing a tumour for expression of NEPOR. The disclosure provides a method to stratify patients having a tumour as suitable (*i.e.* NEPOR not present) or non-suitable (*i.e.*, NEPOR present) for EPO treatment. The method disclosed comprises: (a) isolating a tissue sample from an individual who is receiving or shall receive erythropoietin, (b) determining the level of expression of the NEPOR gene(s) (mRNA) and/or the presence of the NEPOR gene product (protein) from the isolated tissue, and (c) correlating the presence of an NEPOR gene expression product or the presence of NEPOR protein to a physiological response to the treatment with erythropoietin. In a second instance, the present disclosure provides a method for treating patients possessing NEPOR positive tumors. Furthermore, the present disclosure provides a method for treating stroke. Finally, by providing a means of comparing binding affinities of putative therapeutics to both NEPOR and EPOR, the present disclosure provides a method for screening for NEPOR specific therapeutics (both antagonistic therapeutics for cancer, and agonistic therapeutics for treatment of hypoxia associated disease such as stroke). Such therapeutics will lack the haematopoietic activity associated with EPOR binding and signaling.

NEPOR – Molecular definition

We have identified a novel multimeric EPO receptor, which we term NEPOR. NEPOR comprises EPHB4 and/or Ephrin A1 molecules either as homodimers or heterodimers. Without being bound by theory, these components may also heterodimerize with the EPO receptor. A synopsis of the possible molecular compositions of NEPOR is provided in Figure 3. Despite the room for molecular promiscuity involving other components from ephrin biology, EPH-B4 and/or EphrinA1 are components of a novel EPO receptor (NEPOR). As such NEPOR is primarily composed of EPH-B4 and Ephrin A1, either as a homodimers and/or in heterodimeric association with each other, or the EPO receptor. Without being bound by theory, given the strong functional association between EPH-B4 and Ephrin B2, NEPOR may also comprise Ephrin B2 disclosed herein as SEQ ID NO. 4 (amino acid sequence), SEQ ID NO. 8 (mRNA sequence), and SEQ ID NO. 12 (binding region).

Table 5 shows, without being bound by theory, the possible molecular composition of dimeric EPO receptors. The prototypical haematopoietic EPO receptor (EPOR) represents a homodimer of two EPOR (SEQ ID NO. 1) monomers (1). Our results suggest that a novel tissue protective EPO receptor dimer is comprised of Ephrin A1 (SEQ ID NO. 3) and EPH-B4 (SEQ ID NO.2). Possible scenarios are shown in Table 5.

20

Table 5:

	Description	Monomer 1	Monomer 2
1	EPOR	SEQ ID NO.1	SEQ ID NO.1
2	NEPOR	SEQ ID NO.1	SEQ ID NO.2
3	NEPOR	SEQ ID NO.1	SEQ ID NO.3
4	NEPOR	SEQ ID NO.2	SEQ ID NO.2
5	NEPOR	SEQ ID NO.2	SEQ ID NO.3
6	NEPOR	SEQ ID NO.3	SEQ ID NO.3
7	NEPOR	SEQ ID NO.1	SEQ ID NO.4
8	NEPOR	SEQ ID NO.2	SEQ ID NO.4
9	NEPOR	SEQ ID NO.3	SEQ ID NO.4
10	NEPOR	SEQ ID NO.4	SEQ ID NO.4

SEQ ID NO.1

25 >EPOR

MDHLGASLWFPQVGS LCLLLAGAAWAPPPNLPDPKFESKAALLAARGPEELLCFTERLEDL
 VCFWEEAASAGVGPGNYSFSYQLEDEPWKLCRLHQAPTARGAVRFWC SLPTADTSSFVPL
 ELRVTAASGAPRYHRV IHINEVVLLDAPVGLVARLADESGHVLRWLPPPETPMTSHIRY
 EVDVSAGNGAGSVQRVEILEGRTECVLSNLRGRTTRYTF AVRARMAEPSFGGFWSAWSEPV
 30 SLLTPSDLDPLILTL SLILVVILVLLTVLALLSHRRALKQKIWPGIPSPSEFEGLFTTH
 KGNFQLWLYQNDGCLWWSPCTPFTEDPPASLEVL SERCWGTMQAVEPGTDDEGP LLEPVG
 SEHAQDTYLVLDKWLLPRNPPSEDLP GP GGSVDIVAMDEGSEASSCSSALASKPSPEGAS

AASFEYTLDPSSQLLRPWTLCPELPPTPPHLKYLYLVVSDSGISTDYSSGDSQGAQGGL
SDGPFYSNPYENSLIPAAEPLPPSYVACS

SEQ ID NO.2

5 >EPH-B4

MELRVLLCWASLAAALEETLLNNTKLEADLKWVTFPQVDGQWEELSGLDDEEQHSVRTYEV
CDVQRAPGQAHWLRTGWVPRRGAVHVYATLRFTMLECLSLPRAGRSCKETFTVFYYESDA
DTATALTPAWMENPYIKVDTVAAEHLTRKRPGAEATGKVNKTLRLGPLSKAGFYLAFOQ
10 QGACMALLSLHLEFYKKCAQLTVNLTRFPETVPRELVPVAGSCVVDAPAPGPSPSLYCR
EDGQWAEQPVTCSCAPGFEEAEGNTKCRACAQGTFFKPLSGEGSCQPCPANSHTNTIGSA
VCQCRVGYFRARTDPRGAPCTTPPSAPRSVVSRLNGSSLHLEWSAPLES GGREDLTYALR
CRECRPGGSCAPCGGDLTFDPGPRDLVEPWVVVRGLRDPFTYTFEVTALNGVSSLATGPV
PFEPVNVTTDREVPPAVSDIRVTRSSPSSLSLAWAVPRAPSGAVLDYEVKYHEKGAEGPS
SVRFLKTSENRAELRGLKRGASYLVQVRARSEAGYGPFQGEHHSQTQLDESEGWREQLAL
15 IAGTAVVGVLVLVVIIVAVLCLRKQSNGREAEYSKDHGQYLIGHGTVYIDPFTYEDPN
EAVREFAKEIDVSYVKIEEVIGAGEFGEVCRGLKAPGKKESCVAIKTLKGGYTERQRRE
FLSEASIMGQFEHPNIIIRLEGVVTNSMPVMILTEFMENGALDSFLRLNDGQFTVIQLVGM
LRGIASGMRYLAEMSYVHRDLAARNILVNSNLVCKVSDFGLSRFLEENSSDPTYTSSLGG
KIPIRWTAPEAIAFRKFTSASDAWSYGIWMWEVMSFGERPYWDMNSQDVINAIEQDYRLP
20 PPPDCPTSLHQLMLDCWQKDRNARPRFPQVVSALDKMIRNPASLKIVARENGGASHPLLD
QRQPHYSAFGSVGEWLRAIKMGRYEESFAAAGFGSFELVSQISAEDLLRIGVTLAGHQKK
ILASVQHMKSQAKPGTGGTGGPAPQY

SEQ ID NO.3

25 >EphrinA1

MEFLWAPLLGLCCSLAAADRHTVFWNSSNPFRNEDYTIHVQLNDYVDIICPHYEDHSVA
DAAMEQYILYLVEHEEYQLCQFQSKDQVRWQCNRPSAKHGPEKLSEKFQRFPTFLGKEF
KEGHSYYYISKPIHQHEDRCLRLKVTVSGKITHSPQAHDNPQEKRLAADDPEVRVLHSIG
HSAAPRLFPPLAWTVLLLPLLLLQTP

30

SEQ ID NO.4

>EphrinB2

MAVRRDSVWKYCWGLMVLCRTAISKSIVLEPIYWNSSNSKFLPGQGLVLYPQIGDKLDI
ICPKVDSKTVGQYEEYKVYVMDKDQADRCTIKKENTPLLNCAPDQDIKFTIKFQEFSPN
35 LWGLEFQKNKDYYIISTSNGLSLEGLDNQEGGVCQTRAMKILMKVGQDASSAGSTRNKDPT
RRPELEAGTNGRSSTTSPFVKPNPGSSTDGNSAGHSGNNILGSEVALFAGIASGCIIFIV
IIITLVVLLLKYRRRHRKHSPQHTTTLSLSTLATPKRSGNNNGSEPSDIIIPLRTADSVF
CPHYEKVSGDYGHPVYIVQEMPPQSPANIYYKV

40 The present disclosure includes any splice variant of the polypeptides of SEQ ID NOS 1-4
components possessing the extracellular EPO binding region (for EPH-B4 this region of
proposed to encompass the two fibronectinIII domains; the pink oval structures in Figure 3B, D
and F) and the intracellular signalling part, is also capable of mediating EPO's (and derivatives
thereof) cyto-protective effect.

45

NEPOR: Prognostic implications

The type 1 cytokine, Erythropoietin (EPO), possesses both haematopoietic and tissue protective
activities. The present disclosure provides that the latter functionality is mediated via interactions
50 of EPO with a novel EPO receptor, termed NEPOR. The model provides that binding of EPO to
NEPOR receptor complexes, on NEPOR positive cancer cells, confers survival advantage to
such cells. The implicit physiological outcome for patients possessing NEPOR positive cancers
is therefore increased loco-regional cancer progression and poorer overall survival.

Thus, the present disclosure provides a diagnostic or prognostic test that can predict whether or not cancer patients administered EPO will respond negatively in terms of survival outcome. The prognostic test comprises determining NEPOR (*i.e.* EPH-B4, and/or Ephrin A1) in tumour tissue, or more particularly cancer cells. In another embodiment NEPOR component gene expression levels in tumour cells can be compared to baseline levels or levels in surrounding normal cells or tissue. Therefore, a comparative analysis looking at elevated or normal baseline expression levels of NEPOR component expression, using standard gene expression analysis methods (such as q-PCR and DNA microarray analyses) provides a diagnostic test that can determine whether or not administration of EPO to cancer patients will unwittingly enhance tumour cell survival (a negative outcome).

As stated, one method that can be used for comparing levels of gene expression of components of NEPOR and/or EPH-B4, and/or Ephrin A1 is Quantitative polymerase chain reaction (qPCR). This is a modification of PCR or polymerase chain reaction used to rapidly measure the quantity of DNA present in a tissue sample. Like other forms of polymerase chain reaction, the process is used to amplify nucleic acid samples, via the temperature-mediated enzyme DNA polymerase. PCR amplifies DNA exponentially, doubling the number of molecules present with each amplification cycle. The number of amplification cycles and the amount of PCR end-product should allow one to calculate the initial quantity of NEPOR-specific genetic material and/or EPH-B4 and/or Ephrin A1 genetic material in particular mRNA molecules using NEPOR-specific component sequences in particular and/or EPH-B4, and/or Ephrin A1 sequences for the two primers used for amplification.

In addition, gene expression analysis of NEPOR components and/or EPH-B4, and/or Ephrin A1 can be done with a microarray analysis containing a plurality of capture probes specific for sequences of the NEPOR complex in particular and/or EPH-B4, and/or Ephrin A1. As EPO is proposed to stimulate survival of NEPOR positive cancer cells and/or EPH-B4, and/or Ephrin A1 positive cells, it is important to test all cancer patients for NEPOR status and/or and/or EPH-B4, and/or Ephrin A1 status prior to and during EPO administration. This is best done with a microarray analysis for expression status of NEPOR component genes in tumour tissue and with mRNA samples taken from tumour tissue. Ascertaining the levels of endogenous tumour associated NEPOR (*i.e.* EPH-B4, and/or EphrinA1) expression, provide correlations as to patient prognosis/survival rate.

The present disclosure thus provides a method to stratify patients having a tumour as suitable (*i.e.* NEPOR not present and/or EPH-B4, and/or Ephrin A1 present) or non-suitable (*i.e.*, NEPOR present and/or and/or EPH-B4, and/or Ephrin A1 present) for EPO treatment. The method disclosed comprises: (a) isolating a tissue sample from an individual who is receiving or

shall receive erythropoietin, (b) determining the level of expression of EPH-B4 and/or Ephrin A1 from the isolated tissue, and (c) correlating the presence of these component gene expression products to a negative physiological response to the treatment with erythropoietin.

5 SEQ ID NO.5
 >erythropoietin receptor (EPOR), mRNA
 ACTTAGAGGCGCCTGGTCGGGAAGGGCCTGGTCAGCTGCGTCCGGCGGAGGCAGCTGCTGACCCAGCTGT
 GGACTGTGCCGGGGGGCGGGGACGGAGGGGCAGGAGCCCTGGGCTCCCCGTGGCGGGGGCTGTATCATGG
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 10 GCGGGCGCTAACCTCCCGGACCCCAAGTTCGAGAGCAAAGCGGCCTTGCTGGCGGGCCGGGGGCCCGAA
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 20 CTCGTGGTCATCCTGGTGTGCTGACCGTGTCTCGCGCTGCTCTCCACCGCCGGGCTCTGAAGCAGAAGA
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35 SEQ ID NO.6
 >EPH receptor B4 (EPHB4), mRNA
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 5 ACGAGGTCAAATACCATGAGAAGGGCGCCGAGGGTCCCAGCAGCGTGCGGTTCCTGAAGACGTCAGAAAA
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 20 GGGAGAGGCCGTACTGGGACATGAGCAATCAGGACGTGATCAATGCCATTGAACAGGACTACCGGCTGCC
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 30 AGCCACCTCGGGGAAGTCCAGACCAAGGGTGAGGGCGCCTTTCCCTCAGGACTGGGTGTGACCAGAGGAA
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 40 GCTCCAGGGGTAAAAAAGAAAAAAGAAAAA

SEQ ID NO.7

>Ephrin-A1 (EFNA1) mRNA

GCCAGATCTGTGAGCCCAGCGCTGACTGCGCCGCGGAGAAAGCCAGTGGGAACCCAGACCCATAGGAGAC
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5 SEQ ID NO.8

>ephrin-B2 (EFNB2), mRNA

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 5 ATCTGCTTTAGTTTCACATTCAGTTAGCCCCAGAAAATGAAATCCGTGAAGTCACATTCACATCTGTT
 TCAAACCTGAATTTGTTCTTAAAAAATAAAATATTTTTTTCTATGGAAAAA

Detection of NEPOR component mRNA (SEQ ID NOs 5-8) should preferentially be performed
 using probes complementary to the sub-region of SEQ ID NO's 5-8, encoding the EPO binding
 10 domain and is particular SEQ Id NO. 6 and/or 7 encoding EPH-B4 and Ephrin A1. This implies
 for EPH-B4, probes complementary to SEQ ID NO. 10.; for Ephrin A1, probes complementary
 to SEQ ID NO. 11.

SEQ ID NO.9
 15 >epor_epobinding_coding region
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SEQ ID NO.10
 25 >ephb4_epobinding_coding region
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 35 GCTACCTGGTGCAGGTACGGGCGCGCTCTGAGGCCGGCTACGGGCCCTTCGGCCAGGAACATCACAGCCAGACCCAA
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SEQ ID NO.11
 40 >ephrinA1_epobinding_coding region
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 TGTGCAGCTGAATGACTACGTGGACATCATCTGTCCGCACTATGAAGATCACTCTGTGGCAGACGCTGCCATGGAGC
 AGTACATACTGTACCTGGTGGAGCATGAGGAGTACCAGCTGTGCCAGCCCCAGTCCAAGGACCAAGTCCGCTGGCAG
 TGCAACCGGCCAGTGCCAAGCATGGCCCCGAGAAGCTGTCTGAGAAGTTCCAGCGCTTCACACCTTTACCCCTGGG
 CAAGGAGTTCAAAGAAGGACACAGCTACTACTACATCTCAAACCCATCCACCAGCATGAAGACCGCTGCTTGAGGT
 45 TGAAGGTGACTGTGAGTGGCAAAATCACTCAC

SEQ ID NO.12
 50 >ephrinb2_epobinding_coding region
 TCCAAATCGATAGTTTGTAGAGCCTATCTATTGGAATTCCTCGAACTCCAAATTTCTACCTGGACAAGGACTGGTACT
 ATACCCACAGATAGGAGACAAATTGGATATTATTTGCCCCAAAGTGGACTCTAAAACCTGTTGGCCAGTATGAATATT
 ATAAAGTTTATATGGTTGATAAAGACCAAGCAGACAGATGCACTATTAAGAAGGAAAATACCCCTCTCCTCAACTGT
 GCCAAACCAGACCAAGATATCAAATTCACCATCAAGTTTCAAGAATTCAGCCCTAACCTCTGGGGTCTAGAATTTCA
 GAAGAACAAGATTATTACATTATATCTACATCAAATGGGTCTTTGGAGGGCCTGGATAACCAGGAGGGAGGGGTGT
 GCCAGACAAGAGCCATGAAGATCCTCATGAAGTTGGACAA

55

The determination of the presence of the Ephrin A1 and/or the determination of the presence of
 the EPH-B4 gene product (mRNA) may be done by using a hybridization technique or an

amplification technique. It is preferred that the technique is selected from the group of, real-time-PCR, northern-blot analysis, reverse transcription and amplification, zymography, ligase-chain-reaction, NASBA, RNase Protection Assay (RPA), capillary electrophoresis with laser induced fluorescence (CE-LIF) and combinations thereof.

5

Specifically, the individual is a cancer patient who is to be treated with erythropoietin or is being treated with erythropoietin. Preferably, the negative physiological effect is poorer patient survival due to enhanced tumor progression. Preferably, the presence of a higher level of NEPOR component genes (mRNA) and/or the presence of NEPOR component gene expression
10 products (proteins) and/or EPH-B4 and/or Ephrin A1 on tumor tissues is indicative of poorer survival prognosis upon treatment with erythropoietin.

Preferably, the determination of the presence of the NEPOR dimer complex is done by detecting the respective NEPOR proteins with an immunoassay. Also peptides thereof may be detected.
15 The immunoassay is selected from the group of immunoprecipitation, a protein array or binding to a mass microbalance instrument (for example, Q-Sense or Attana), enzyme immunoassay (EIA), radioimmunoassay (RIA) or fluorescent immunoassay, a chemiluminescent assay, an agglutination assay, nephelometric assay, turbidimetric assay, a Western blot, a competitive immunoassay, a noncompetitive immunoassay, a homogeneous immunoassay a heterogeneous
20 immunoassay, a bioassay and a reporter-assay such as a luciferase-assay. Preferably, the immunoassay is an ELISA. Preferably, the anti-NEPOR antibody and/or EPH-B4 and/or Ephrin A1 antibody is a monoclonal or polyclonal antibody, for example selected from - or similar to - the antibodies listed in Table 6.

25 Preferably, detection of NEPOR component proteins should preferentially be performed using antibodies detecting the sub-regions of SEQ ID NOs 6 and 7, representing the EPO binding domain. This implies for EPH-B4, antibodies specific to SEQ ID NO. 14.; for Ephrin A1, antibodies specific to SEQ ID NO. 15.

30 SEQ ID NO.13
>epor_epobinding_region
SKAALLAARGPEELLCFTERLEDLVCFWEEAASAGVGPGNYSFSYQLEDEPWKLCRLHQAPTARGAVRFWCSLPTAD
TSSFVPLELRVTAASGAPRYHRVIHINEVVLLDAPVGLVARLADESGHVVLRLWLPPEPMPMTSHIRYEVDVSAGNGA
GSVQRVEILEGRTECVLSNLRGRTRYTFVRARMAEPPSFGGFWSAWSEPVSLLTPSDLDP

35

SEQ ID NO.14
>ephb4_epobinding_region
PSAPRSVVSRLNGSSLHLEWSAPLES GGREDLTIALRCRECRPGGSCAPCGGDLTFDPGPRDLVEPWVVVRGLRPDF
TYTFEVTALNGVSSLATGPVPFEPVNVTTDREVPPAVSDIRVTRSSPSSLSLAWAVPRAPSGAVLDYEVKYHEKGAE
40 GPSSVRFLKTSENRAELRGLKRGASYLVQVRARSEAGYGPFQGEHHSQTQLDESEGWREQAL

SEQ ID NO.15
>ephrinA1_epobinding_region
LAAADRHTVFWNSSNPKFRNEDYTIHVQLNDYVDIICPHYEDHSVADAAMEQYILYLVEHEEYQLCQPQSKDQVRWQ
45 CNRPSAKHGPEKLSEKFQRFPTLKGKEFKEGHSYYYISKPIHQHEDRCLRLKVTVSGKITH

SEQ ID NO.16

>ephrinb2_epobinding_region

SKSIVLEPIYWNSSNSKFLPGQGLVLYPQIGDKLDIICPKVDSKTVGQY EYYKVY MVDK DQADRCTIKKENTPLLNC
 5 AKPDQDIKFTIKFQEFSPNLWGLEFQKNKDYYIIISTNGSLEGLDNQEGGVCQTRAMKILMKVGQ

Preferably, the individual is a cancer patient who is to be treated with erythropoietin or is being treated with erythropoietin. The tissue sample may be selected from the group of biological tissues and fluids such as blood, lymph, urine, cerebral fluid. The tissue sample may also be a
 10 tumor biopsy sample. It is preferred that the tissue sample is from the cancer tissue or circulating cells derived from same.

It is preferred that the cancer of the cancer patient is selected from the group of, head and neck cancer, breast cancer, liver cancer, colorectal cancer, small intestine cancer, leukemia, prostate
 15 cancer, lung cancer, ovarian cancer, pancreatic cancer, endometrial cancer, stomach cancer, non-Hodgkin lymphoma, kidney cancer, Renal cell carcinoma (RCC), malignant melanoma, gallbladder cancer, bladder cancer, vulvar cancer, Penile cancer, testicular cancer, thymus cancer, Kaposi's sarcoma, eye cancer, adrenal gland cancer, brain cancer, cervical cancer, appendix cancer, adenoid cancer, bile duct cancer, urethral cancer, spinal cancer, Ewing's family
 20 of tumors, extragonal germ cell cancer, extra hepatic bile duct cancer, fallopian tube cancer, soft tissue cancers, bone cancer, Hodgkin's lymphoma, anal cancer, malignant mesothelioma, vaginal cancer skin cancer, central nervous system cancer (craniopharyngioma), pleuropulmonary blastoma, nasal cavity and paranasal sinus cancer transitional cell cancer of renal pelvis and ureter, pituitary gland cancer, squamous cell carcinoma of the head and neck (HNSCC), prostate
 25 cancer, colorectal cancer, lung cancer, brain cancer, bladder cancer, and salivary gland cancer. It is particularly preferred that the cancer is selected from the group of squamous cell carcinoma of the head and neck (HNSCC), prostate cancer, colorectal cancer, lung cancer, kidney cancer, brain cancer and bladder cancer.

30 **NEPOR and Disease Intervention and Therapy Design/Screening.**

Without being bound by theory, NEPOR is proposed to mediate the cyto-protective effects of EPO and its variants. Thus, EPO and variants that have been shown to possess cyto-protective (but not haematopoietic) activity can affect NEPOR function. Therefore, the present disclosure
 35 provides knowledge of NEPOR's composition that can be used to optimize the structure and efficacy of such therapeutic molecules (that is, better manage the structure-activity relationship or SAR of the EPO pharmacophore). Moreover, the present disclosure provides knowledge of NEPOR's composition that can be used to identify novel NEPOR regulating compounds. For example, in diseases associated with hypoxic conditions (*e.g.*, stroke, heart attack), NEPOR
 40 binding compounds of enhanced efficacy can be developed to mimic the effects of EPO on NEPOR. Similarly, NEPOR specific antagonists (such as those molecules that bind the active

site of NEPOR yet do not transducer signal are antagonists of EPO function. Such EPO antagonist agents, when concomitantly administered with EPO, can allow for EPO effects to improve haematopoiesis (that is, treat the anaemia) yet prevent the side effect of promoting tumour cell growth, survival and angiogenesis in NEPOR positive cancers such as HNSCC. Moreover, contrasting the relative activity of compounds to the tissue protective NEPOR receptor complex in comparison to the EPOR receptor homodimer provides for generating NEPOR specific/directed therapies.

Definition of NEPOR provides methods for identifying therapeutic molecules that modulate NEPOR's tissue protective signalling activity. This comprises: (a) contacting a test compound with the NEPOR receptor complex and/or EPH-B4 and/or Ephrin A1 and an EPOR homodimer complex; (b) measuring and comparing the level of tissue protective activity initiated by NEPOR activation with the activation of EPOR homodimer signalling; (c) identifying a test compound which increases or decreases the level of tissue protective NEPOR complex activity as compared to the level of EPOR complex activation; and (d) assaying the identified therapeutics for tissue protective activity mediated via NEPOR, but lack of EPOR activation and (e) assaying the identified therapeutics for NEPOR inhibitory activity. The method is useful for identifying therapeutics that modulates the interaction between a tissue protective NEPOR complex and/or EPH-B4 and/or Ephrin A1 and the EPO ligand. The method is furthermore useful for identifying therapies for treating diseases of the central nervous system or peripheral nervous system which have primarily neurological or psychiatric symptoms, ophthalmic diseases, cardiovascular diseases, cardiopulmonary diseases, respiratory diseases, kidney, urinary and reproductive diseases, bone diseases, skin diseases, gastrointestinal diseases and endocrine and metabolic abnormalities and cancer.

More specifically, identification of NEPOR provides a method identifying (I1) a compound that modulates the tissue protective activity of NEPOR, comprising:

(a) contacting a test compound with a tissue protective NEPOR receptor complex (N) and/or EPH-B4 and/or Ephrin A1 or tissue protective cytokine receptor complex-expressing cell; measuring the level of the activity of (N) in the cell; identifying a test compound that increases or decreases the level of activity of (N) as compared to the level of activity of (N) measured in the absence of the test compound; and assaying the identified test compound for tissue protective activity;

(b) contacting a test compound with a cell that is recombinantly engineered to express (N), where the cell or the recombinant cell is transformed with a nucleic acid comprising a nucleotide sequence that is functionally linked to a promoter and encodes EPH-B4 and/or Ephrin A1 polypeptides; measuring the level of activity of (N) in the cell; and

(c) contacting a test compound with a tissue protective NEPOR receptor complex-expressing cell, where the cell is transformed with a nucleic acid comprising a nucleotide

sequence that encodes a reporter gene functionally linked to regulatory element associated with the activity of (N); identifying a test compound that increases or decreases the level of reporter gene expression relative to the level of reporter gene expression measured in the absence of the test compound; and assaying the identified test compound for a tissue protective activity.

5

The present disclosure further provides a method for identifying (I2) a compound that binds to (N), comprising:

(a) contacting (N) with a tissue protective NEPOR receptor complex ligand and/or EPH-B4 and/or Ephrin A1 ligand attached to a first label, and an equivalent amount of a test compound attached to a second label under conditions conducive to binding, removing unbound material from (N), and detecting the level of the first and second labels, where if the second label is present the compound binds (N) and if the level of the first label decreases relative to the level of the first label when the labelled ligand is contacted with (N) under conditions conducive to binding in the absence of a test compound after removal of unbound material, then a compound that binds to (N) is identified; or

(b) contacting a test compound with a ligand-binding tissue protective receptor NEPOR complex fragment comprising at least one EPH-B4 receptor or Ephrin A1 receptor, extracellular domain fused to a Fc fragment attached to a solid support, removing unbound test compounds from the solid support, and identifying the compound attached to the tissue protective NEPOR receptor complex fragment, such that a compound bound to the solid support is identified as a compound that binds to a tissue protective NEPOR receptor complex; and identifying (I3) a compound that modulates the binding of a tissue protective NEPOR receptor complex ligand to (N), or compound that modulates the interaction between (N) and tissue protective cytokine receptor complex ligand, involves (i) contacting a tissue protective NEPOR receptor complex ligand with (N) in the presence of one or more test compounds under conditions conducive to binding, and measuring the amount of tissue protective cytokine receptor complex ligand bound to (N).

The present disclosure further provides novel tissue protective NEPOR receptor complexes in particular EPH-B4 and/or Ephrin A1 containing complexes that can be used to provide an *in vitro* screening assay for NEPOR specific therapies; by measuring the binding of test compounds to the tissue protective NEPOR receptor complex in comparison to EPOR homodimer complexes. The test compound is labelled and binding of the labelled test compound to the receptor complexes detailed in Figure 9 is measured by detecting the label attached to the test compound. Alternatively, a label free detection approach such as surface plasmon resonance may be employed. Such an approach can provide for novel neuroprotective therapies (*i.e.* NEPOR agonists) which lack haematopoietic activity. Such an approach can also provide for novel oncotherapies (*i.e.* NEPOR antagonists *i.e.* at least a and/or EPH-B4 and/or Ephrin A1 agonist) which

do not inhibit haematopoiesis. The nature of such screening arrays involving recombinant receptor constructs is demonstrated in Figure 9 (in the exemplified case as Fc constructs).

Use

5

(I1) is useful for identifying a compound that modulates NEPOR's tissue protective activity. (I2) is useful for identifying a compound that binds to NEPOR. (I3) is useful for identifying a compound that modulates the binding of a tissue protective NEPOR receptor complex ligand to (N), or compound that modulates the interaction between (N) and tissue protective cytokine
 10 receptor complex ligand (claimed). The compounds identified using (I1)-(I3) are useful for treating various conditions of the central and peripheral nervous systems (*e.g.*, hypoxia, and/or ischemia, epilepsy, chronic seizure disorders, neurotoxin poisoning, septic shock, anaphylactic shock), neuropsychologic disorders (senile dementia, Alzheimer's disease, Parkinson's disease, dermentia, multiple sclerosis, Creutzfeldt-Jakob disease, Huntington's disease), inflammatory
 15 diseases (*e.g.*, chronic bronchitis, rheumatoid arthritis, glomerulonephritis, encephalitis, meningitis, polymyositis), ophthalmic diseases (*e.g.*, angiitis, retinal ischemia), cardiovascular diseases (*e.g.*, myocardial infraction, myocarditis), cardiopulmonary diseases (*e.g.*, asthma, pulmonary thrombosis), respiratory diseases, kidney, urinary, and reproductive diseases (*e.g.*, myasthenia gravis, diabetes, autoimmune diseases), bone diseases (*e.g.*, osteopenia, Paget's
 20 disease), gastrointestinal diseases and endocrine and metabolic abnormalities.

The compounds identified using (I1)-(I3) are also useful for treating NEPOR positive cancers in particular and/or EPH-B4 and/or Ephrin A1 positive cancers including, head and neck cancer, breast cancer, liver cancer, colorectal cancer, small intestine cancer, leukemia, prostate cancer,
 25 lung cancer, ovarian cancer, pancreatic cancer, endometrial cancer, stomach cancer, non-Hodgkin lymphoma, kidney cancer, Renal cell carcinoma (RCC), malignant melanoma, gallbladder cancer, bladder cancer, vulvar cancer, Penile cancer, testicular cancer, thymus cancer, Kaposi's sarcoma, eye cancer, adrenal gland cancer, brain cancer, cervical cancer, appendix cancer, adenoid cancer, bile duct cancer, urethral cancer, spinal cancer, Ewing's family
 30 of tumors, extragonal germ cell cancer, extra hepatic bile duct cancer, fallopian tube cancer, soft tissue cancers, bone cancer, Hodgkin's lymphoma, anal cancer, malignant mesothelioma, vaginal cancer skin cancer, central nervous system cancer (craniopharyngioma), pleuropulmonary blastoma, nasal cavity and paranasal sinus cancer transitional cell cancer of renal pelvis and ureter, pituitary gland cancer, sqamous cell carcinoma of the head and neck (HNSCC), prostate
 35 cancer, colorectal cancer, lung cancer, brain cancer, bladder cancer, and salivary gland cancer. It is particularly preferred that the cancer is selected from the group of squamous cell carcinoma of the head and neck (HNSCC), prostate cancer, colorectal cancer, lung cancer, kidney cancer, brain cancer and bladder cancer.

NEPOR in Oncology Therapy

The hypothesis of the present disclosure is that EPO results in poorer survival outcomes (at least in some cancers) because of its effects on NEPOR activity i.e. in particular EPH-B4 and/or Ephrin A1 activity. Therefore, treatment of these NEPOR positive patients with a NEPOR targeted therapy is a prudent path to disease intervention. Specific approaches to antagonising NEPOR mediated survival signals include, for example:

a) NEPOR specific antagonistic antibodies. Such antibodies block and antagonise the extracellular regions of the molecule specifically associated with the mediation of NEPOR's cyto-protective activity.

b) NEPOR specific small-molecules. Such small molecules block and antagonise the extracellular regions of the molecule specifically associated with the mediation of NEPOR's cytoprotective activity.

c) high-affinity peptides which specifically target NEPOR to block and antagonise the mediation of EPO's cytoprotective activity.

d) Small molecules targeting EPH-B4's intracellular tyrosine kinase domain (e.g. Dasatinib), including:

1: CID: 1095868, AKI-STT-00166305; ZINC00818264; BAS 09636496 IUPAC: N-[5-[(3-chlorophenyl)methyl]-1,3-thiazol-2-yl]-2-(4,6-dimethylpyrimidin-2-yl)sulfanylamide. MW: 404.93678 | MF: C₁₈H₁₇ClN₄OS₂. (MW is molecular weight and MF is molecular formula)

2: CID: 1465558, IUPAC: 2-[(3-chlorobenzoyl)amino]-4-methyl-N-pyridin-3-yl-1,3-thiazole-5-carboxamide, MW: 372.82872 | MF: C₁₇H₁₃ClN₄O₂S.

3: CID: 1468201, IUPAC: N-[5-[(2-chlorophenyl)carbamoyl]-4-methyl-1,3-thiazol-2-yl]pyridine-4-carboxamide, MW: 372.82872 | MF: C₁₇H₁₃ClN₄O₂S.

4: CID: 3062316, Dasatinib; Sprycel; BMS Dasatinib, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C₂₂H₂₆ClN₇O₂S.

5: CID: 3072360, 142287-40-9; Pyrimido(4,5-d)pyrimidin-4(1H)-one, 7-methyl-1-phenyl-2-((3-(4-(2-thiazolyl)-1-piperazinyl)propyl)thio)- IUPAC: 2-methyl-8-phenyl-7-[3-[4-(1,3-thiazol-2-yl)piperazin-1-yl]propylsulfanyl]pyrimido[6,5-d]pyrimidin-5-one, MW: 479.6209 | MF: C₂₃H₂₅N₇O₂S.

6: CID: 5041467, STK154706; ZINC04687922, IUPAC: [2-[(2-methylphenyl)amino]-1,3-thiazol-4-yl]-(4-pyrimidin-2-ylpiperazin-1-yl)methanone, MW: 380.4667 | MF: C₁₉H₂₀N₆O₂S.

7: CID: 9822929, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-imidazol-1-ylpyridazin-3-yl)amino]-1,3-thiazole-5-carboxamide, MW: 411.869 | MF: C₁₈H₁₄ClN₇O₂S.

8: CID: 9927718, IUPAC: N-(2-chloro-6-methylphenyl)-2-(cyclopropanecarbonylamino)-1,3-thiazole-5-carboxamide, MW: 335.809 | MF: C₁₅H₁₄ClN₃O₂S.

- 9: CID: 10006113, IUPAC: N-[4-chloro-2-[(5-chloropyridin-2-yl)carbamoyl]phenyl]-5-methyl-6,7-dihydro-4H-[1,3]thiazolo[5,4-c]pyridine-2-carboxamide hydrochloride, MW: 498.81322 | MF: C₂₀H₁₈Cl₃N₅O₂S.
- 10: CID: 10006114, IUPAC: N-[4-chloro-2-[(5-chloropyridin-2-yl)carbamoyl]phenyl]-5-methyl-6,7-dihydro-4H-[1,3]thiazolo[5,4-c]pyridine-2-carboxamide, MW: 462.35228 | MF: C₂₀H₁₇Cl₂N₅O₂S.
- 11: CID: 10052635, IUPAC: 2-[[2-methyl-5-[[6-[(4-methylpiperazin-1-yl)methyl]pyridin-2-yl]amino]phenyl]amino]-N-(2-methylphenyl)-1,3-thiazole-5-carboxamide, MW: 527.68362 | MF: C₂₉H₃₃N₇O₂S.
- 12: CID: 10195898, IUPAC: N-[(4-chlorophenyl)methyl]-2-[[[(2S)-2-hydroxy-2-pyrimidin-2-ylethyl]-methylamino]methyl]-4-methyl-7-oxothieno[2,3-e]pyridine-6-carboxamide, MW: 497.99706 | MF: C₂₄H₂₄ClN₅O₃S.
- 13: CID: 10206276, IUPAC: N-[4-[(5-chloropyridin-2-yl)carbamoyl]-2-phenyl-1,3-thiazol-5-yl]-1-propan-2-ylpiperidine-4-carboxamide, MW: 484.01354 | MF: C₂₄H₂₆ClN₅O₂S.
- 14: CID: 10252208, IUPAC: 2-[4-(5-amino-1,3-thiazol-2-yl)phenyl]-3-(5-chloropyridin-2-yl)quinazolin-4-one, MW: 431.89746 | MF: C₂₂H₁₄ClN₅O₂S.
- 15: CID: 10253695, IUPAC: 2-[4-[3-(5-chloropyridin-2-yl)-4-oxoquinazolin-2-yl]phenyl]-1,3-thiazole-5-carboxamide, MW: 459.90756 | MF: C₂₃H₁₄ClN₅O₂S.
- 16: CID: 10301604, IUPAC: N-[4-[(5-chloropyridin-2-yl)carbamoyl]-2-(3,4-difluorophenyl)-1,3-thiazol-5-yl]-1-propan-2-ylpiperidine-4-carboxamide, MW: 519.994466 | MF: C₂₄H₂₄ClF₂N₅O₂S.
- 17: CID: 10344807, IUPAC: N-[2-[4-[3-(5-chloropyridin-2-yl)-4-oxoquinazolin-2-yl]phenyl]-1,3-thiazol-4-yl]acetamide, MW: 473.93414 | MF: C₂₄H₁₆ClN₅O₂S.
- 18: CID: 10368624, IUPAC: N-[(4-chlorophenyl)methyl]-2-[[[(2-hydroxy-2-pyrimidin-2-ylethyl)-methylamino]methyl]-7-methyl-4-oxothieno[3,2-e]pyridine-5-carboxamide, MW: 497.99706 | MF: C₂₄H₂₄ClN₅O₃S.
- 19: CID: 10370949, IUPAC: (3Z)-4-[[[(2S)-2-(3-chlorophenyl)-2-hydroxyethyl]amino]-3-[6-methyl-2-[4-(1,3-thiazol-2-ylmethyl)piperazin-1-yl]-7,9-dihydropurin-8-ylidene]pyridin-2-one, MW: 578.08832 | MF: C₂₇H₂₈ClN₉O₂S.
- 20: CID: 10412586, IUPAC: N-[2-[4-[3-(5-chloropyridin-2-yl)-4-oxoquinazolin-2-yl]phenyl]-1,3-thiazol-5-yl]acetamide, MW: 473.93414 | MF: C₂₄H₁₆ClN₅O₂S.
- 21: CID: 10413555, IUPAC: N-[(4-chlorophenyl)methyl]-2-[[[(2R)-2-hydroxy-2-pyrimidin-2-ylethyl]-methylamino]methyl]-7-methyl-4-oxothieno[3,2-e]pyridine-5-carboxamide, MW: 497.99706 | MF: C₂₄H₂₄ClN₅O₃S.
- 22: CID: 10456156, IUPAC: 4-[(3-chlorothiophen-2-yl)methylamino]-2-[(4-morpholin-4-ylphenyl)amino]pyrimidine-5-carboxamide, MW: 444.93774 | MF: C₂₀H₂₁ClN₆O₂S.
- 23: CID: 10458706, IUPAC: N-[5-[2-[(4-chlorophenyl)amino]pyrimidin-4-yl]-4-methyl-1,3-thiazol-2-yl]-3-(2-morpholin-4-ylethylamino)propanamide, MW: 502.03212 | MF: C₂₃H₂₈ClN₇O₂S.

- 24: CID: 11153014, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(2,6-dimethylpyrimidin-4-yl)amino]-1,3-thiazole-5-carboxamide, MW: 373.85984 | MF: C17H16ClN5OS.
- 25: CID: 11167695, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[2-methyl-6-(2-morpholin-4-ylethylamino)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C22H26ClN7O2S.
- 26: CID: 11168231, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-chloro-2-methylpyrimidin-4-yl)amino]-N-[(4-methoxyphenyl)methyl]-1,3-thiazole-5-carboxamide, MW: 514.42684 | MF: C24H21Cl2N5O2S.
- 27: CID: 11200510, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(2-hydroxyethylamino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 403.88582 | MF: C18H18ClN5O2S.
- 28: CID: 11247793, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(methyl-(3-methylaminopropyl)amino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 444.9808 | MF: C21H25ClN6OS.
- 29: CID: 11260009, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(hydroxymethyl)piperidin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 472.9909 | MF: C22H25ClN6O2S.
- 30: CID: 11269410, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-chloro-2-methylpyrimidin-4-yl)amino]-1,3-thiazole-5-carboxamide, MW: 394.27832 | MF: C16H13Cl2N5OS.
- 31: CID: 11282881, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(2-morpholin-4-ylethylamino)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 473.97896 | MF: C21H24ClN7O2S.
- 32: CID: 11283174, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(3-morpholin-4-ylpropylamino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 487.01748 | MF: C23H27ClN6O2S.
- 33: CID: 11328827, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(3-imidazol-1-ylpropylamino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 467.97438 | MF: C22H22ClN7OS.
- 34: CID: 11407465, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(2-hydroxyethylamino)-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 418.90046 | MF: C18H19ClN6O2S.
- 35: CID: 11466196, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[2-methyl-6-(3-morpholin-4-ylpropylamino)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide. MW: 502.03212 | MF: C23H28ClN7O2S.
- 36: CID: 11466607, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide hydrochloride, MW: 524.46648 | MF: C22H27Cl2N7O2S.
- 37: CID: 11487256, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-morpholin-4-ylpyrimidin-4-yl)amino]-1,3-thiazole-5-carboxamide, MW: 430.91116 | MF: C19H19ClN6O2S.

- 38: CID: 11505502, IUPAC: 2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]pyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide. MW: 626.65257 | MF: C29H29F3N8O3S.
- 39: CID: 11512538, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]ethyl 2,2-dimethylpropanoate, MW: 572.12196 | MF: C27H34ClN7O3S.
- 40: CID: 11539665, IUPAC: (3-chloro-2-fluorophenyl)-[4-[[6-[(5-fluoro-1,3-thiazol-2-yl)amino]pyridin-2-yl]methyl]piperazin-1-yl]methanone, MW: 449.904626 | MF: C20H18ClF2N5OS.
- 41: CID: 11540687, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide hydrate, MW: 506.02082 | MF: C22H28ClN7O3S.
- 42: CID: 11569328, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[3-[4-(2-hydroxyethyl)piperazin-1-yl]-5-methylphenyl]amino]-1,3-thiazole-5-carboxamide, MW: 486.02942 | MF: C24H28ClN5O2S.
- 43: CID: 11570976, IUPAC: 2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)phenyl]carbamoyl]phenyl]-1,3-thiazole-5-carboxamide, MW: 640.67915 | MF: C30H31F3N8O3S.
- 44: CID: 11577776, IUPAC: 2-[[6-(2-hydroxyethylamino)-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 571.57407 | MF: C26H24F3N7O3S.
- 45: CID: 11590089, IUPAC: (3-chloro-2-fluorophenyl)-[4-[5-methyl-6-(1,3-thiazol-2-ylamino)pyridin-2-yl]piperazin-1-yl]methanone, MW: 431.914163 | MF: C20H19ClFN5OS.
- 46: CID: 11606973, IUPAC: N-[5-[[3-[4-(2-hydroxyethyl)piperazin-1-yl]-5-(trifluoromethyl)benzoyl]amino]-2-methylphenyl]-2-(pyridin-2-ylamino)-1,3-thiazole-5-carboxamide, MW: 625.66451 | MF: C30H30F3N7O3S.
- 47: CID: 11650098, IUPAC: 2-[[6-(4-methylpiperazin-1-yl)pyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 596.62659 | MF: C28H27F3N8O2S.
- 48: CID: 11650132, IUPAC: pentyl N-[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]-N-[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]carbamate, MW: 602.14794 | MF: C28H36ClN7O4S.
- 49: CID: 11650511, IUPAC: N-[5-[[3-(4-ethylpiperazin-1-yl)-5-(trifluoromethyl)benzoyl]amino]-2-methylphenyl]-2-[[6-(2-hydroxyethylamino)-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 683.74695 | MF: C32H36F3N9O3S.
- 50: CID: 11664355, IUPAC: 2-[(2-methyl-6-morpholin-4-ylpyrimidin-4-yl)amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 597.61135 | MF: C28H26F3N7O3S.

- 51: CID: 11664511, IUPAC: 2-[[4-[4-(2-hydroxyethyl)piperazin-1-yl]pyridin-2-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 625.66451 | MF: C30H30F3N7O3S.
- 52: CID: 11669430, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(2-methyl-6-piperazin-1-yl)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 443.95298 | MF: C20H22ClN7OS.
- 53: CID: 11676373, IUPAC: (3-chloro-2-fluorophenyl)-[4-[[6-(1,3-thiazol-2-ylamino)pyridin-2-yl]methyl]piperazin-1-yl]methanone, MW: 431.914163 | MF: C20H19ClFN5OS.
- 54: CID: 11684148, IUPAC: (3-chloro-2-fluorophenyl)-[4-[[6-[(5-chloro-1,3-thiazol-2-yl)amino]pyridin-2-yl]methyl]piperazin-1-yl]methanone, MW: 466.359223 | MF: C20H18Cl2FN5OS.
- 55: CID: 11700117, IUPAC: 2-[[6-(4-ethylpiperazin-1-yl)-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 624.67975 | MF: C30H31F3N8O2S.
- 56: CID: 11707091, IUPAC: 2-[[2-methyl-6-(4-methylpiperazin-1-yl)pyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 610.65317 | MF: C29H29F3N8O2S.
- 57: CID: 11714286, IUPAC: 2-[[5-[4-(2-hydroxyethyl)piperazin-1-yl]pyridin-2-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 625.66451 | MF: C30H30F3N7O3S.
- 58: CID: 11714353, IUPAC: 2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 640.67915 | MF: C30H31F3N8O3S.
- 59: CID: 11752136, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[5-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C22H26ClN7O2S.
- 60: CID: 11772766, IUPAC: 4-[2-(3-chlorophenyl)ethylamino]-2-pyridin-4-yl-1,3-thiazole-5-carboxamide, MW: 358.8452 | MF: C17H15ClN4OS.
- 61: CID: 11775143, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(2-methyl-6-morpholin-4-yl)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 444.93774 | MF: C20H21ClN6O2S.
- 62: CID: 11854012, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]acetic acid, MW: 501.98906 | MF: C22H24ClN7O3S.
- 63: CID: 11854269, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]ethyl hydrogen sulfate, MW: 568.06874 | MF: C22H26ClN7O5S2.
- 64: CID: 11854270, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[2-(2-hydroxyethylamino)ethylamino]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 461.96826 | MF: C20H24ClN7O2S

- 65: CID: 11854271, IUPAC: 2-[[6-(2-aminoethylamino)-2-methylpyrimidin-4-yl]amino]-N-(2-chloro-6-methylphenyl)-1,3-thiazole-5-carboxamide, MW: 417.9157 | MF: C18H20ClN7OS.
- 66: CID: 11854272, IUPAC: 2-[[2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]acetyl]amino]ethanesulfonic acid, MW: 609.12066 | MF: C24H29ClN8O5S2.
- 67: CID: 11854533, IUPAC: N-(2-chloro-4-hydroxy-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 504.00494 | MF: C22H26ClN7O3S.
- 68: CID: 11854534, IUPAC: N-[2-chloro-6-(hydroxymethyl)phenyl]-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 504.00494 | MF: C22H26ClN7O3S.
- 69: CID: 11854535, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)-4-oxidopiperazin-4-ium-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 504.00494 | MF: C22H26ClN7O3S.
- 70: CID: 11854536, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]-1-oxidopiperazin-1-ium-1-yl]acetic acid, MW: 517.98846 | MF: C22H24ClN7O4S.
- 71: CID: 11949914, IUPAC: 4-[[2-(5-chloro-2-fluorophenyl)-5-dimethylaminopyrimidin-4-yl]amino]-N-[2-(2-hydroxyethylamino)ethyl]pyridine-3-carboxamide, MW: 473.931003 | MF: C22H25ClFN7O2.
- 72: CID: 11951866, IUPAC: 4-[[2-(5-chloro-2-fluorophenyl)-5-pyrrolidin-1-ylpyrimidin-4-yl]amino]-N-(2-hydroxyethyl)pyridine-3-carboxamide, MW: 456.900483 | MF: C22H22ClFN6O2.
- 73: CID: 11952045, IUPAC: 4-[[2-(5-chloro-2-fluorophenyl)-5-pyrrolidin-1-ylpyrimidin-4-yl]amino]-N-[(2S)-2-hydroxypropyl]pyridine-3-carboxamide, MW: 470.927063 | MF: C23H24ClFN6O2.
- 74: CID: 15979866, IUPAC: 5-[2-[[4-(4-acetylpiperazin-1-yl)pyridin-2-yl]amino]-1,3-thiazol-5-yl]-N-methylpyridine-3-carboxamide, MW: 437.51802 | MF: C21H23N7O2S.
- 75: CID: 15980109, IUPAC: N-(2-aminoethyl)-5-[2-[(4-morpholin-4-ylpyridin-2-yl)amino]-1,3-thiazol-5-yl]pyridine-3-carboxamide, MW: 425.50732 | MF: C20H23N7O2S.
- 76: CID: 15980233, IUPAC: N-(2-hydroxyethyl)-5-[2-[(4-morpholin-4-ylpyridin-2-yl)amino]-1,3-thiazol-5-yl]pyridine-3-carboxamide, MW: 426.49208 | MF: C20H22N6O3S.
- 77: CID: 15980347, IUPAC: N-(2-methylaminoethyl)-5-[2-[(4-morpholin-4-ylpyridin-2-yl)amino]-1,3-thiazol-5-yl]pyridine-3-carboxamide, MW: 439.5339 | MF: C21H25N7O2S.
- 78: CID: 15980351, IUPAC: 5-[2-[[4-[4-(2-hydroxyacetyl)piperazin-1-yl]pyridin-2-yl]amino]-1,3-thiazol-5-yl]-N-(2,2,2-trifluoroethyl)pyridine-3-carboxamide, MW: 521.51539 | MF: C22H22F3N7O3S.
- 79: CID: 15982537, IUPAC: (3-chloro-2-fluorophenyl)-[4-[6-[(5-fluoro-1,3-thiazol-2-yl)amino]-5-methylpyridin-2-yl]piperazin-1-yl]methanone, MW: 449.904626 | MF: C20H18ClF2N5OS.

- 80: CID: 16034848, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 2,3-dihydroxybutanedioic acid, MW: 638.09238 | MF: C26H32ClN7O8S.
- 81: CID: 16037977, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-5-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C22H26ClN7O2S.
- 82: CID: 16061431, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 4-[(4-methylpiperazin-1-yl)methyl]-N-[4-methyl-3-[(4-pyridin-3-ylpyrimidin-2-yl)amino]phenyl]benzamide, MW: 981.60828 | MF: C51H57ClN14O3S.
- 83: CID: 16223227, IUPAC: but-2-enedioic acid; N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 604.0777 | MF: C26H30ClN7O6S.
- 84: CID: 16223228, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide hydrobromide, MW: 568.91748 | MF: C22H27BrClN7O2S.
- 85: CID: 16223229, IUPAC: but-2-enedioic acid; N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 604.0777 | MF: C26H30ClN7O6S.
- 86: CID: 16223316, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; methanesulfonic acid, MW: 584.1112 | MF: C23H30ClN7O5S2.
- 87: CID: 16223317, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; phosphoric acid, MW: 586.000721 | MF: C22H29ClN7O6PS.
- 88: CID: 16223318, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 2-hydroxybenzoic acid, MW: 626.12628 | MF: C29H32ClN7O5S.
- 89: CID: 16223319, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; sulfuric acid, MW: 586.08402 | MF: C22H28ClN7O6S2.
- 90: CID: 16223320, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 4-methylbenzenesulfonic acid, MW: 660.20716 | MF: C29H34ClN7O5S2.
- 91: CID: 16584134, AKE-PB223730486, IUPAC: N-(4-chlorophenyl)-2-[(4,5-dimethyl-1,3-thiazol-2-yl)amino]-4-methylpyrimidine-5-carboxamide, MW: 373.85984 | MF: C17H16ClN5OS.

- 92: CID: 16584137, AKE-PB223730492, IUPAC: N-(3-chlorophenyl)-2-[(4,5-dimethyl-1,3-thiazol-2-yl)amino]-4-methylpyrimidine-5-carboxamide, MW: 373.85984 | MF: C17H16ClN5OS.
- 93: CID: 16584139, AKE-PB223730496, IUPAC: 2-[(4,5-dimethyl-1,3-thiazol-2-yl)amino]-4-methyl-N-(2-methylphenyl)pyrimidine-5-carboxamide, MW: 353.44136 | MF: C18H19N5OS.
- 94: CID: 16655683, IUPAC: 2-[(6-chloro-2-methylpyrimidin-4-yl)amino]-N-(2,6-dichlorophenyl)-1,3-thiazole-5-carboxamide, MW: 414.6968 | MF: C15H10Cl3N5OS.
- 95: CID: 16655839, IUPAC: N-(2,6-dichlorophenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 508.42402 | MF: C21H23Cl2N7O2S.
- 96: CID: 16660745, IUPAC: N-(4-fluorophenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 399.441923 | MF: C19H18FN5O2S.
- 97: CID: 16660747, IUPAC: N-(4-ethylphenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 409.50462 | MF: C21H23N5O2S.
- 98: CID: 16660907, IUPAC: 4-(2-hydroxyethylamino)-N-(4-methylphenyl)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 395.47804 | MF: C20H21N5O2S.
- 99: CID: 16661063, IUPAC: N-(4-chlorophenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 415.89652 | MF: C19H18ClN5O2S.
- 100: CID: 16661212, IUPAC: N-(2,4-dimethylphenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 409.50462 | MF: C21H23N5O2S.
- 101: CID: 16661214, IUPAC: 4-(1-hydroxybutan-2-ylamino)-N-(4-methylphenyl)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 423.5312 | MF: C22H25N5O2S.

Herein, CID is the compound identifier as defined in Pubchem.

e) Small molecules targeting and antagonising downstream components of the NEPOR signalling pathway, particularly EPH-B4 tyrosine kinase inhibitors.

f) Combination therapies involving one or more of approaches a-e.

g) The present disclosure also provides a combination therapy. Co-administration of EPO with an intracellular inhibitor of NEPOR signalling (e.g. Dasatinib) is proposed to maintain EPO signalling via EPOR (and thus promote haematopoiesis) while inhibiting survival of NEPOR positive tumour cells.

NEPOR Based Therapeutics to Treat Neuronal Insults

Without being bound by theory, the present disclosure provides that EPO is neuroprotective because of its effects on NEPOR activity, i.e. in particular and/or EPH-B4 and/or Ephrin A1 activity. Therefore, the present disclosure provides a method for treating ischemic stroke,

trauma, epilepsy, neurodegenerative diseases, and cognitive dysfunction with an agonistic NEPOR targeted therapy. Specific approaches to positively enhance NEPOR mediated survival signals include:

- a) NEPOR specific antibodies. Such antibodies bind and initiate/enhance the mediation of NEPOR's cyto-protective activity.
- b) NEPOR specific small-molecules. Such small molecules bind and initiate/enhance the mediation of NEPOR's cytoprotective activity.
- c) NEPOR-targeting EPO mutants and glycosylated versions thereof. Due to EPOR's strict conformational requirements for mediating signalling in response to EPO, the following EPOR mutants (SEQ ID NO. 17 – SEQ ID NO. 212.) favour binding to NEPOR as opposed to EPOR and thus primarily act as tissue protective.

SEQ ID NO.17

APPRLICDSRVLERYLLEAKEAENITRVGQQAVEVWQGLALLSEAVLRGQALLVNSSQPWEPLQLHVDKAVSGLRSL
TLLRALGAQKEAISPDAASAAPLRTITADTFRKLFRVYSNFLRGKCLKLYTGEACRTGDR

SEQ ID NO.18

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQALLVNSSQPWEPLQLHVD
KAVSGLRSLTLLRALGAQKEAISPDAASAAPLRTITADTFRKLFRVYSNFLRGKCLKLYTGEACRTGDR

SEQ ID NO.19

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYALLVNSSQPWEPLQLHVDKAVSGLRSLT
TLLRALGAQKEAISPDAASAAPLRTITADTFRKLFRVYSNFLRGKCLKLYTGEACRTGDR

SEQ ID NO.20

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEPWEPLQLHVDKAVSGLRSLTTL
LRALGAQKEAISPDAASAAPLRTITADTFRKLFRVYSNFLRGKCLKLYTGEACRTGDR

SEQ ID NO.21

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPPGVGQLFPAVGAPAAACG

SEQ ID NO.22

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENNNHC

SEQ ID NO.23

APPRLICDSRVLERYLLEAKEAENIT

SEQ ID NO.24

APPRLICDSRVLEAYLLEAKEAENIT

SEQ ID NO.25

APPRLICDSRVLEEYLLEAKEAENIT

SEQ ID NO.26

APPRLICDSRVLERYL

SEQ ID NO.27

APPRLI

SEQ ID NO.28

APPRLICDSRVLERYILEAKEAENVMTGCAEGPRLSENITVPDTKVNIFYAWKRMEKELMSPPDTPPPAPLRTLTVDT
FCKLFRVYANFLRGKCLKLYTGEVCRGDR

Deletions of hWT 4 EPOR interaction sites

- SEQ ID NO.29
 APPRLICEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRGQALLVNSSQPWEP
 LQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLKLYTGEACRTGDR
- 5 SEQ ID NO.30
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDFYAWKRMEVGQQAVEVWQGLALLSEAVLRGQALL
 VNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLKLYTG
 EACRTGDR
- 10 SEQ ID NO.31
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLKLYTGEACR
 TGDR
- 15 SEQ ID NO.32
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLKLYTGEACR
 TGDR
- 20 C-term deletions beginning at the last Cysteine bridge C161
- SEQ ID NO.33
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
 25 LYTGEA
- SEQ ID NO.34
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
 30 LYTGE
- SEQ ID NO.35
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
 35 LYTG
- SEQ ID NO.36
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
 40 LYT
- SEQ ID NO.37
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
 45 LY
- SEQ ID NO.38
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
 50 L
- SEQ ID NO.39
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
 55
- SEQ ID NO.40
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 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGKCLK
- 60 SEQ ID NO.41
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFVYSNFLRGK

SEQ ID NO.42
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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 5

SEQ ID NO.43
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 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLR

10 SEQ ID NO.44
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFL

15 SEQ ID NO.45
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNF

20 SEQ ID NO.46
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSN

25 SEQ ID NO.47
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYS

30 SEQ ID NO.48
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVY

35 SEQ ID NO.49
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRV

40 SEQ ID NO.50
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFR

45 SEQ ID NO.51
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLF

50 SEQ ID NO.52
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKL

55 SEQ ID NO.53
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 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRK

60 SEQ ID NO.54
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 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFR

SEQ ID NO.55
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SEQ ID NO.56
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SEQ ID NO.57

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SEQ ID NO.58

5 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.59

10 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.60

15 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.61

APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.62

20 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDAASAAPLR

SEQ ID NO.63

25 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDAASAAPL

SEQ ID NO.64

30 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDAASAAP

SEQ ID NO.65

35 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDAASAA

SEQ ID NO.66

APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDAASA

SEQ ID NO.67

40 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDAAS

SEQ ID NO.68

45 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDA

SEQ ID NO.69

50 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDA

SEQ ID NO.70

55 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPDA

SEQ ID NO.71

APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISP

SEQ ID NO.72

60 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISP

SEQ ID NO.73
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRALGAQKEAIS
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SEQ ID NO.74
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRALGAQKEAI

10 SEQ ID NO.75
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRALGAQKEA

SEQ ID NO.76
 15 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRALGAQKE

SEQ ID NO.77
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 20 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRALGAQK

SEQ ID NO.78
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SEQ ID NO.79
 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRALGA

30 SEQ ID NO.80
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 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRALG

SEQ ID NO.81
 35 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.82
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 40 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLRA

SEQ ID NO.83
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 QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLLR
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SEQ ID NO.84
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50 SEQ ID NO.85
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SEQ ID NO.86
 55 APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWEPLQLHVDKAVSGLRSLTT

SEQ ID NO.87
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 60 QALLVNSSQPWEPLQLHVDKAVSGLRSLT

SEQ ID NO.88

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSL

SEQ ID NO.89

5 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRS

SEQ ID NO.90

10 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLR

SEQ ID NO.91

15 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.92

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.93

20 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.94

25 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.95

30 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.96

35 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.97

APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.98

40 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHV

SEQ ID NO.99

45 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.100

50 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
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SEQ ID NO.101

55 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQ

SEQ ID NO.102

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SEQ ID NO.103

60 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEP

SEQ ID NO.104
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQPWE
 5

SEQ ID NO.105
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 QALLVNSSQPW

10 SEQ ID NO.106
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 QALLVNSSQP

15 SEQ ID NO.107
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSSQ

20 SEQ ID NO.108
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNSS

25 SEQ ID NO.109
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVNS

30 SEQ ID NO.110
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLVN

35 SEQ ID NO.111
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALLV

40 SEQ ID NO.112
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QALL

45 SEQ ID NO.113
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 QAL

50 SEQ ID NO.114
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 QA

55 SEQ ID NO.115
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
 Q

60 SEQ ID NO.116
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG

SEQ ID NO.117
 APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNFYAWKRMEVGQQAVEVWQGLALLSEAVLR

55 SEQ ID NO.118
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60 SEQ ID NO.119
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 60 SEQ ID NO.140
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SEQ ID NO.141
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5 SEQ ID NO.142
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SEQ ID NO.143
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10 SEQ ID NO.144
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFY

SEQ ID NO.145
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIF

15 SEQ ID NO.146
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVN

SEQ ID NO.147
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKV

20 SEQ ID NO.148
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SEQ ID NO.149
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25 SEQ ID NO.150
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPD

30 SEQ ID NO.151
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVP

SEQ ID NO.152
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITV

35 SEQ ID NO.153
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENIT

SEQ ID NO.154
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENI

40 SEQ ID NO.155
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNEN

45 SEQ ID NO.156
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNE

SEQ ID NO.157
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLN

50 SEQ ID NO.158
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SEQ ID NO.159
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55 SEQ ID NO.160
APPRLICDSRVLERYLLEAKEAENITTGCAEHC

60 SEQ ID NO.161
APPRLICDSRVLERYLLEAKEAENITTGCAEH

SEQ ID NO.162
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5 SEQ ID NO.163
APPRLICDSRVLERYLLEAKEAENITTGCA

SEQ ID NO.164
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10 SEQ ID NO.165
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SEQ ID NO.166
15 APPRLICDSRVLERYLLEAKEAENITT

SEQ ID NO.167
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20 SEQ ID NO.168
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25 SEQ ID NO.170
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30 APPRLICDSRVLERYLLEAKEA

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35 SEQ ID NO.173
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40 SEQ ID NO.175
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50 SEQ ID NO.178
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55 SEQ ID NO.180
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SEQ ID NO.181
60 APPRLICDSRVL

SEQ ID NO.182

APPRLICDSRV

SEQ ID NO.183
APPRLICDSR

5 SEQ ID NO.184
APPRLICDS

10 SEQ ID NO.185
APPRLICD

SEQ ID NO.186
APPRLIC

15 Single Amino Acid Mutations (Ala / Conversions) and all combinations/permutations thereof
and all glycosylated versions of same. All possible combinations/permutations of mutations
contained in Single mutations of SEQ ID NOs. 187-208 and glycosylated versions thereof.

20 SEQ ID NO.187
APPRLICASRVLERYLLEAKEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

25 SEQ ID NO.188
APPRLICRSRVLERYLLEAKEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

30 SEQ ID NO.189
APPRLICDSRVLEAYLLEAKEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

35 SEQ ID NO.190
APPRLICDSRVLEEYLLEAKEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

40 SEQ ID NO.191
APPRLICDSRVLERYLLEAAEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

45 SEQ ID NO.192
APPRLICDSRVLERYLLEAEEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

50 SEQ ID NO.193
APPRLICDSRVLERYLLEAKEAENITTTGCAEHCSLNENITVPDAKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

55 SEQ ID NO.194
APPRLICDSRVLERYLLEAKEAENITTTGCAEHCSLNENITVPDTAVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTTLRLALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR

SEQ ID NO.195

- APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTEVNFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 5 SEQ ID NO.196
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKANFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 10 SEQ ID NO.197
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVAFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 15 SEQ ID NO.198
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 20 SEQ ID NO.199
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDEAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 25 SEQ ID NO.200
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVAGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 30 SEQ ID NO.201
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLASLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 35 SEQ ID NO.202
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLESLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 40 SEQ ID NO.203
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRALTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLRGKLG
LYTGEACRTGDR
- 45 SEQ ID NO.204
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFAVYSNFLRGKLG
LYTGEACRTGDR
- 50 SEQ ID NO.205
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFEVYSNFLRGKLG
LYTGEACRTGDR
- 55 SEQ ID NO.206
APPRLICDSRVLERYLLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSAFLRGKLG
LYTGEACRTGDR
- 60 SEQ ID NO.207

APPRLICDSRVLERYLLEAKEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLAGKLK
LYTGEACRTGDR

5 SEQ ID NO.208
APPRLICDSRVLERYLLEAKEAENITTTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRG
QALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLEGLKLK
LYTGEACRTGDR

10 EPO peptides overlapping interaction regions

SEQ ID NO.209
APPRLICDSRVLERYLLEAKEAENITTT

15 SEQ ID NO.210
NENITVPDTKVNIFYAWKRMEV

SEQ ID NO.211
NSSQPWEPLQLHVDKAVSGLRSLTLL

20 SEQ ID NO.212
FRKLFRVYSNFLAGKLK

d) NEPOR-targeting EPO chimera's. Such mutants bind and initiate/enhance the
25 mediation of NEPOR's cytoprotective activity. For example, in a scenario where NEPOR
constitutes an Ephrin A1 molecule (either as a homodimer or in heterodimeric association with
EPOR), then chimeric proteins involving fusions of part of EPH-B4's Ephrin-ligand-binding
domain and part of the EPO molecule may be developed as optimised binding partners. This
implies fusing an N-terminal portion of EPO (derived from SEQ IDNO. 213) to a C-terminal
30 portion of EPH-B4's Ephrin ligand binding domain (SEQ IDNO. 214), giving a sequence similar
to SEQ IDNO. 215, or fusing an N-terminal portion of EPH-B4's Ephrin ligand binding domain
(derived from SEQ ID NO. 214) to a C-terminal portion of EPO (SEQ ID NO. 213), giving a
sequence similar to SEQ ID NO. 216.

e) high-affinity peptides which specifically target NEPOR to initiate/enhance the
35 mediation of EPO's cytoprotective activity.

f) Small molecules targeting and enhancing the activity of downstream components of
NEPOR.

g) Combination therapies involving one or more of approaches a-f.

40 SEQ ID NO.213
>P01588|EPO_HUMAN Erythropoietin - Homo sapiens (Human).
MGVHECPAWLWLLLSLLSLPLGLPVLGAPPRLICDSRVLERYLLEAKEAENITTTGCAEHC
SLNENITVPDTKVNIFYAWKRMEVGQQAVEVWQGLALLSEAVLRGQALLVNSSQPWEPLQL
HVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRKLFRVYSNFLAGKL
45 KLYTGEACRTGDR

SEQ ID NO.214
>EPH-B4_ephrin_ligand_binding_domain
EETLLNTKLETADLKWVTFPQVDGQWEELSGLDEEQHSVRTYEVCQVQAPGQAHWLRTG
50 WVPRRGAVHVYATLRFMTLECLSLPRAGRSCKETFTVFYYESDADTATALTPAWMENPYI
KVDTVAAEHLTRKRPGAEATGKVNKTLRLGPLSKAGFYLAQDQGACMALLSLHLFYKK
C

SEQ ID NO.215

>NtermEPO_CtermEPHB4LBD

APPRLICDSRVLERYLEAKEAENITTGCAEHCSLNENITVPDTKVNIFYAWKRMEVGQQA
 5 VEVWQGLALLSEAVLRGQALLVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAIS
 PPDAASALTPAWMENPYIKVDTVAAEHLTRKRPGAEATGKVNKTLRLGPLSKAGFYLA
 QDQGACMALLSLHLFYKCC

SEQ ID NO.216

10 >NtermEPHB4LBD_CtermEPO

EETLLNNTKLETADLKWVTFFQVDGQWEELSGLDEEQHSVRTYEVCQVQAPGQAHWLRTG
 WVPRRGAVHVYATLRFMTLECLSLPRAGRSCKETFTVFYYESDADTATALSEAVLRGQAL
 LVNSSQPWEPLQLHVDKAVSGLRSLTLLRALGAQKEAISPPDAASAAPLRTITADTFRK
 LFRVYSNFLRGKLKLYTGEACRTGDR

15

Compounds in Combination with EPO

Such compounds, in combination with EPO, inhibit EPH-B4's tyrosine kinase activity while permitting EPOR mediated signalling/haematopoiesis. The following 101 compounds, either
 20 alone or in combination, inhibit the tyrosine kinase activity of EPH-B4 containing NEPOR dimers. Therefore, the present disclosure provides a combination therapeutic agent of a tyrosine kinase inhibitor in combination with EPO to provide the hematopoietic properties of EPO along with the prevention of NEPOR signalling so as to block the potentially fatal side effect of EPO to promote tumour survival and angiogenesis.

25

1: CID: 1095868, AKI-STT-00166305; ZINC00818264; BAS 09636496 IUPAC: N-[5-[(3-chlorophenyl)methyl]-1,3-thiazol-2-yl]-2-(4,6-dimethylpyrimidin-2-yl)sulfanylacetamide. MW: 404.93678 | MF: C₁₈H₁₇CIN₄O₂S. (MW is molecular weight and MF is molecular formula).

2: CID: 1465558, IUPAC: 2-[(3-chlorobenzoyl)amino]-4-methyl-N-pyridin-3-yl-1,3-thiazole-5-carboxamide, MW: 372.82872 | MF: C₁₇H₁₃CIN₄O₂S.

3: CID: 1468201, IUPAC: N-[5-[(2-chlorophenyl)carbamoyl]-4-methyl-1,3-thiazol-2-yl]pyridine-4-carboxamide, MW: 372.82872 | MF: C₁₇H₁₃CIN₄O₂S.

4: CID: 3062316, Dasatinib; Sprycel; BMS Dasatinib, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C₂₂H₂₆CIN₇O₂S.

5: CID: 3072360, 142287-40-9; Pyrimido(4,5-d)pyrimidin-4(1H)-one, 7-methyl-1-phenyl-2-((3-(4-(2-thiazolyl)-1-piperazinyl)propyl)thio)- IUPAC: 2-methyl-8-phenyl-7-[3-[4-(1,3-thiazol-2-yl)piperazin-1-yl]propylsulfanyl]pyrimido[6,5-d]pyrimidin-5-one, MW: 479.6209 | MF: C₂₃H₂₅N₇O₂S.

40 6: CID: 5041467, STK154706; ZINC04687922, IUPAC: [2-[(2-methylphenyl)amino]-1,3-thiazol-4-yl]-(4-pyrimidin-2-ylpiperazin-1-yl)methanone, MW: 380.4667 | MF: C₁₉H₂₀N₆O₂S.

7: CID: 9822929, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-imidazol-1-ylpyridazin-3-yl)amino]-1,3-thiazole-5-carboxamide, MW: 411.869 | MF: C₁₈H₁₄CIN₇O₂S.

8: CID: 9927718, IUPAC: N-(2-chloro-6-methylphenyl)-2-(cyclopropanecarbonylamino)-1,3-thiazole-5-carboxamide, MW: 335.809 | MF: C₁₅H₁₄CIN₃O₂S.

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- 9: CID: 10006113, IUPAC: N-[4-chloro-2-[(5-chloropyridin-2-yl)carbamoyl]phenyl]-5-methyl-6,7-dihydro-4H-[1,3]thiazolo[5,4-c]pyridine-2-carboxamide hydrochloride, MW: 498.81322 | MF: C₂₀H₁₈Cl₃N₅O₂S.
- 10: CID: 10006114, IUPAC: N-[4-chloro-2-[(5-chloropyridin-2-yl)carbamoyl]phenyl]-5-methyl-6,7-dihydro-4H-[1,3]thiazolo[5,4-c]pyridine-2-carboxamide, MW: 462.35228 | MF: C₂₀H₁₇Cl₂N₅O₂S.
- 11: CID: 10052635, IUPAC: 2-[[2-methyl-5-[[6-[(4-methylpiperazin-1-yl)methyl]pyridin-2-yl]amino]phenyl]amino]-N-(2-methylphenyl)-1,3-thiazole-5-carboxamide, MW: 527.68362 | MF: C₂₉H₃₃N₇O₂S.
- 12: CID: 10195898, IUPAC: N-[(4-chlorophenyl)methyl]-2-[[[(2S)-2-hydroxy-2-pyrimidin-2-ylethyl]-methylamino]methyl]-4-methyl-7-oxothieno[2,3-e]pyridine-6-carboxamide, MW: 497.99706 | MF: C₂₄H₂₄ClN₅O₃S.
- 13: CID: 10206276, IUPAC: N-[4-[(5-chloropyridin-2-yl)carbamoyl]-2-phenyl-1,3-thiazol-5-yl]-1-propan-2-ylpiperidine-4-carboxamide, MW: 484.01354 | MF: C₂₄H₂₆ClN₅O₂S.
- 14: CID: 10252208, IUPAC: 2-[4-(5-amino-1,3-thiazol-2-yl)phenyl]-3-(5-chloropyridin-2-yl)quinazolin-4-one, MW: 431.89746 | MF: C₂₂H₁₄ClN₅O₂S.
- 15: CID: 10253695, IUPAC: 2-[4-[3-(5-chloropyridin-2-yl)-4-oxoquinazolin-2-yl]phenyl]-1,3-thiazole-5-carboxamide, MW: 459.90756 | MF: C₂₃H₁₄ClN₅O₂S.
- 16: CID: 10301604, IUPAC: N-[4-[(5-chloropyridin-2-yl)carbamoyl]-2-(3,4-difluorophenyl)-1,3-thiazol-5-yl]-1-propan-2-ylpiperidine-4-carboxamide, MW: 519.994466 | MF: C₂₄H₂₄ClF₂N₅O₂S.
- 17: CID: 10344807, IUPAC: N-[2-[4-[3-(5-chloropyridin-2-yl)-4-oxoquinazolin-2-yl]phenyl]-1,3-thiazol-4-yl]acetamide, MW: 473.93414 | MF: C₂₄H₁₆ClN₅O₂S.
- 18: CID: 10368624, IUPAC: N-[(4-chlorophenyl)methyl]-2-[[[(2-hydroxy-2-pyrimidin-2-ylethyl)-methylamino]methyl]-7-methyl-4-oxothieno[3,2-e]pyridine-5-carboxamide, MW: 497.99706 | MF: C₂₄H₂₄ClN₅O₃S.
- 19: CID: 10370949, IUPAC: (3Z)-4-[[[(2S)-2-(3-chlorophenyl)-2-hydroxyethyl]amino]-3-[6-methyl-2-[4-(1,3-thiazol-2-ylmethyl)piperazin-1-yl]-7,9-dihydropurin-8-ylidene]pyridin-2-one, MW: 578.08832 | MF: C₂₇H₂₈ClN₉O₂S.
- 20: CID: 10412586, IUPAC: N-[2-[4-[3-(5-chloropyridin-2-yl)-4-oxoquinazolin-2-yl]phenyl]-1,3-thiazol-5-yl]acetamide, MW: 473.93414 | MF: C₂₄H₁₆ClN₅O₂S.
- 21: CID: 10413555, IUPAC: N-[(4-chlorophenyl)methyl]-2-[[[(2R)-2-hydroxy-2-pyrimidin-2-ylethyl]-methylamino]methyl]-7-methyl-4-oxothieno[3,2-e]pyridine-5-carboxamide, MW: 497.99706 | MF: C₂₄H₂₄ClN₅O₃S.
- 22: CID: 10456156, IUPAC: 4-[(3-chlorothiophen-2-yl)methylamino]-2-[(4-morpholin-4-ylphenyl)amino]pyrimidine-5-carboxamide, MW: 444.93774 | MF: C₂₀H₂₁ClN₆O₂S.
- 23: CID: 10458706, IUPAC: N-[5-[2-[(4-chlorophenyl)amino]pyrimidin-4-yl]-4-methyl-1,3-thiazol-2-yl]-3-(2-morpholin-4-ylethylamino)propanamide, MW: 502.03212 | MF: C₂₃H₂₈ClN₇O₂S.

- 24: CID: 11153014, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(2,6-dimethylpyrimidin-4-yl)amino]-1,3-thiazole-5-carboxamide, MW: 373.85984 | MF: C17H16ClN5OS.
- 25: CID: 11167695, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[2-methyl-6-(2-morpholin-4-ylethylamino)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C22H26ClN7O2S.
- 26: CID: 11168231, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-chloro-2-methylpyrimidin-4-yl)amino]-N-[(4-methoxyphenyl)methyl]-1,3-thiazole-5-carboxamide, MW: 514.42684 | MF: C24H21Cl2N5O2S.
- 27: CID: 11200510, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(2-hydroxyethylamino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 403.88582 | MF: C18H18ClN5O2S.
- 28: CID: 11247793, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(methyl-(3-methylaminopropyl)amino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 444.9808 | MF: C21H25ClN6OS.
- 29: CID: 11260009, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(hydroxymethyl)piperidin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 472.9909 | MF: C22H25ClN6O2S.
- 30: CID: 11269410, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-chloro-2-methylpyrimidin-4-yl)amino]-1,3-thiazole-5-carboxamide, MW: 394.27832 | MF: C16H13Cl2N5OS.
- 31: CID: 11282881, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(2-morpholin-4-ylethylamino)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 473.97896 | MF: C21H24ClN7O2S.
- 32: CID: 11283174, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(3-morpholin-4-ylpropylamino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 487.01748 | MF: C23H27ClN6O2S.
- 33: CID: 11328827, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(3-imidazol-1-ylpropylamino)pyridin-2-yl]amino]-1,3-thiazole-5-carboxamide, MW: 467.97438 | MF: C22H22ClN7OS.
- 34: CID: 11407465, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-(2-hydroxyethylamino)-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 418.90046 | MF: C18H19ClN6O2S.
- 35: CID: 11466196, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[2-methyl-6-(3-morpholin-4-ylpropylamino)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide. MW: 502.03212 | MF: C23H28ClN7O2S.
- 36: CID: 11466607, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide hydrochloride, MW: 524.46648 | MF: C22H27Cl2N7O2S.
- 37: CID: 11487256, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(6-morpholin-4-ylpyrimidin-4-yl)amino]-1,3-thiazole-5-carboxamide, MW: 430.91116 | MF: C19H19ClN6O2S.

- 38: CID: 11505502, IUPAC: 2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]pyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide. MW: 626.65257 | MF: C₂₉H₂₉F₃N₈O₃S.
- 39: CID: 11512538, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]ethyl 2,2-dimethylpropanoate, MW: 572.12196 | MF: C₂₇H₃₄ClN₇O₃S.
- 40: CID: 11539665, IUPAC: (3-chloro-2-fluorophenyl)-[4-[[6-[(5-fluoro-1,3-thiazol-2-yl)amino]pyridin-2-yl]methyl]piperazin-1-yl]methanone, MW: 449.904626 | MF: C₂₀H₁₈ClF₂N₅O₂S.
- 41: CID: 11540687, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide hydrate, MW: 506.02082 | MF: C₂₂H₂₈ClN₇O₃S.
- 42: CID: 11569328, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[3-[4-(2-hydroxyethyl)piperazin-1-yl]-5-methylphenyl]amino]-1,3-thiazole-5-carboxamide, MW: 486.02942 | MF: C₂₄H₂₈ClN₅O₂S.
- 43: CID: 11570976, IUPAC: 2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)phenyl]carbamoyl]phenyl]-1,3-thiazole-5-carboxamide, MW: 640.67915 | MF: C₃₀H₃₁F₃N₈O₃S.
- 44: CID: 11577776, IUPAC: 2-[[6-(2-hydroxyethylamino)-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 571.57407 | MF: C₂₆H₂₄F₃N₇O₃S.
- 45: CID: 11590089, IUPAC: (3-chloro-2-fluorophenyl)-[4-[5-methyl-6-(1,3-thiazol-2-ylamino)pyridin-2-yl]piperazin-1-yl]methanone, MW: 431.914163 | MF: C₂₀H₁₉ClFN₅O₂S.
- 46: CID: 11606973, IUPAC: N-[5-[[3-[4-(2-hydroxyethyl)piperazin-1-yl]-5-(trifluoromethyl)benzoyl]amino]-2-methylphenyl]-2-(pyridin-2-ylamino)-1,3-thiazole-5-carboxamide, MW: 625.66451 | MF: C₃₀H₃₀F₃N₇O₃S.
- 47: CID: 11650098, IUPAC: 2-[[6-(4-methylpiperazin-1-yl)pyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 596.62659 | MF: C₂₈H₂₇F₃N₈O₂S.
- 48: CID: 11650132, IUPAC: pentyl N-[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]-N-[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]carbamate, MW: 602.14794 | MF: C₂₈H₃₆ClN₇O₄S.
- 49: CID: 11650511, IUPAC: N-[5-[[3-(4-ethylpiperazin-1-yl)-5-(trifluoromethyl)benzoyl]amino]-2-methylphenyl]-2-[[6-(2-hydroxyethylamino)-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 683.74695 | MF: C₃₂H₃₆F₃N₉O₃S.
- 50: CID: 11664355, IUPAC: 2-[(2-methyl-6-morpholin-4-ylpyrimidin-4-yl)amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 597.61135 | MF: C₂₈H₂₆F₃N₇O₃S.

- 51: CID: 11664511, IUPAC: 2-[[4-[4-(2-hydroxyethyl)piperazin-1-yl]pyridin-2-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 625.66451 | MF: C30H30F3N7O3S.
- 52: CID: 11669430, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(2-methyl-6-piperazin-1-yl)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 443.95298 | MF: C20H22ClN7OS.
- 53: CID: 11676373, IUPAC: (3-chloro-2-fluorophenyl)-[4-[[6-(1,3-thiazol-2-ylamino)pyridin-2-yl]methyl]piperazin-1-yl]methanone, MW: 431.914163 | MF: C20H19ClFN5OS.
- 54: CID: 11684148, IUPAC: (3-chloro-2-fluorophenyl)-[4-[[6-[(5-chloro-1,3-thiazol-2-yl)amino]pyridin-2-yl]methyl]piperazin-1-yl]methanone, MW: 466.359223 | MF: C20H18Cl2FN5OS.
- 55: CID: 11700117, IUPAC: 2-[[6-(4-ethylpiperazin-1-yl)-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 624.67975 | MF: C30H31F3N8O2S.
- 56: CID: 11707091, IUPAC: 2-[[2-methyl-6-(4-methylpiperazin-1-yl)pyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 610.65317 | MF: C29H29F3N8O2S.
- 57: CID: 11714286, IUPAC: 2-[[5-[4-(2-hydroxyethyl)piperazin-1-yl]pyridin-2-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 625.66451 | MF: C30H30F3N7O3S.
- 58: CID: 11714353, IUPAC: 2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-N-[2-methyl-5-[[3-(trifluoromethyl)benzoyl]amino]phenyl]-1,3-thiazole-5-carboxamide, MW: 640.67915 | MF: C30H31F3N8O3S.
- 59: CID: 11752136, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[5-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C22H26ClN7O2S.
- 60: CID: 11772766, IUPAC: 4-[2-(3-chlorophenyl)ethylamino]-2-pyridin-4-yl-1,3-thiazole-5-carboxamide, MW: 358.8452 | MF: C17H15ClN4OS.
- 61: CID: 11775143, IUPAC: N-(2-chloro-6-methylphenyl)-2-[(2-methyl-6-morpholin-4-yl)pyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 444.93774 | MF: C20H21ClN6O2S.
- 62: CID: 11854012, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]acetic acid, MW: 501.98906 | MF: C22H24ClN7O3S.
- 63: CID: 11854269, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]ethyl hydrogen sulfate, MW: 568.06874 | MF: C22H26ClN7O5S2.
- 64: CID: 11854270, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[2-(2-hydroxyethylamino)ethylamino]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 461.96826 | MF: C20H24ClN7O2S

- 65: CID: 11854271, IUPAC: 2-[[6-(2-aminoethylamino)-2-methylpyrimidin-4-yl]amino]-N-(2-chloro-6-methylphenyl)-1,3-thiazole-5-carboxamide, MW: 417.9157 | MF: C₁₈H₂₀CIN₇OS.
- 66: CID: 11854272, IUPAC: 2-[[2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]piperazin-1-yl]acetyl]amino]ethanesulfonic acid, MW: 609.12066 | MF: C₂₄H₂₉CIN₈O₅S₂.
- 67: CID: 11854533, IUPAC: N-(2-chloro-4-hydroxy-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 504.00494 | MF: C₂₂H₂₆CIN₇O₃S.
- 68: CID: 11854534, IUPAC: N-[2-chloro-6-(hydroxymethyl)phenyl]-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 504.00494 | MF: C₂₂H₂₆CIN₇O₃S.
- 69: CID: 11854535, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)-4-oxidopiperazin-4-ium-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 504.00494 | MF: C₂₂H₂₆CIN₇O₃S.
- 70: CID: 11854536, IUPAC: 2-[4-[6-[[5-[(2-chloro-6-methylphenyl)carbamoyl]-1,3-thiazol-2-yl]amino]-2-methylpyrimidin-4-yl]-1-oxidopiperazin-1-ium-1-yl]acetic acid, MW: 517.98846 | MF: C₂₂H₂₄CIN₇O₄S.
- 71: CID: 11949914, IUPAC: 4-[[2-(5-chloro-2-fluorophenyl)-5-dimethylaminopyrimidin-4-yl]amino]-N-[2-(2-hydroxyethylamino)ethyl]pyridine-3-carboxamide, MW: 473.931003 | MF: C₂₂H₂₅CIFN₇O₂.
- 72: CID: 11951866, IUPAC: 4-[[2-(5-chloro-2-fluorophenyl)-5-pyrrolidin-1-ylpyrimidin-4-yl]amino]-N-(2-hydroxyethyl)pyridine-3-carboxamide, MW: 456.900483 | MF: C₂₂H₂₂CIFN₆O₂.
- 73: CID: 11952045, IUPAC: 4-[[2-(5-chloro-2-fluorophenyl)-5-pyrrolidin-1-ylpyrimidin-4-yl]amino]-N-[(2S)-2-hydroxypropyl]pyridine-3-carboxamide, MW: 470.927063 | MF: C₂₃H₂₄CIFN₆O₂.
- 74: CID: 15979866, IUPAC: 5-[2-[[4-(4-acetylpiperazin-1-yl)pyridin-2-yl]amino]-1,3-thiazol-5-yl]-N-methylpyridine-3-carboxamide, MW: 437.51802 | MF: C₂₁H₂₃N₇O₂S.
- 75: CID: 15980109, IUPAC: N-(2-aminoethyl)-5-[2-[(4-morpholin-4-ylpyridin-2-yl)amino]-1,3-thiazol-5-yl]pyridine-3-carboxamide, MW: 425.50732 | MF: C₂₀H₂₃N₇O₂S.
- 76: CID: 15980233, IUPAC: N-(2-hydroxyethyl)-5-[2-[(4-morpholin-4-ylpyridin-2-yl)amino]-1,3-thiazol-5-yl]pyridine-3-carboxamide, MW: 426.49208 | MF: C₂₀H₂₂N₆O₃S.
- 77: CID: 15980347, IUPAC: N-(2-methylaminoethyl)-5-[2-[(4-morpholin-4-ylpyridin-2-yl)amino]-1,3-thiazol-5-yl]pyridine-3-carboxamide, MW: 439.5339 | MF: C₂₁H₂₅N₇O₂S.
- 78: CID: 15980351, IUPAC: 5-[2-[[4-[4-(2-hydroxyacetyl)piperazin-1-yl]pyridin-2-yl]amino]-1,3-thiazol-5-yl]-N-(2,2,2-trifluoroethyl)pyridine-3-carboxamide, MW: 521.51539 | MF: C₂₂H₂₂F₃N₇O₃S.
- 79: CID: 15982537, IUPAC: (3-chloro-2-fluorophenyl)-[4-[6-[(5-fluoro-1,3-thiazol-2-yl)amino]-5-methylpyridin-2-yl]piperazin-1-yl]methanone, MW: 449.904626 | MF: C₂₀H₁₈CIF₂N₅OS.

- 80: CID: 16034848, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 2,3-dihydroxybutanedioic acid, MW: 638.09238 | MF: C26H32ClN7O8S.
- 81: CID: 16037977, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-5-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 488.00554 | MF: C22H26ClN7O2S.
- 82: CID: 16061431, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 4-[(4-methylpiperazin-1-yl)methyl]-N-[4-methyl-3-[(4-pyridin-3-ylpyrimidin-2-yl)amino]phenyl]benzamide, MW: 981.60828 | MF: C51H57ClN14O3S.
- 83: CID: 16223227, IUPAC: but-2-enedioic acid; N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 604.0777 | MF: C26H30ClN7O6S.
- 84: CID: 16223228, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide hydrobromide, MW: 568.91748 | MF: C22H27BrClN7O2S.
- 85: CID: 16223229, IUPAC: but-2-enedioic acid; N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 604.0777 | MF: C26H30ClN7O6S.
- 86: CID: 16223316, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; methanesulfonic acid, MW: 584.1112 | MF: C23H30ClN7O5S2.
- 87: CID: 16223317, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; phosphoric acid, MW: 586.000721 | MF: C22H29ClN7O6PS.
- 88: CID: 16223318, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 2-hydroxybenzoic acid, MW: 626.12628 | MF: C29H32ClN7O5S.
- 89: CID: 16223319, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; sulfuric acid, MW: 586.08402 | MF: C22H28ClN7O6S2.
- 90: CID: 16223320, IUPAC: N-(2-chloro-6-methylphenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide; 4-methylbenzenesulfonic acid, MW: 660.20716 | MF: C29H34ClN7O5S2.
- 91: CID: 16584134, AKE-PB223730486, IUPAC: N-(4-chlorophenyl)-2-[(4,5-dimethyl-1,3-thiazol-2-yl)amino]-4-methylpyrimidine-5-carboxamide, MW: 373.85984 | MF: C17H16ClN5OS.

92: CID: 16584137, AKE-PB223730492, IUPAC: N-(3-chlorophenyl)-2-[(4,5-dimethyl-1,3-thiazol-2-yl)amino]-4-methylpyrimidine-5-carboxamide, MW: 373.85984 | MF: C17H16ClN5OS.

93: CID: 16584139, AKE-PB223730496, IUPAC: 2-[(4,5-dimethyl-1,3-thiazol-2-yl)amino]-4-methyl-N-(2-methylphenyl)pyrimidine-5-carboxamide, MW: 353.44136 | MF: C18H19N5OS.

94: CID: 16655683, IUPAC: 2-[(6-chloro-2-methylpyrimidin-4-yl)amino]-N-(2,6-dichlorophenyl)-1,3-thiazole-5-carboxamide, MW: 414.6968 | MF: C15H10Cl3N5OS.

95: CID: 16655839, IUPAC: N-(2,6-dichlorophenyl)-2-[[6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-yl]amino]-1,3-thiazole-5-carboxamide, MW: 508.42402 | MF: C21H23Cl2N7O2S.

96: CID: 16660745, IUPAC: N-(4-fluorophenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 399.441923 | MF: C19H18FN5O2S.

97: CID: 16660747, IUPAC: N-(4-ethylphenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 409.50462 | MF: C21H23N5O2S.

98: CID: 16660907, IUPAC: 4-(2-hydroxyethylamino)-N-(4-methylphenyl)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 395.47804 | MF: C20H21N5O2S.

99: CID: 16661063, IUPAC: N-(4-chlorophenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 415.89652 | MF: C19H18ClN5O2S.

100: CID: 16661212, IUPAC: N-(2,4-dimethylphenyl)-4-(2-hydroxyethylamino)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 409.50462 | MF: C21H23N5O2S.

101: CID: 16661214, IUPAC: 4-(1-hydroxybutan-2-ylamino)-N-(4-methylphenyl)-6-methylsulfanyl-2-pyridin-4-ylpyrimidine-5-carboxamide, MW: 423.5312 | MF: C22H25N5O2S.

NEPOR: Combined Prognostic and Therapeutic Value in Cancer Treatment.

Without being bound by theory, the observation that EPO treated patients often have poorer survival outcomes (at least in some cancers) means that treatment of these patients with a NEPOR targeted therapy provides a pharmacogenetic approach to targeted cancer treatment providing tumour tissue can be assessed for expression of NEPOR. Such a therapeutic perspective changes the balance in favour of performing biopsies under all suitable circumstances – meaning for cancers where EPOR, EPH-B4 and/or EphrinA1 are typically expressed.

The present disclosure further provides a method for imaging tumour tissue that is susceptible to enhanced survival in response to EPO treatment, comprising administering an anti-NEPOR antibody or NEPOR binding peptide linked to a radio-ligand or other imaging agent, and measuring for tissue distribution and location of the radio-ligand or other imaging agent.

If a tumour is NEPOR positive, then EPO is contraindicated and a NEPOR targeted therapy is administered. If NEPOR is not present, then it is safe to administer EPO. Both outcomes stand to benefit patient outcome, regardless of whether a patient is NEPOR positive or negative. Again,
 5 this shifts the balance in favour of performing routine biopsies.

In one embodiment the invention relates to an siRNA molecule specific to EPH-B4 and/or Ephrin A1 for use in treating a cancer patient that is or will receive EPO.

10 EPH-B4 siRNAs and Antisense Oligodeoxynucleotides

Various EphB4-specific anti-sense phosphorothioate-modified oligodeoxynucleotides (ODNs) and siRNA may be synthesized from (e.g. by Qiagen. The most active antisense ODN and siRNA that knocks down EphB4 expression in the transiently transfected 293T cell line is
 15 chosen. The antisense ODN that may be used is AS-10 which spans nucleotides 1980 to 1999 with a sequence 5'-ATG GAG GCC TCG CTC AGA AA-3' (SEQ ID NO. 217). To eliminate cytokine responses, the cytosine at the CpG site may be methylated (AS-10M) without any loss in EphB4 knockdown efficiency (data not shown). Scrambled ODNs containing random nucleotide sequence and a similar CpG site, 5'-TAC CTG AAG GTC AGG CGA AC-3' (SEQ ID
 20 NO. 218), may be used as control. siRNA 465 corresponding to the sequences 5'-GGU GAA UGU CAA GAC GCU GUU-3' (SEQ ID NO. 219) and 3'-UUC CAC UUA CAG UUC UGC GAC-5' (SEQ ID NO. 220) may be used for RNA interference. Control siRNA may be generated by mutating three bases in this sequence to effectively abrogate EphB4 knockdown. This mutated siRNA (siRNA Δ) had the sequences 5'-AGU UAA UAU CAA GAC GCU GUU-3' (SEQ ID
 25 NO. 221) and 3'-UUU CAA UUA UAG UUC UGC GAC-5' (SEQ ID NO. 222). Additionally, siRNA directed against green fluorescent protein with sequences 5'-CGC UGA CCC UGA AGU UCA TUU-3' (SEQ ID NO. 223) and 3'-UUG CGA CUG GGA CUU CAA GUA-5' (SEQ ID NO. 224) may be used as a negative control.

30 siRNA may be obtained from numerous companies in particular Sigma Aldrich:
 The siRNA's from the sigma catalogue predicted using Rosetta siRNA design algorithm
EPHRIN A1

siRNA_ID	entrezgene_ID	approx_start_nucleotide
SASI_Hs01_00211016	NM_004428	247
35 SASI_Hs01_00211017	NM_004428	223

	SASI_Hs01_00211018	NM_004428	248
	SASI_Hs01_00211019	NM_004428	1071
	SASI_Hs01_00211020	NM_004428	256
	SASI_Hs01_00211021	NM_004428	208
5	SASI_Hs01_00211022	NM_004428	829
	SASI_Hs01_00211023	NM_004428	1015
	SASI_Hs01_00211024	NM_004428	846
	SASI_Hs01_00211025	NM_004428	225
	SASI_Hs01_00071683	NM_182685	248
10	SASI_Hs01_00071684	NM_182685	214
	SASI_Hs01_00071685	NM_182685	242
	SASI_Hs01_00071686	NM_182685	1000
	SASI_Hs01_00071687	NM_182685	263
	SASI_Hs01_00071688	NM_182685	203
15	SASI_Hs01_00071689	NM_182685	769
	SASI_Hs01_00071690	NM_182685	948
	SASI_Hs01_00071691	NM_182685	778
	SASI_Hs01_00071692	NM_182685	227

20 **EPHB4**

	siRNA_ID	entrezgene_ID	approx_start_nucleotide
	SASI_Hs01_00039855	NM_004444	1756
	SASI_Hs01_00039856	NM_004444	577
	SASI_Hs01_00039857	NM_004444	1373
25	SASI_Hs01_00039858	NM_004444	2290
	SASI_Hs01_00039859	NM_004444	2318
	SASI_Hs01_00039860	NM_004444	2353
	SASI_Hs01_00039861	NM_004444	2898
	SASI_Hs01_00039862	NM_004444	2245
30	SASI_Hs01_00039863	NM_004444	1679
	SASI_Hs01_00039864	NM_004444	1416

Antibodies to NEPOR

The present disclosure includes several antibodies that bind to NEPOR components. The following Table 6 provides a list of such antibodies and their availability.

Table 6
Company

Item	Antigen	Catalog Number	Applications	Type
EPOR				
Abcam	Goat Anti-EPO Receptor Polyclonal Antibody, Unconjugated	EPOR	ab10653	ELISA, WB
ABR-Affinity BioReagents	Mouse Anti-Human EPOR Monoclonal Antibody, Unconjugated, Clone 3D10	EPOR	MA1-51823	WB, ELISA
Abnova Corporation	Mouse Anti-Human EPOR Monoclonal Antibody, Unconjugated, Clone 3D10	EPOR	H00002057-M01	WB, Capture ELISA
Abcam	Goat Anti-Human EPO Receptor Polyclonal Antibody, Unconjugated	EPOR	ab27497	ELISA, WB
Abcam	Mouse Anti-Human EPO Receptor Monoclonal Antibody, Unconjugated, Clone MM-0031-6G7	EPOR	ab56310	WB
ABR-Affinity BioReagents	Mouse Anti-Human EPOR Polyclonal Antibody, Unconjugated	EPOR	PA1-51822	WB
IMGENEX	Goat Anti-Human EPOR Polyclonal Antibody, Unconjugated	EPOR	IMG-3771	WB, ELISA
Lifespan Biosciences	Rabbit Anti-Human Erythropoietin Receptor (EPOR) Polyclonal Antibody, Unconjugated	EPOR	LS-C6720	ELISA
GeneTex	Mouse Anti-Human EPOR Monoclonal Antibody, Unconjugated, Clone 3D10	EPOR	GTX91710	ELISA, WB
Lifespan Biosciences	Rabbit Anti-Human EPOR Polyclonal Antibody, Unconjugated	EPOR	LS-C6719-100	ELISA
Novus Biologicals	Mouse Anti-Human EPOR Polyclonal Antibody, Unconjugated	EPOR	H00002057-A01	Polyclonal
Novus Biologicals	Mouse Anti-Human EPOR Monoclonal Antibody, Unconjugated, Clone 3D10	EPOR	H00002057-M01	Monoclonal
Lifespan Biosciences	Sheep Anti-Human Erythropoietin Receptor (EPOR) Polyclonal Antibody, Unconjugated	EPOR	LS-C6718	ELISA, WB
Lifespan Biosciences	Sheep Anti-Human Erythropoietin Receptor (EPOR) Polyclonal Antibody, Unconjugated	EPOR	LS-C6716	Polyclonal
Lifespan Biosciences	Sheep Anti-Human EPOR Polyclonal Antibody, Unconjugated	EPOR	LS-C6717-50	ELISA
Santa Cruz Biotechnology, Inc.	Rabbit Anti-Human EpoR (C-20) Polyclonal Antibody, Unconjugated	EpoR (C-20)	sc-695	WB, IP, IF, ICH.

Santa Cruz Biotechnology, Inc.	Rabbit Anti-EpoR (M-20) Polyclonal Antibody, Unconjugated	EpoR (M-20)	sc-697	WB, IP, IF, ICH.	Polyclonal
Santa Cruz Biotechnology, Inc.	Rabbit Anti-EpoR Polyclonal Antibody, Unconjugated	EpoR	sc-5624	WB, IP, IF, ICH.	Polyclonal
EPH-B4					
Abgent	Rabbit Anti-EPH-B4 C-term RB1659-1660 Polyclonal Antibody, Unconjugated	EPH-B4 C-term	AP7625a	ELISA; IHC.	Polyclonal
ABR-Affinity BioReagents ABR-Affinity	Rabbit Anti-Human EPH-B4 Polyclonal Antibody, Unconjugated	EPH-B4	PA1-24241	WB	Polyclonal
BioReagents AbD Serotec	Mouse Anti-Human EPH-B4 Monoclonal Antibody, Unconjugated, Clone 1D1	EPH-B4	MA1-51815	ELISA	Monoclonal
AbD Serotec	Human Anti-Human EPH-B4 Monoclonal Antibody, Unconjugated, Clone 1327	EPH-B4	HCA001	IHC, WB, ELISA	Monoclonal
Invitrogen	Human Anti-Human EPH-B4 Monoclonal Antibody, Unconjugated, Clone 3934	EPH-B4	HCA025	IHC, WB, ELISA	Monoclonal
GeneTex	Anti-EPH-B4 receptor Monoclonal Antibody, Unconjugated, Clone 3D7F8	EPH-B4	35-2900	WB, ELISA	Monoclonal
Invitrogen	Rabbit Anti-EPH-B4 Polyclonal Antibody, Unconjugated	EPH-B4	GTX77656	WB	Polyclonal
Invitrogen	Mouse Anti-EPH-B4 Receptor Monoclonal Antibody,, Clone 3D7G8	EPH-B4	182394	IHC(FFPE)	Monoclonal
GeneTex	Anti-Eph Receptor Sampler Pack Antibody, Mouse Anti-Human EPH-B4 Monoclonal Antibody, Unconjugated, Clone 1D1	EPH-B4 EPH-B4	901100 GTX91629	ELISA	Monoclonal
Novus Biologicals	Mouse Anti-Human EPH-B4 Receptor Monoclonal Antibody,, Clone 3D7G8	EPH-B4	371800	WB ELISA IP, IHC	Monoclonal
R&D Systems	Mouse Anti-Human EPH-B4 Monoclonal Antibody, Unconjugated, Clone 1D1	EPH-B4	H00002050- M01		Monoclonal
Raybiotech, Inc.	Goat Anti-Human EPH-B4 Polyclonal Antibody, Unconjugated	EPH-B4	AF3038	FC, IHC, WB	Polyclonal
R&D Systems	Human Anti-Human EPH-B4, (packaged with HRP-Conjugated Secondary Antibody); Monoclonal Antibody, Unconjugated	EPH-B4	DS-MB- 01224		Monoclonal
Santa Cruz Biotechnology, Inc.	Rat Anti-Human EPH-B4 Monoclonal Antibody, Unconjugated, Clone 395810	EPH-B4	MAB3038	FC, IHC, WB	Monoclonal
Santa Cruz Biotechnology, Inc.	Goat Anti-EPH-B4 Polyclonal Antibody, Unconjugated	EPH-B4	sc-7284	WB, IF	Polyclonal
Santa Cruz	Goat Anti-EPH-B4 Polyclonal Antibody,	EPH-B4	sc-7285	WB, IF	Polyclonal

Biotechnology, Inc. Santa Cruz	Unconjugated Rabbit Anti-EPH-B4 Polyclonal Antibody,	EPH-B4	sc-5536	WB, IF	Polyclonal
Biotechnology, Inc. Raybiotech, Inc.	Unconjugated Human Anti-Human EPH-B4, (packaged with HRP-Conjugated Secondary Antibody); Monoclonal Antibody, Unconjugated	EPH-B4	DS-MB- 01225		Monoclonal
EFNA1					
Invitrogen	Anti-Ephrin A1 Polyclonal Antibody, Unconjugated, Clone ZMD.39	EFNA1	34-3300		Polyclonal
Novus Biologicals	Mouse Anti-Human EFNA1 Monoclonal Antibody, Unconjugated, Clone 3C6	EFNA1	H00001942- M01		Monoclonal
Santa Cruz	Rabbit Anti-ephrin-A1 (V-18) Polyclonal Antibody, Unconjugated	EFNA1 (V-18)	sc-911	WB, IF	Polyclonal
Biotechnology, Inc. Santa Cruz	Rabbit Anti-ephrin-A1 Polyclonal Antibody, Unconjugated	EFNA1	sc-20719	WB, IP, IF	Polyclonal
Biotechnology, Inc. Abcam	Rabbit Anti-Human Ephrin A1 Receptor Polyclonal Antibody, Unconjugated	EFNA1	ab37857	ELISA, IHC, WB	Polyclonal
GeneTex	Mouse Anti-Human EFNA1 Monoclonal Antibody, Unconjugated, Clone 3C7	EFNA1	GTX91614		Monoclonal
EFNB2					
Novus Biologicals	Mouse Anti-Human EFNB2 Polyclonal Antibody, Unconjugated	EFNB2	H00001948- A01		Polyclonal
Santa Cruz	Rabbit Anti-ephrin-B2 (P-20) Polyclonal Antibody, Unconjugated	EFNB2 (P-20)	sc-1010	WB, IF	Polyclonal
Biotechnology, Inc. Santa Cruz	Goat Anti-ephrin-B2 Polyclonal Antibody, Unconjugated	EFNB2	sc-19227	WB, IF, IP	Polyclonal
Biotechnology, Inc. Santa Cruz	Rabbit Anti-ephrin-B2 Polyclonal Antibody, Unconjugated	EFNB2	sc-15397	WB, IF, IP	Polyclonal

EXAMPLES

Example 1

5 A variety of sequence analysis approaches were pursued, including the search for homologues of the EPO binding domain from EPOR, a domain analysis based method combined with text-mining, and EPO homology analysis followed by text-mining of resultant hits. Only that part of the human proteome exposed to the extracellular environment was investigated. This allowed a focus on homologies that were significant, though possibly overlooked within the context of a complete proteome analysis. This formed the XtraCell database. The XtraCell database performed a signal peptide and transmembrane prediction for the entire human proteome. All proteins possessing at least one of these features were stored in a first version of the extracellular database. Given that not all extracellular proteins actually possess either of these features, there was extracted a list of protein domains specific to the extracellular environment from a SMART (Simple Modular Architecture Research Tool - SMART is a well-known protein domain database with a strong bias towards domains contained in signalling proteins.) These were then screened against the human proteome using the HMMER algorithm. HMMER is a freely distributable implementation of profile HMM software for protein sequence analysis - Profile hidden Markov models (profile HMMs) can be used to do sensitive database searching using statistical descriptions of a sequence family's consensus. All hits were added to the XtraCell database and the dataset made non-redundant. A final version of the XtraCell database was established for the purpose of these EPO specific analyses (Figure 3).

25 Example 2

This example illustrates a domain-based approach coupled with a text-mining and genome-wide analysis. The operating theory was that any novel EPO receptor involved in mediating EPO's neuroprotective effect might also possess the two membrane proximal fibronectin 3 (FN3) domains (as found in EPOR), whilst at the same time being hypoxia inducible. Such conserved domain architecture is compatible with both a heterodimeric complex containing EPOR and/or an independent hypoxia inducible homodimeric receptor. All proteins containing two membrane proximal FN3 domains from the human proteome (84 in all) were extracted and asked whether there was any evidence for their role in response to low oxygen conditions/ischaemia. The latter analysis was performed using a text-mining approach that encompasses the use of comprehensive protein synonyms, and concepts such as hypoxia and ischaemia. Of the 84 proteins containing the 2FN3-TM domain composition, only four showed evidence for mediating response to low oxygen conditions: EPH-B4, IL6RB, TIE1

and GM-CSF. Apart from EPH-B4, the cellular role of each of these proteins has been studied and an important role in response to hypoxia established.

Direct examination of the EPH-B4 locus revealed that it directly juxtaposes the EPO locus, albeit on the opposite strand. This close genomic association was conserved in all vertebrate genomes examined. The need for immediate response of cells to low oxygen conditions and thus the need to co-transcribe/-translate key effector molecules was seen. Moreover, such genomic co-localisation of functionally associated molecules is seen for other receptor:ligand partners (e.g. MST1 and its receptor MST1R: see Figure 4).

To examine this possibility in greater detail, we analysed the promoter, 5' UTR and 3' UTR regions of EPO, EPHB4 and EPOR in search of hypoxia inducible factor binding sites. Here we utilised the 'match' algorithm from Genomatix, searching for strict conservation of the core binding site residues and at least 90% conservation of non-core residues. We found that the EPO and EPH-B4 loci possessed numerous hypoxia-inducible transcription factor binding sites. In contrast, the EPOR gene regulatory regions were found to be complete devoid of such HIF-1 binding sites, again hinting at a possible role for EPHB4 as a hypoxia inducible EPO receptor (see Figure 4).

Example 3

This example shows the homology-based approach using human extra-cellular database. Here we sought to directly identify regions of EPO binding activity in other proteins, by direct comparison to the EPO binding domain of EPOR. The region of EPOR responsible for EPO binding was thus extracted and used to identify homologies with proteins of the XtraCellDB. This specially developed database holds distinct advantages in that all homologies identified are to human extracellular proteins, thus avoiding the need to assess spurious homologies to irrelevant intracellular species. Analysis of resultant homologues revealed a striking homology to the Ephrin A1 protein, within the top four hits. Given what we had learned about EPH-B4's possible role in EPO signalling we decided to assess this homology in greater detail using the Swiss-model protein structure package. Here we employed information derived from the co-crystal structure of Ephrin A5 in association with EphB2 and compared it to EPO:EPOR co-crystal information. Conservation of key residues in structurally aligned positions allowed us to conclude a firm structural basis for association between Ephrin A1 and EPO. Moreover, the realisation that both EphrinA1 and EPHB4 possess a putative affinity for EPO, suggests a more exciting functional context for ephrin biology than heretofore recognised (See Figure 6).

Example 4

This example provides wet lab or *in vivo* data that validates the bioinformatics analysis provide in Examples 1-3 herein. *In vivo* validation of EPH-B4's role in EPO signalling has focussed on the neuroprotective aspect of EPO's function, with a bias towards the hypothesis that EPH-B4 and EPOR are heterodimeric partners. The following table lists the validation experiments for which data are available (see Table 7).

LAB-BASED validation experiments

Method	Goal	Result
Immuno-histochemistry	To assess the expression of EPHB4 protein in brain and how it relates to EPOR expression.	Precipitation stainings on adult rodent brain showed that EPHB4 was expressed in adult neurons in the same pattern as EPO receptor. Staining in hippocampus showed co-expression of EPOR and EPHB4 (see figure 6). Strikingly, the staining was restricted to particular cells within the field of tissue.
Co-IP	Exogenous expression of EPOR/EPHB4 in COS cells. Co-ip with EpoR- and EphB4-antibodies => WB analysis.	Positive. Use of EPOR antibody successfully Co-IP's EPHB4 protein.

10

Immunohistochemistry. For immunofluorescence, sections of paraffin-embedded rat brain tissues (2 µm) were deparaffinated and microwaved (citrate buffer at 600W for 15 min). Afterwards, sections were incubated simultaneously with the EpoR antiserum (1:200; sc-697, Santa Cruz Biotechnology) and the EphB4 antibody (1:100; AF446, R&D Systems) at 4°C over night. After adding a biotinylated anti-goat secondary antibody (1:200; Dianova), sections were incubated with Streptavidin-coupled Alexa Fluor 555 (1:200; Invitrogen, Karlsruhe, Germany) and a FITC-coupled anti-rabbit secondary antibody (1:200; Dianova). The nuclei were counterstained with Hoechst 33342 (1:10,000; Molecular Probes). Controls for the stainings included omission of primary antibodies, fluorophor swapping, and single-fluorescence stainings. Images were obtained with an Olympus IX-81 microscope with narrow-bandwidth monochromator excitation (Polychrome IV, Till Photonics, Gräfelfing, Germany) and appropriate filters.

15

Both EPHB4 and EPOR displayed a striking co-localisation when assessed in rat brain tissue sections. Without being bound by theory, this co-expression suggests functional coupling of both receptors.

20

Co-immunoprecipitation. The principle of an immunoprecipitation is an antibody (monoclonal or polyclonal) against a specific target antigen is allowed to form an immune complex with that target in a sample, such as a cell lysate. The immune complex is then captured on a solid support to which either Protein A or Protein G has been immobilized (Protein A or G binds to the antibody, which is bound to its antigen). The process of capturing this complex from the solution is referred to as precipitation. Any proteins not “precipitated” by the immobilized Protein A or G support are washed away. Finally, components of the bound immune complex (both antigen and antibody) are eluted from the support and analyzed by SDS-PAGE (gel electrophoresis), often followed by Western blot detection to verify the identity of the antigen.

Traditional immunoprecipitation involves the following steps:

1. Form the antigen-antibody complex (immune complex) by incubating specific antibody with the antigen-containing sample for 1 hour to several hours.
2. Capture the immune complex on an immobilized Protein A or Protein G agarose gel support by incubation for 0.5-2 hours.
3. Remove any non-bound protein (non-immune complex sample components) from the precipitated complex by washing gel support with additional sample buffer.
4. Boil gel support in reducing SDS-PAGE sample loading buffer.
5. Recover sample eluted in loading buffer from gel support and analyze by SDS-PAGE.
6. Perform Western blot analysis, probing with antigen-specific antibody.

In a co-immunoprecipitation the target antigen precipitated by the antibody “co-precipitates” a binding partner/protein complex from a lysate, that is, the interacting protein is bound to the target antigen, which becomes bound by the antibody that becomes captured on the Protein A or G gel support. The assumption that is usually made when associated proteins are co-precipitated is that these proteins are related to the function of the target antigen at the cellular level.

Assessment of a putative EPHB4:EPOR association using co-immunoprecipitation showed that both proteins were physically associated. Here, FLAG-tagged EPOR was co-expressed with EPH-B4 in COS cells and then immunoprecipitated using an a-FLAG antibody. As can be seen from Figure 8, EPHB4 was shown to co-immunoprecipitate in these experiments.

Human Fc Antibody Constructs. The Fc conjugate approach is most appropriate when dealing with dimeric cell surface receptors. Here the extracellular portion of EPHB4/EPOR was fused to an Fc fragment. This method has advantages due to its *in vivo* (therapeutic) viability and the fact that it optimally mimics the dimerised receptor state. Figure 9 highlights the Human constructs that are used to show EPHB4’s/EphrinA1’s affinity for EPO.

One of two alternatives can assay the interaction of the Fc constructs with EPO, including, for example, a protein array approach or a surface plasmon resonance analysis.

5 Example 5

Further in vitro and in vivo validation of NEPORs role in mediating EPO function.

In these experiments we sought to determine the response to erythropoietin (EPO) treatment
 10 in a panel of ovarian cancer cell lines. This would be mediated by the expression of erythropoietin receptor (EPOR) as well as two receptors that potentially may be able to activate signaling pathways in response to EPO binding, EPH-B4 and Ephrin A1. It was first necessary to characterize the expression of these receptors in a panel of ovarian cancer cell lines. First we collected RNA from each cell line and reverse transcribed them into cDNA.
 15 Using specific primers for each receptor we analyzed their RNA expression. As evident in the figures the expression of EPOR and EPH-B4 RNA is different in different cell lines suggesting changes in transcriptional regulation during tumorigenesis no significant changes were seen in the EphrinA1. It was then necessary to determine protein expression of these receptors in the panel. Again we see significant differences in the expression of the EPOR and
 20 EPH-B4 receptors though they do not coincide with the RNA expression suggesting there is changes in post transcriptional regulation of these receptors in the cell lines. We then categorized these expression changes particularly with regard to the EPOR and EPH-B4 to then analyze the response to EPO treatment. We analyzed their response to chemotherapy in conjunction with EPO. We found that particularly in the HeyA8 ovarian cancer cell line that
 25 EPO was able to abrogate the apoptosis induced by docetaxel. It was then necessary to analyze the activation of signaling pathways known to be activated by these receptors in response to EPO treatment. Three cell lines were starved for two hours to isolate their response to EPO. Cell lines with higher expression (HeyA8 and HeyA8 MDR) of the EPOR demonstrated activation of the MAPK/ERK pathway while cell lines that expressed higher
 30 EPH-B4 (SKOV3ip1) demonstrated increased activation of the AKT and STAT5b signaling pathways. We then sought to determine a EPO dose that optimized its tumor promoting effect *in vivo*. Female nude mice were injected i.p. with HeyA8 MDR (positive for both EPOR and EPH-B4). At day eight the mice were treated with increasing doses of EPO (10, 50, 100 U) every two days. Treatment continued until tumors became evident, the mice were then
 35 sacrificed and the tumor weight was determined. We saw an increase in tumor weight as

compared to control in the mice treated with 10 and 50 U EPO. The differential expression of EphB4 in cell lines as well as the activation of particular signaling pathways suggested that it would also mediate the tumor promoting effect *in vivo*. To determine this we again injected mice with HeyA8 MDR cell lines i.p. At day eight we began treatment with EPO (50 U 3x
5 week) in conjunction with siRNA specific to EPH-B4. As previously described EphB4 siRNA was able decrease tumor growth alone. Moreover, EPH-B4 siRNA also completely abrogated the EPO induced tumor growth.

CLAIMS:

1. Use of Erythropoietin (EPO) with an inhibitor of Novel Tissue Protective Erythropoietin Receptor (NEPOR) activity, wherein the inhibitor is selected from an anti-NEPOR antibody, an ephrin type-B receptor 4 (EPHB4) tyrosine kinase inhibitor, and an anti-Novol Tissue Protective Erythropoietin Receptor (NEPOR) siRNA, for treating EPO-induced tumour cell survival in NEPOR positive tumour tissue.
2. The use of claim 1 for treating EPO-induced tumour cell survival in NEPOR positive tumour tissue, wherein an effective amount of anti-NEPOR antibody is used in combination with EPO, permitting haematopoietic signalling whilst switching off NEPOR signalling and thus EPO mediated cell survival signals on tumour cells.
3. The use of claim 1 for treating EPO-induced tumour cell survival in NEPOR positive tumour tissue, wherein an effective amount of EPHB4 tyrosine kinase inhibitor is used in combination with EPO, permitting haematopoietic signalling whilst switching off NEPOR signalling and thus EPO mediated cell survival signals on tumour cells.
4. The use of claim 1 for treating EPO-induced tumour cell survival in NEPOR positive tumour tissue, wherein an effective amount of anti-NEPOR siRNA's is used, in combination with EPO, permitting haematopoietic signalling whilst switching off NEPOR signalling and thus EPO mediated cell survival signals on tumour cells.
5. An siRNA which is specific for SEQ ID NO: 6 for use in a method of reducing EPO-induced tumor growth during anemia treatment in a cancer patient that is receiving or will receive Erythropoietin.

6. The siRNA of claim 5, wherein the siRNA is a duplex of SEQ ID NO: 219 and SEQ ID NO: 220.

7. The use according to claim 1 or 4, wherein the inhibitor of NEPOR activity is siRNA which is specific for SEQ ID NO: 6.

FIGURES

FIG. 1

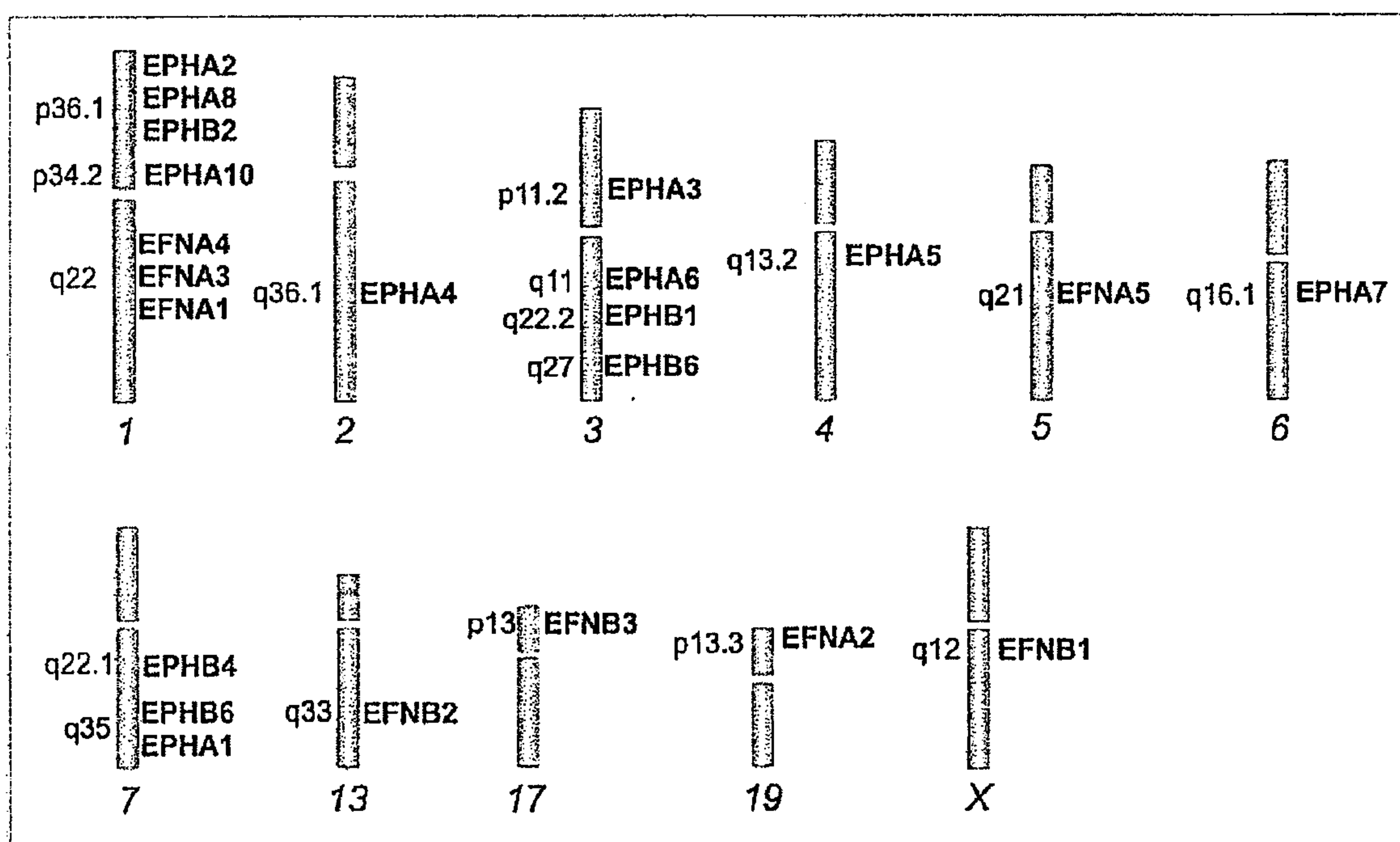


FIG. 2

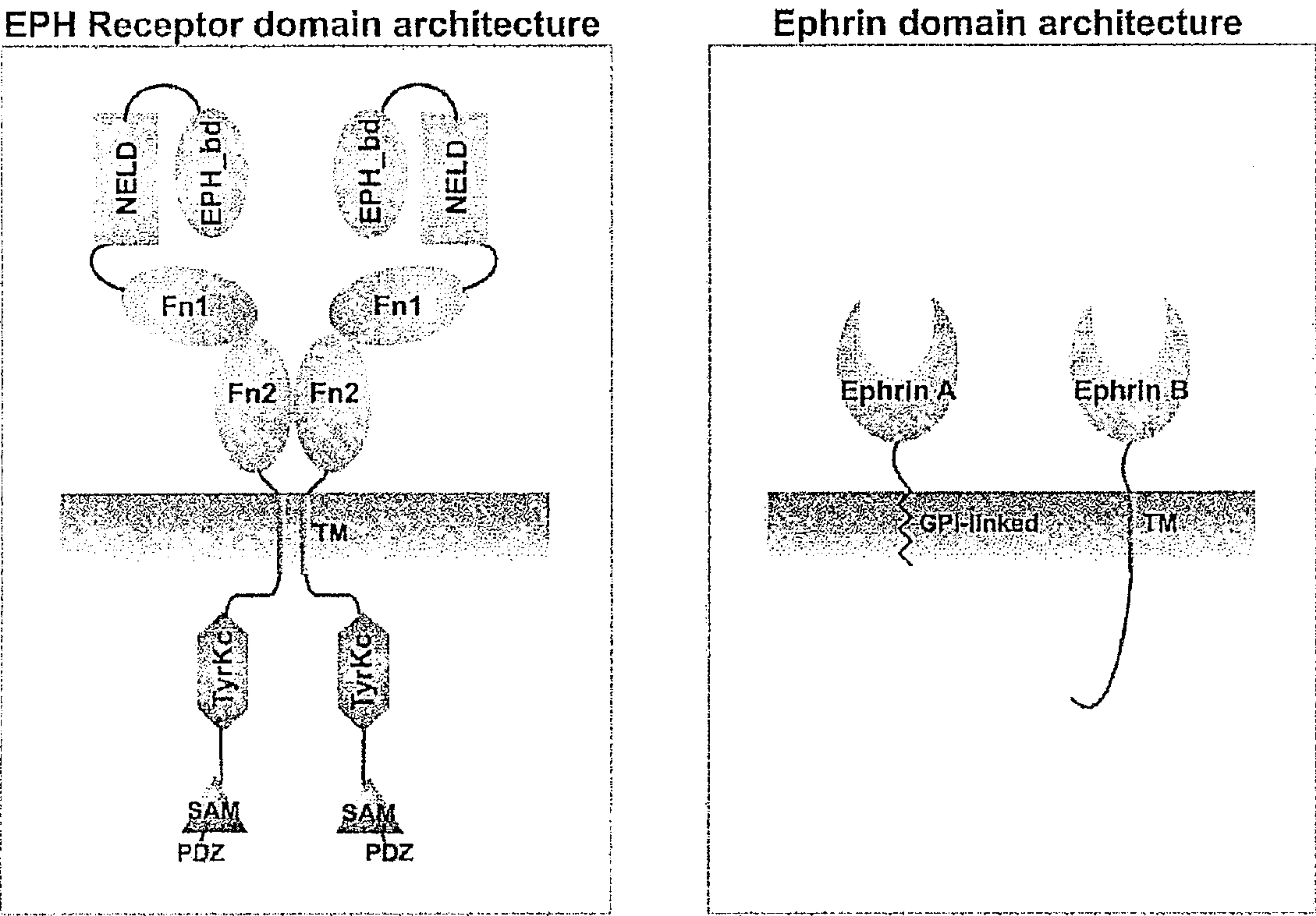


FIG. 3

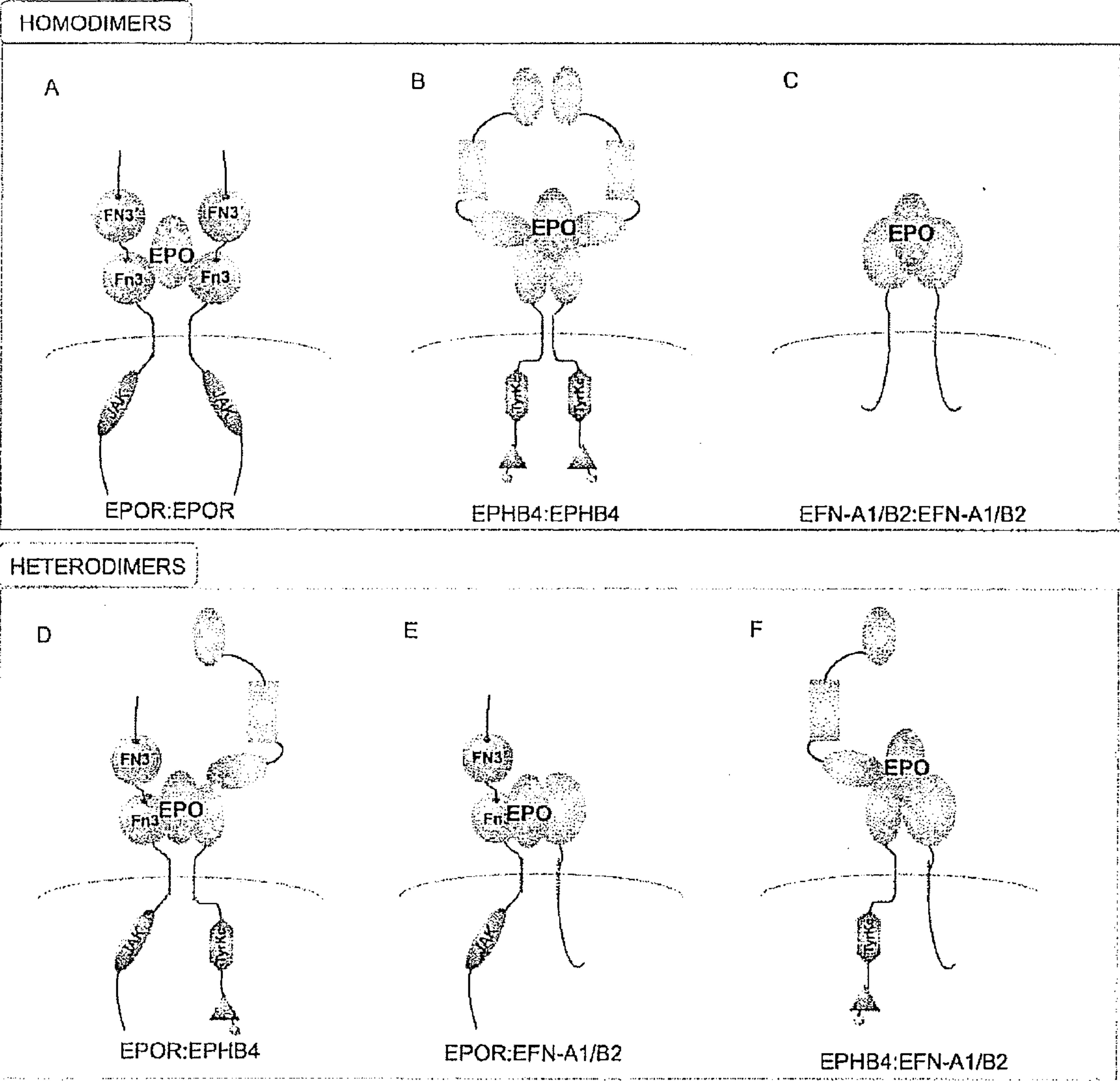


FIG. 4 A

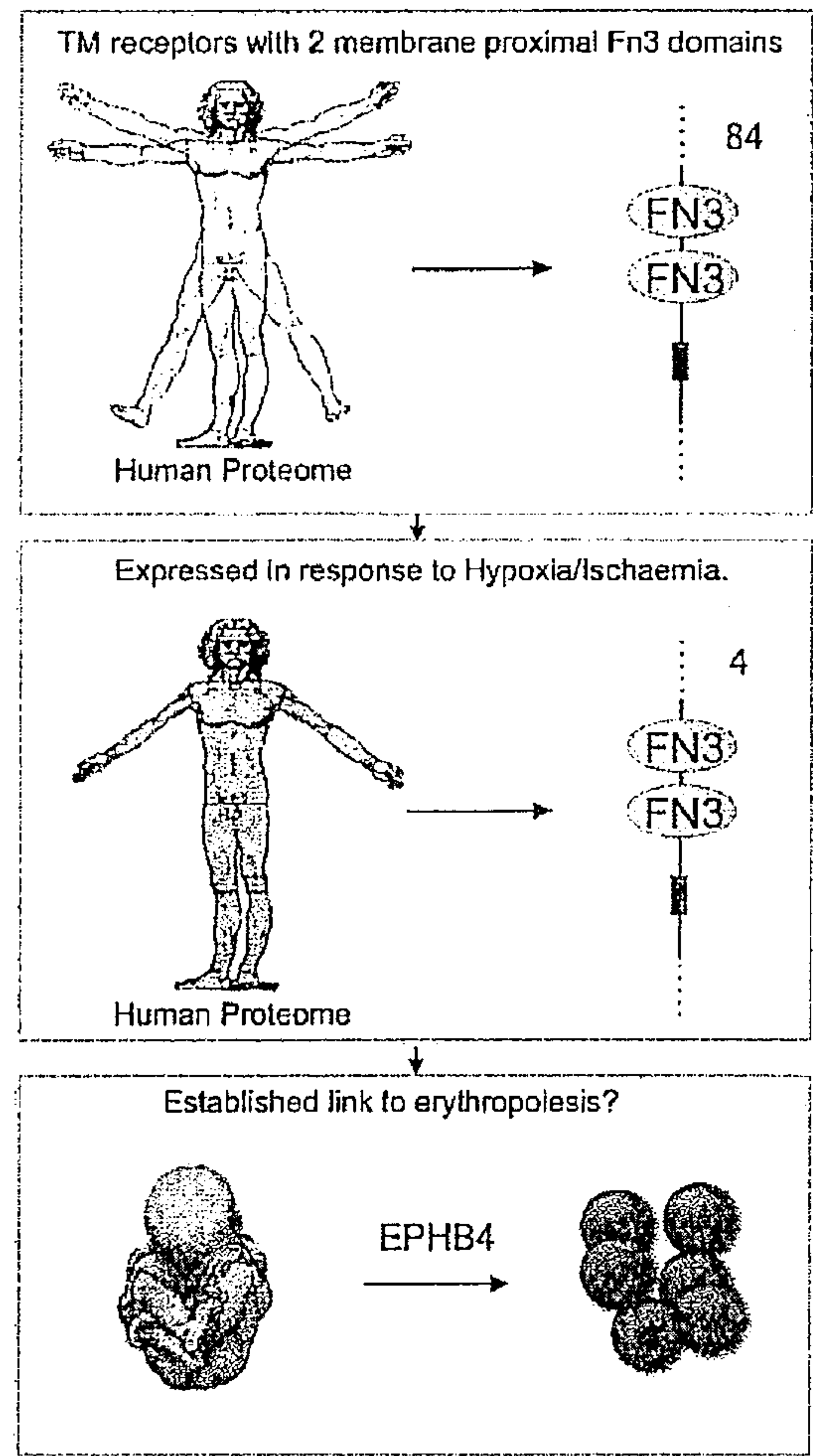


Fig. 4 B

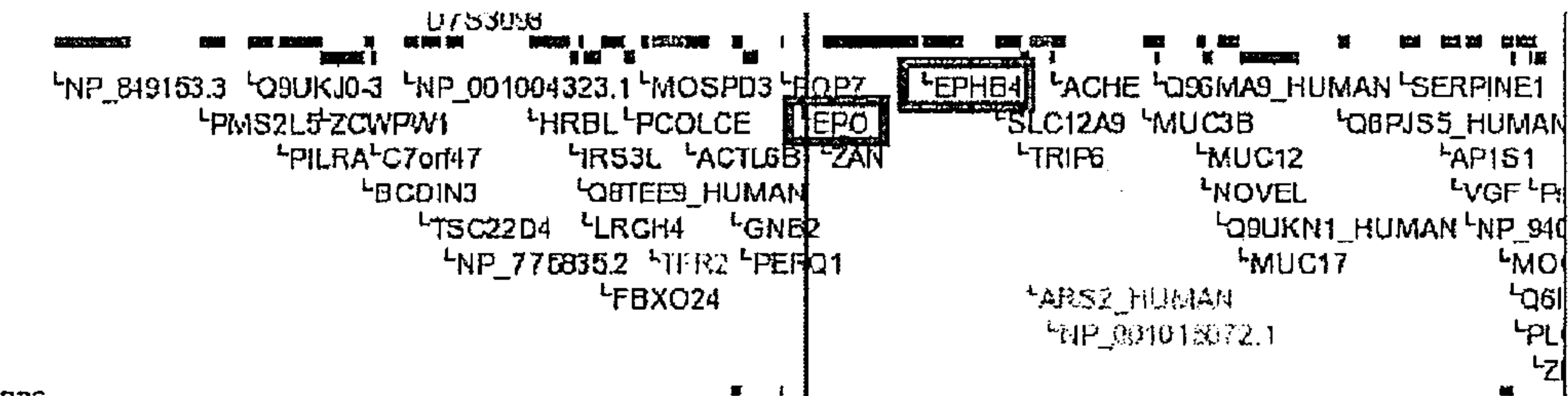


FIG. 5

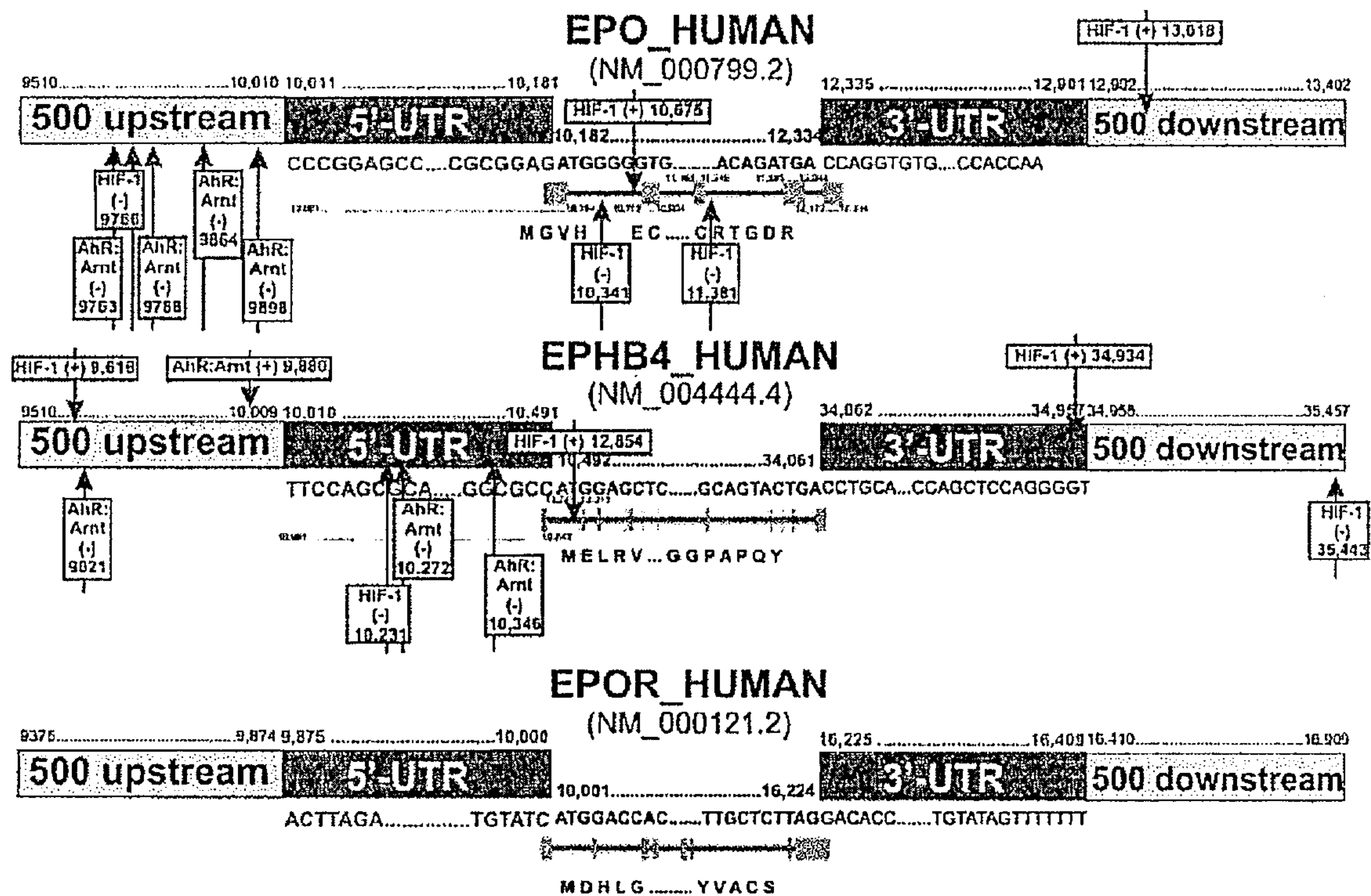


FIG. 6

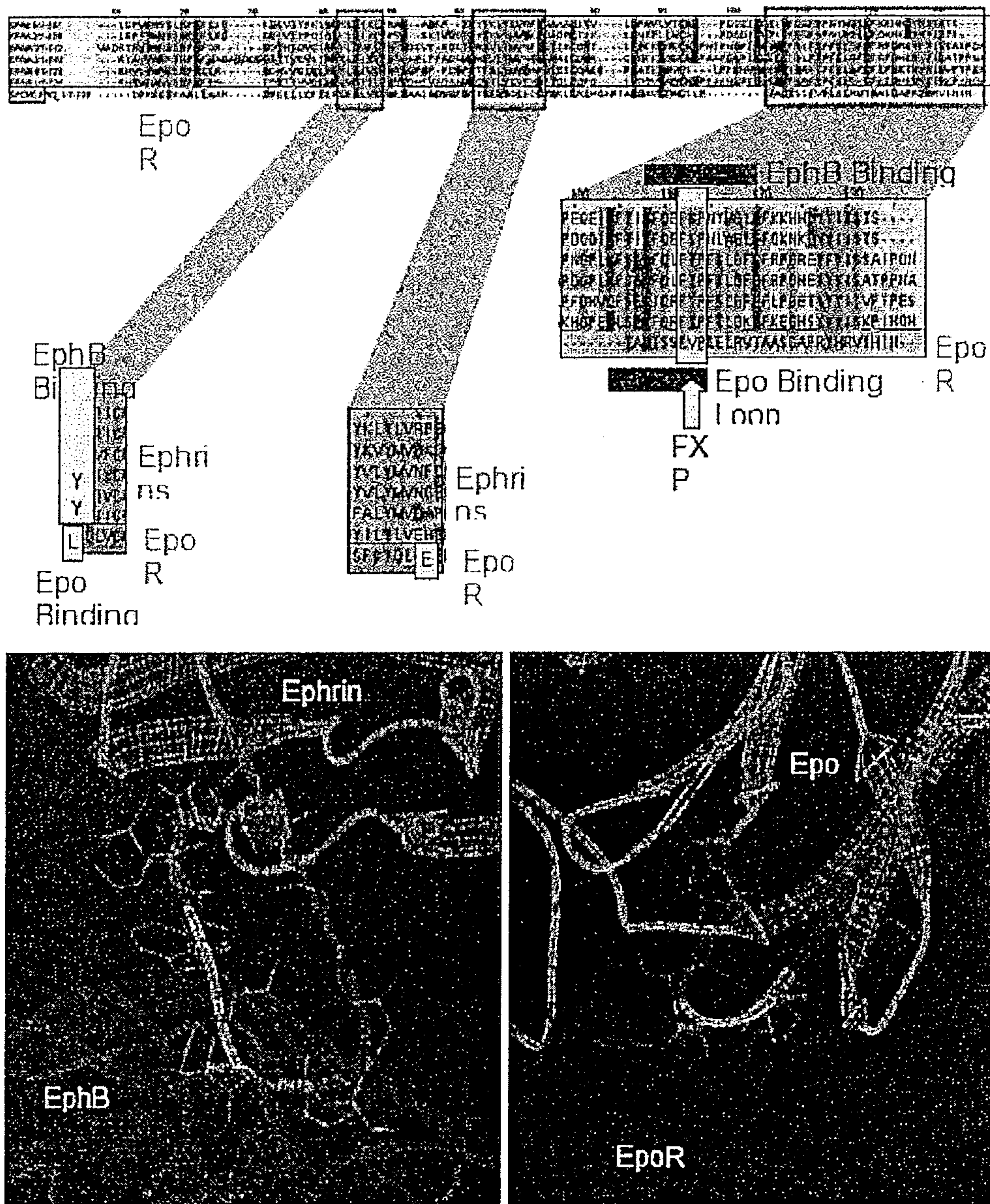


FIG. 7

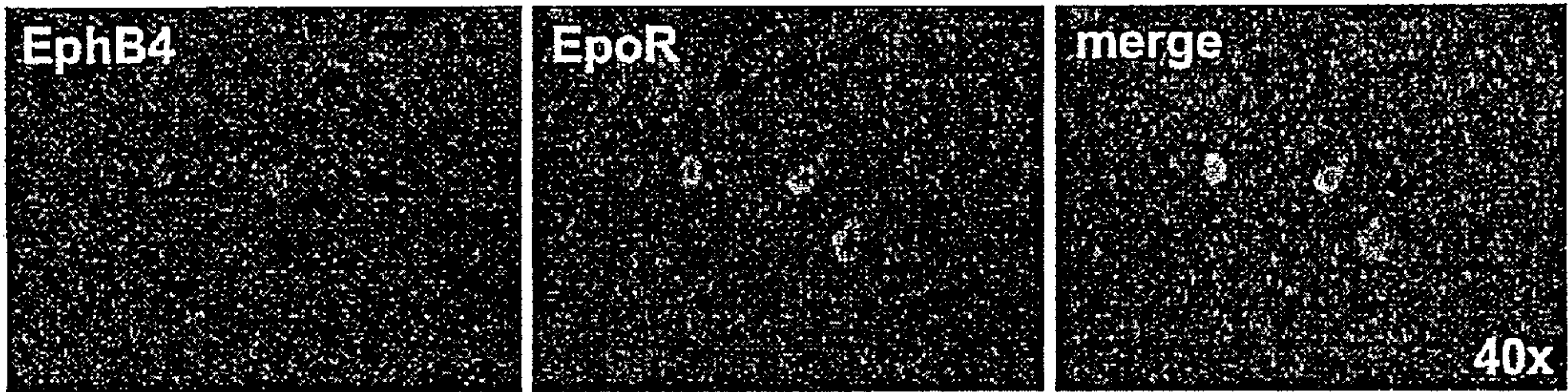


FIG. 8

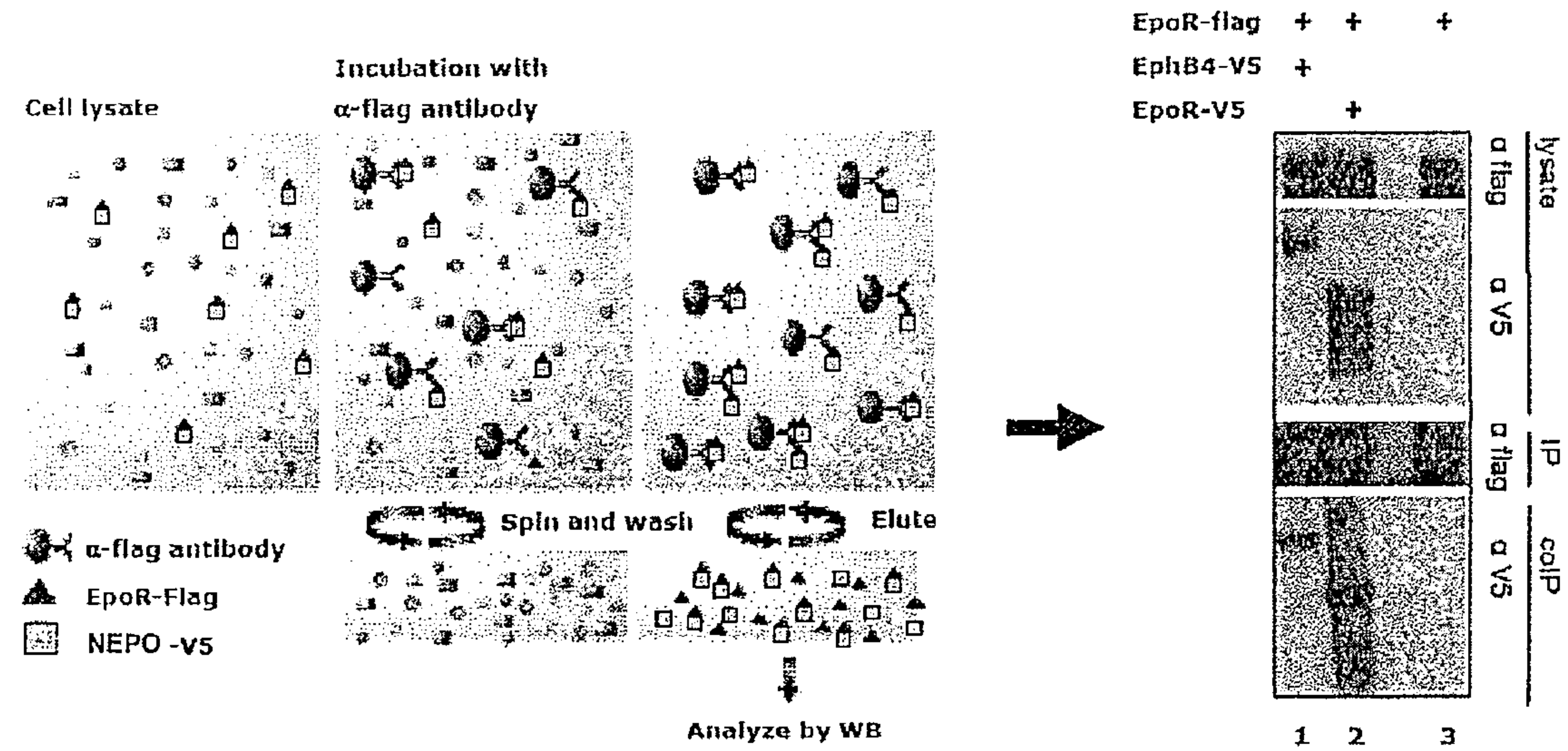


FIG. 9

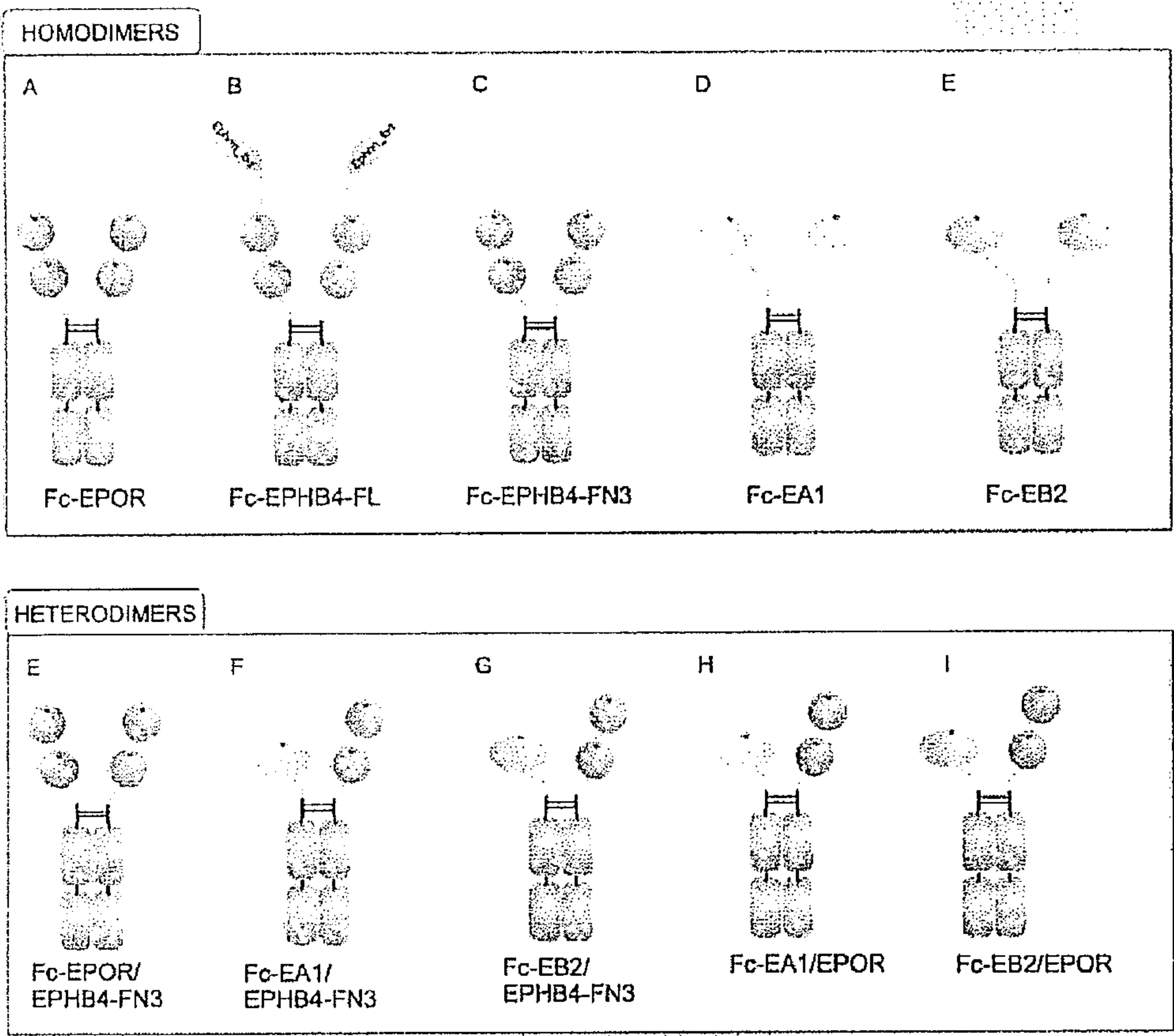


FIG. 10

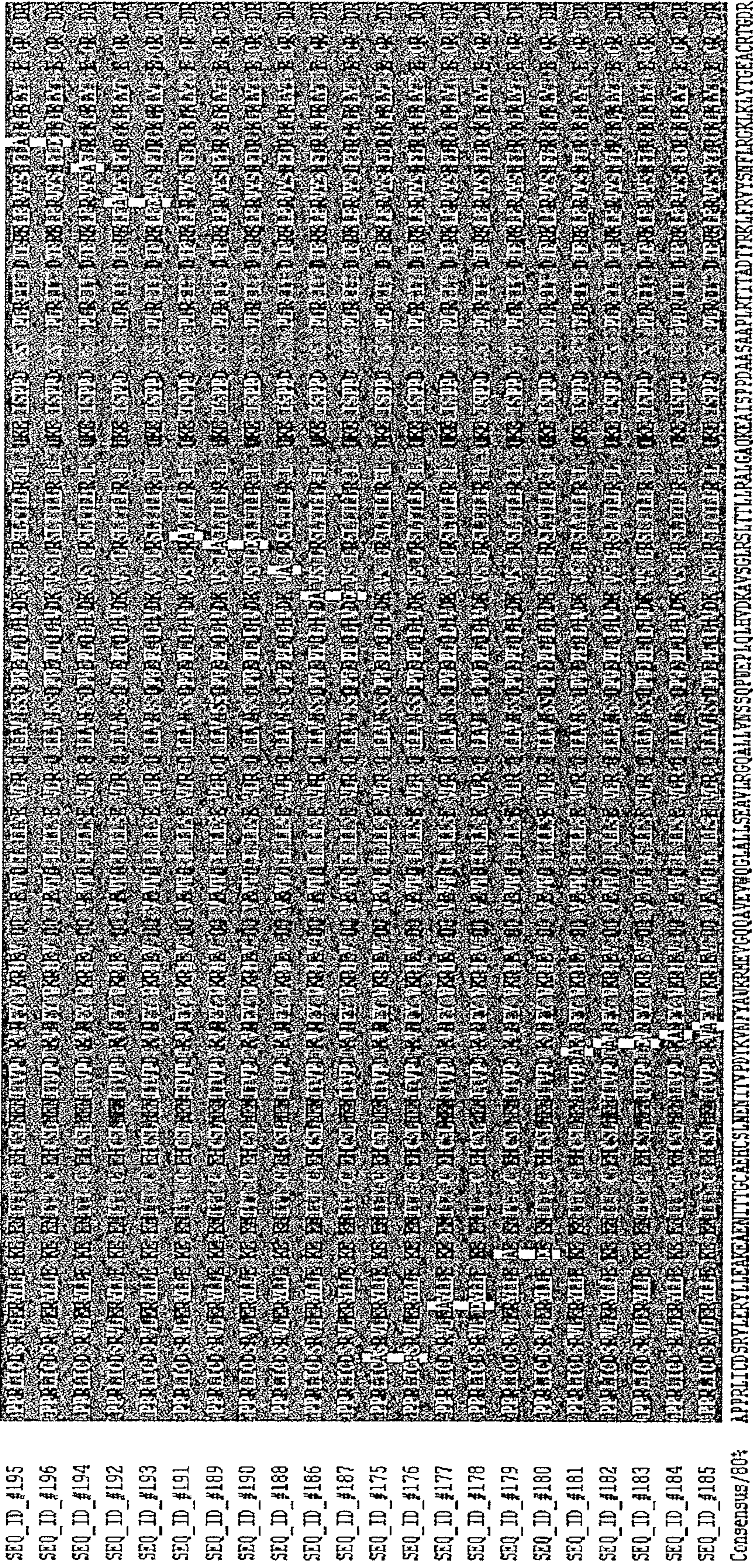
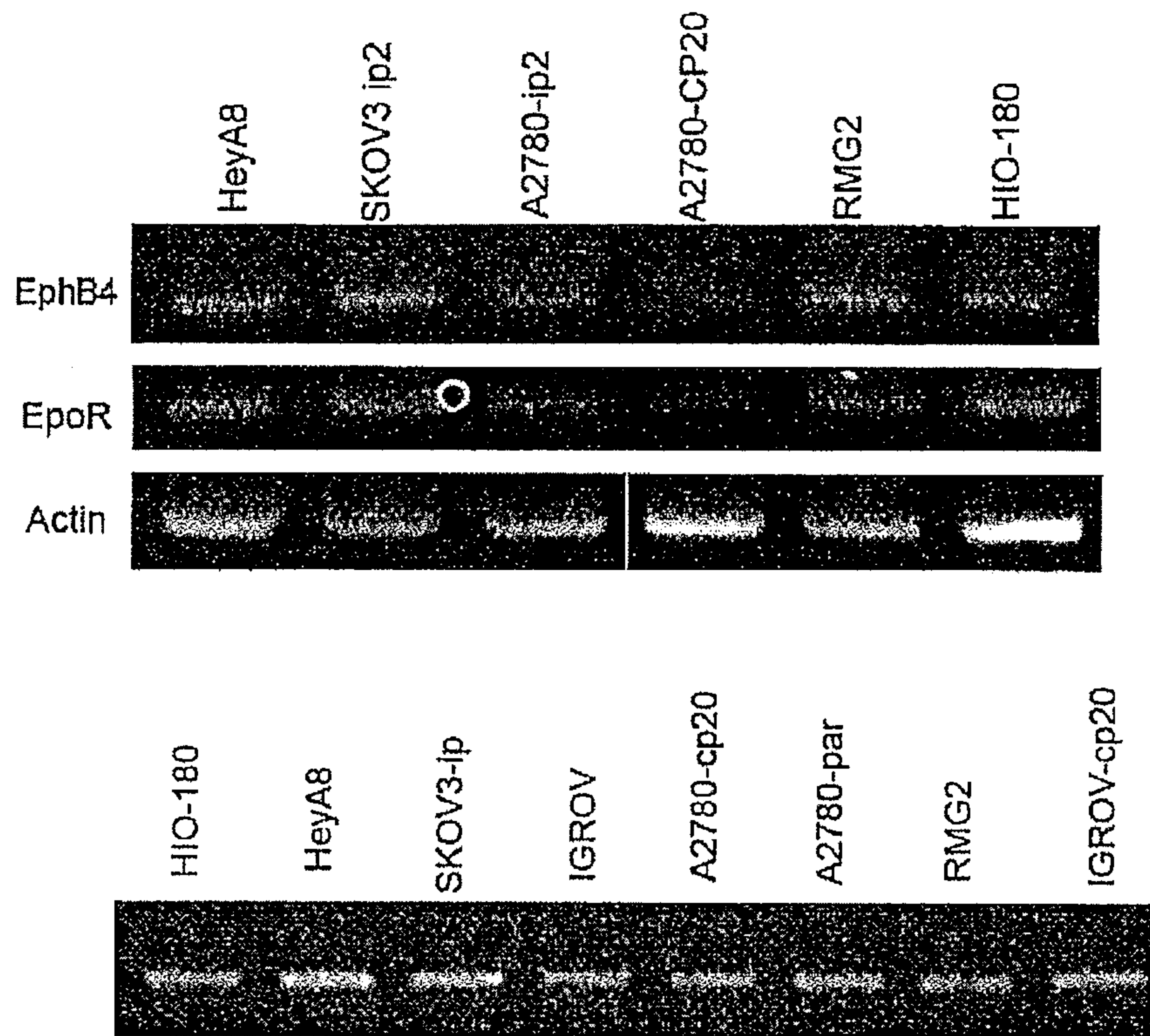


FIG. 11



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FIG. 13

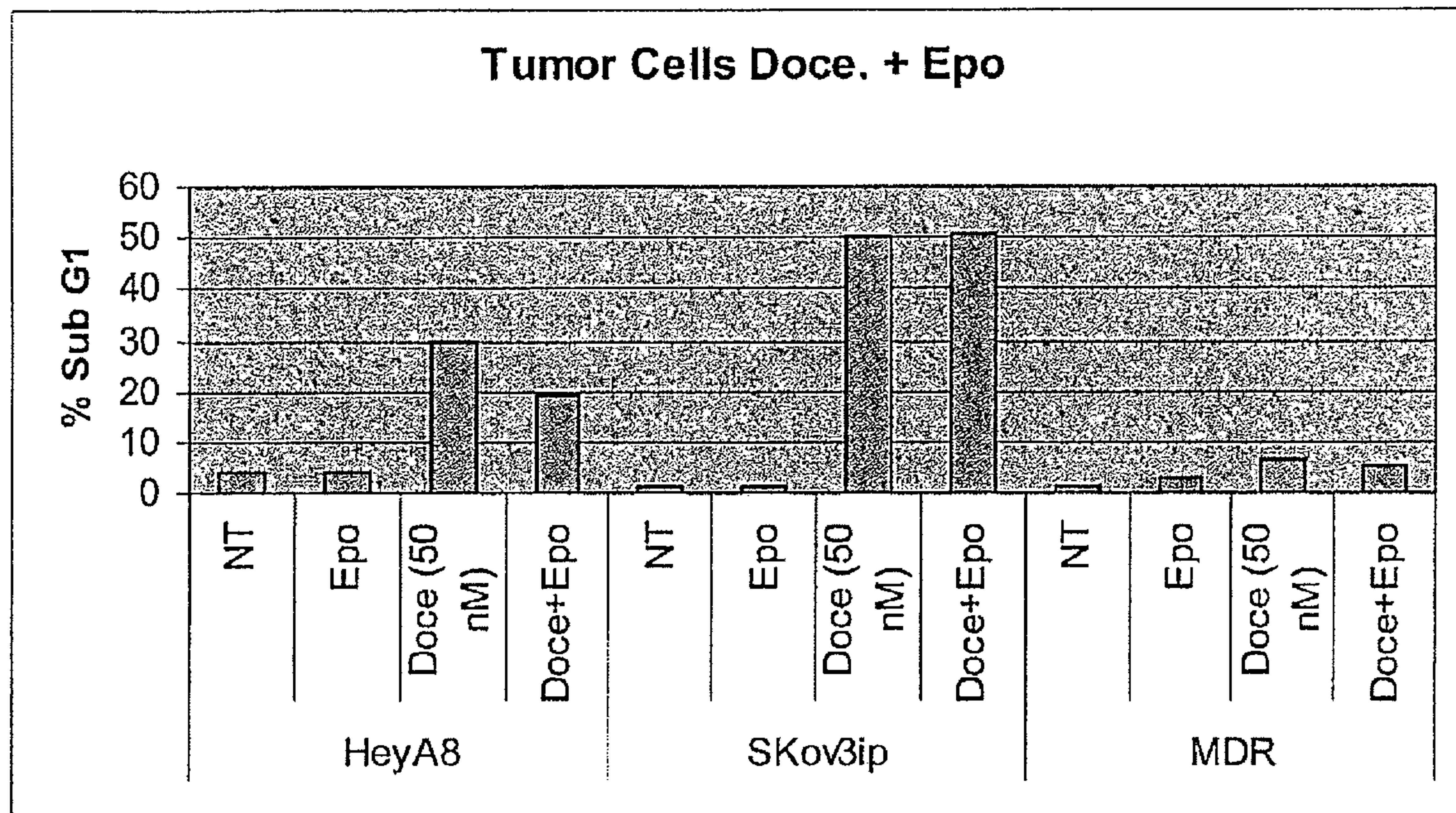
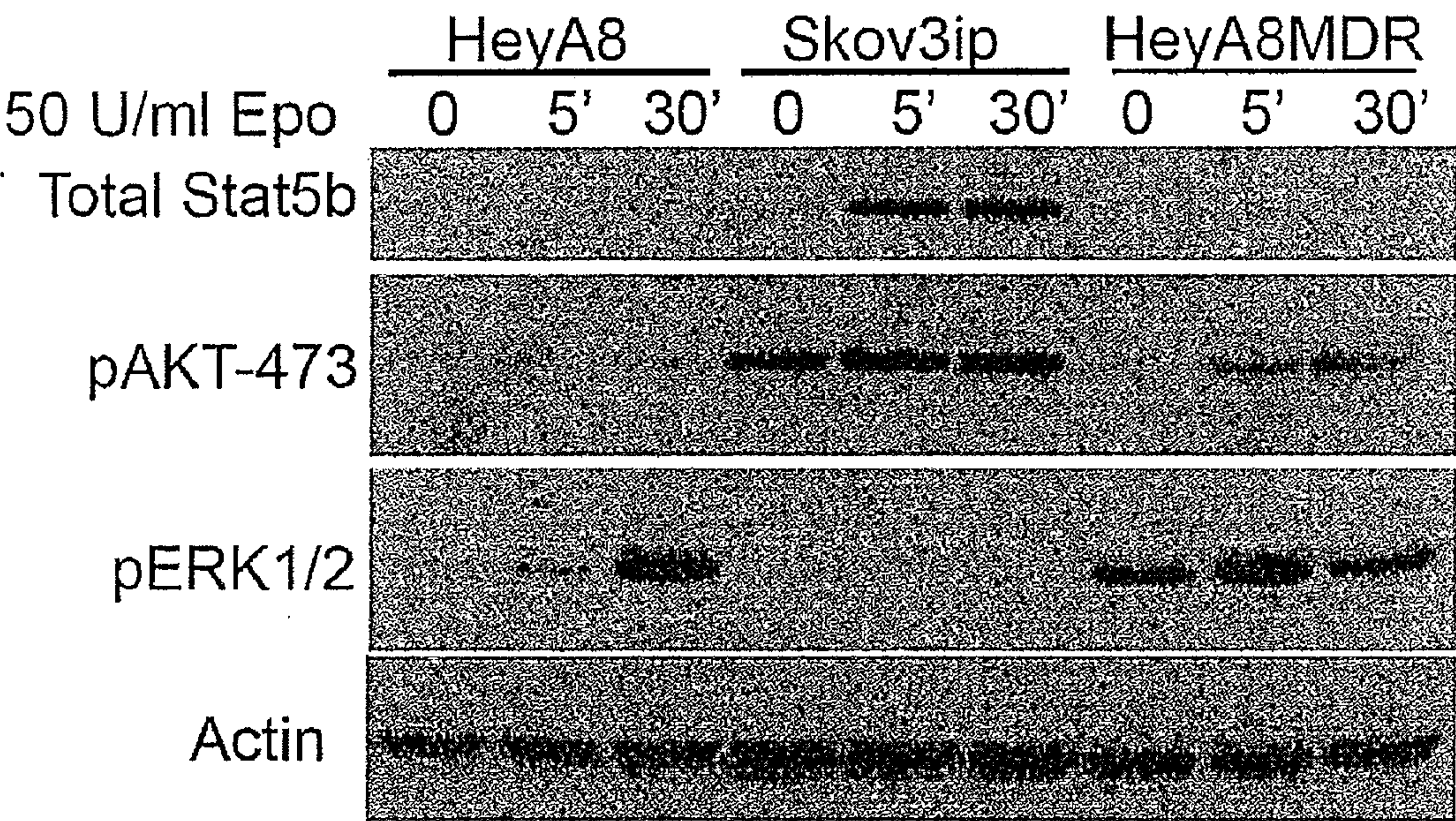
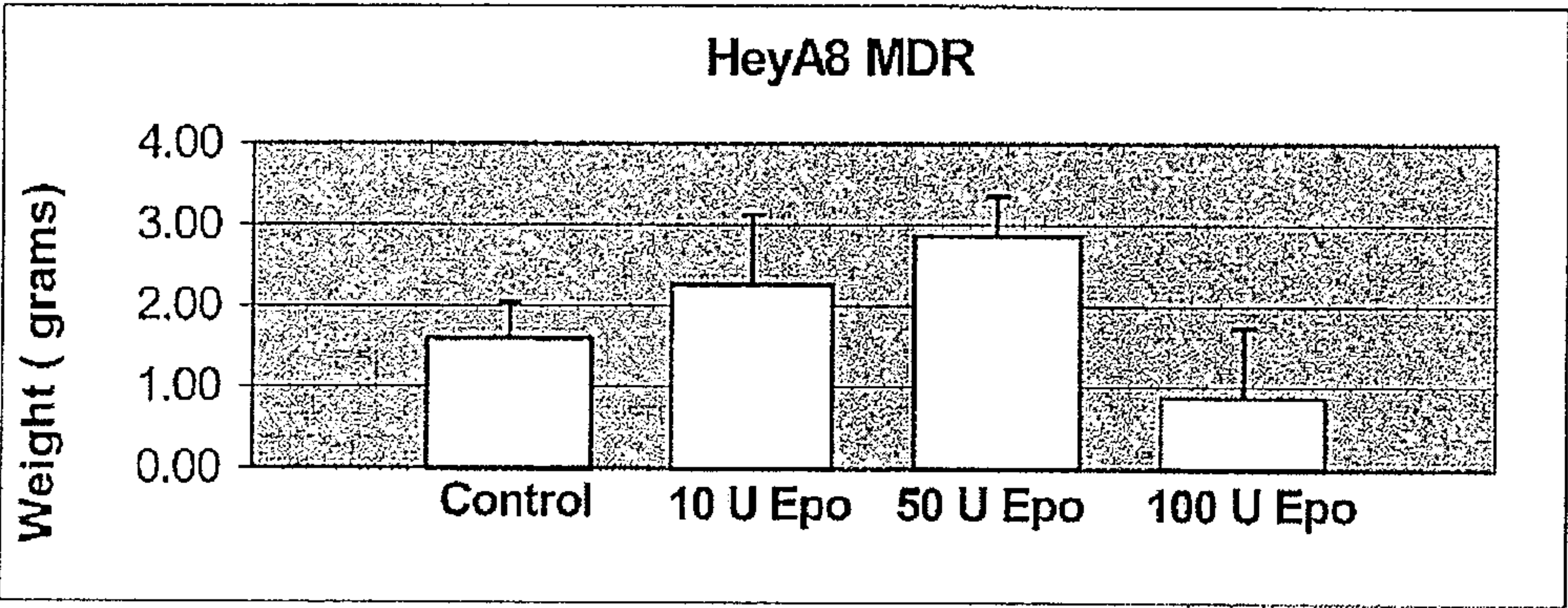


FIG. 14



Cell Line	EpoR	EphB4
Igrov	+	++
Skov3ip	0	++
HeyA8	++	0
HeyA8MDR	+++	+

FIG. 15



HeyA8-MDR
mouse tumor samples

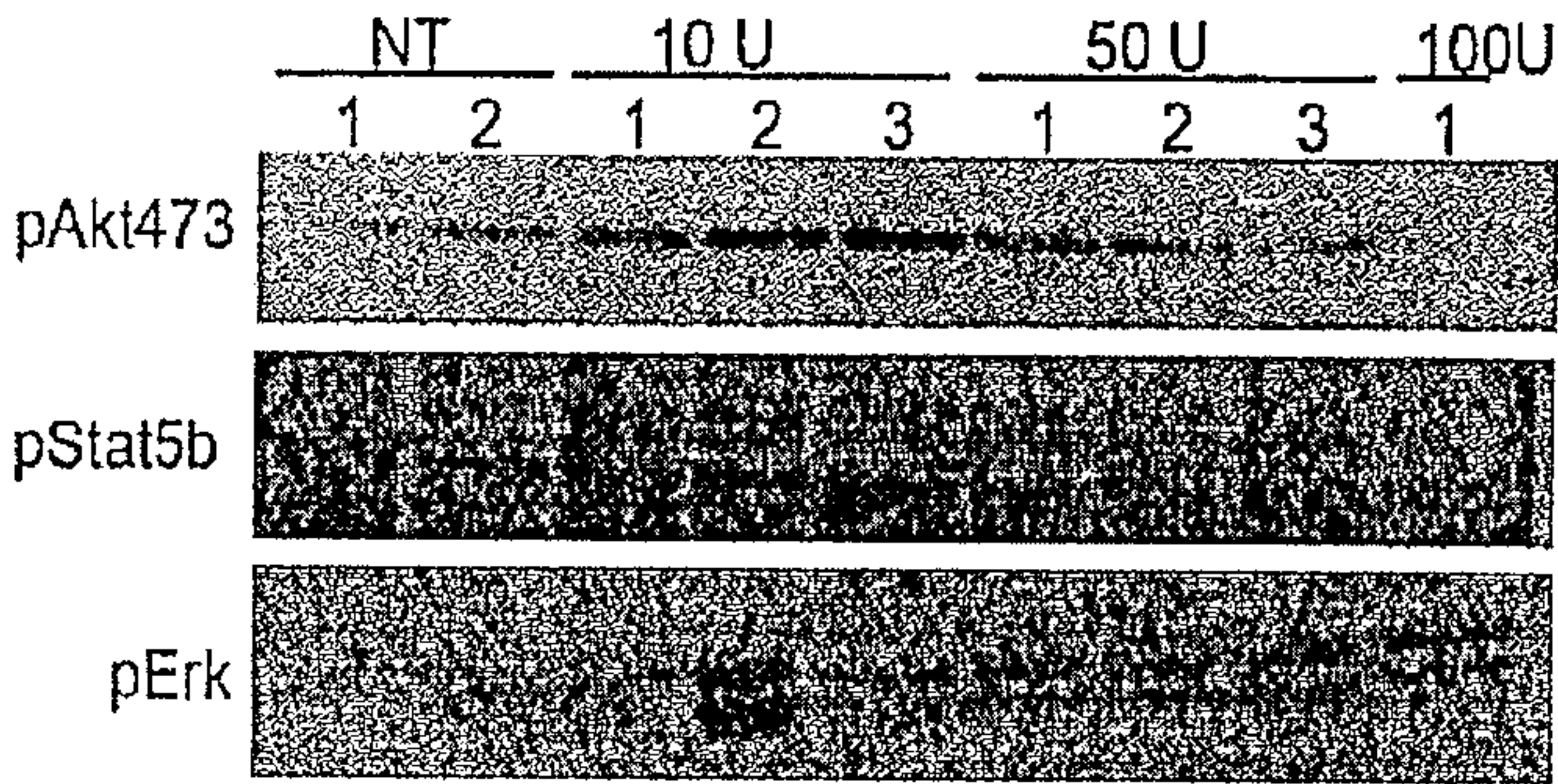
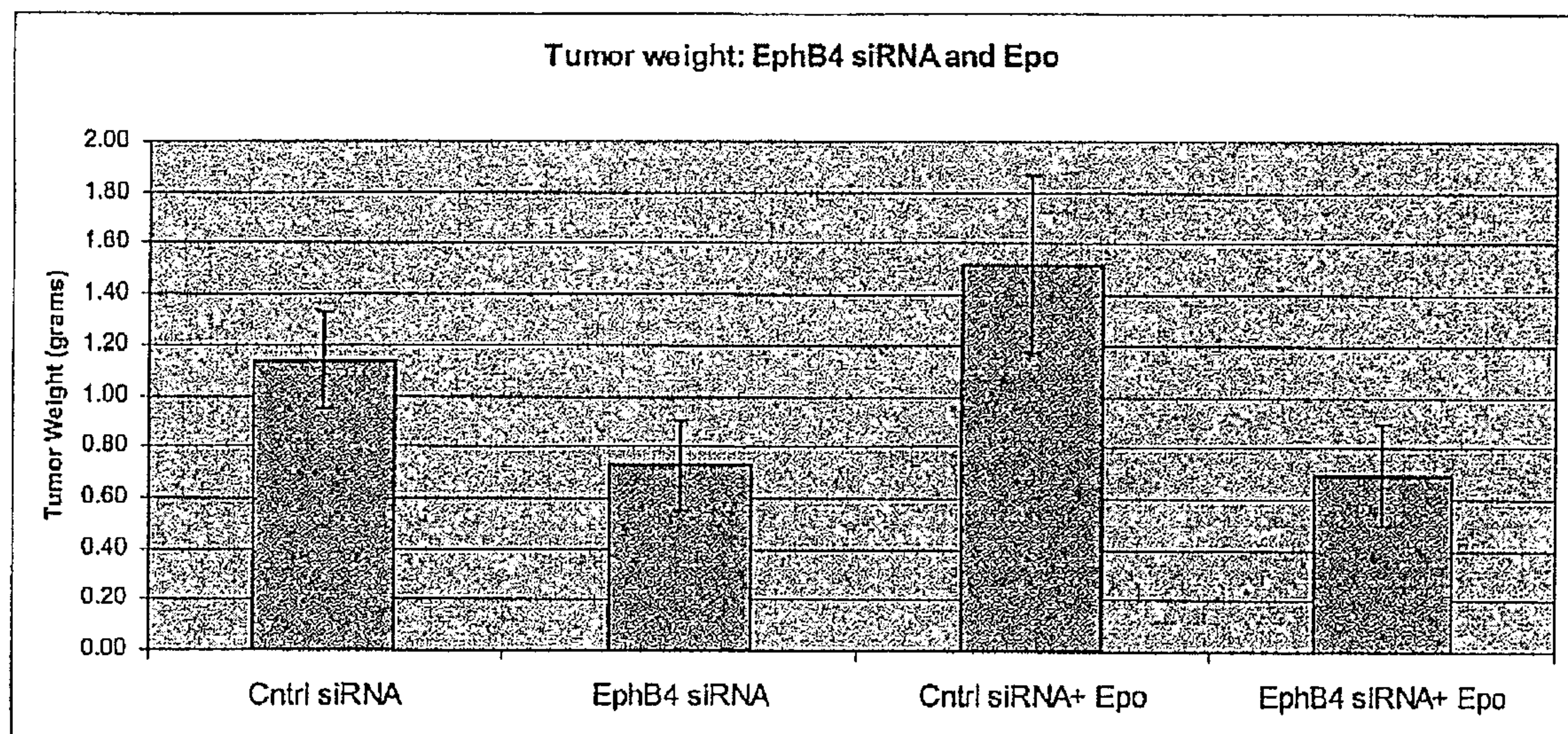


FIG. 16



percent reduction		t-test
0.360976	1 v 2	0.065056
-0.33573	1 v 3	0.024901
-1.09027	2 v 3	0.024901
-0.19542	2 v 4	0.284385
0.428102	3 v 4	0.055284
0.236098	1 v 4	0.155481

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FIG. 17

