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Yang et al.

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(54) **HIPPO PATHWAY BIOLUMINESCENT
BIOSENSOR**

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G01N 33/58 (2006.01)
C07K 14/47 (2006.01)
C07K 14/435 (2006.01)
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(52) **U.S. Cl.**

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(58) **Field of Classification Search**

CPC C12Q 1/66; C12Y 13/12013
See application file for complete search history.

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(57) **ABSTRACT**

Bioluminescent biosensors useful for monitoring and/or quantifying, in vitro or in vivo, activity of the Hippo signaling pathway. The biosensors monitor LATS kinase activity or YAP-TEAD interaction. The biosensors may be used in methods for monitoring and/or quantifying in real-time, in vitro or in vivo, activity of the Hippo signaling pathway, wherein the activity may be LATS kinase activity and/or YAP-TEAD interaction. The biosensors may be provided in kits for monitoring and/or quantifying in real-time, in vitro or in vivo, activity of the Hippo signaling pathway, wherein the activity may be LATS kinase activity and/or YAP-TEAD interaction.

14 Claims, 19 Drawing Sheets

Specification includes a Sequence Listing.

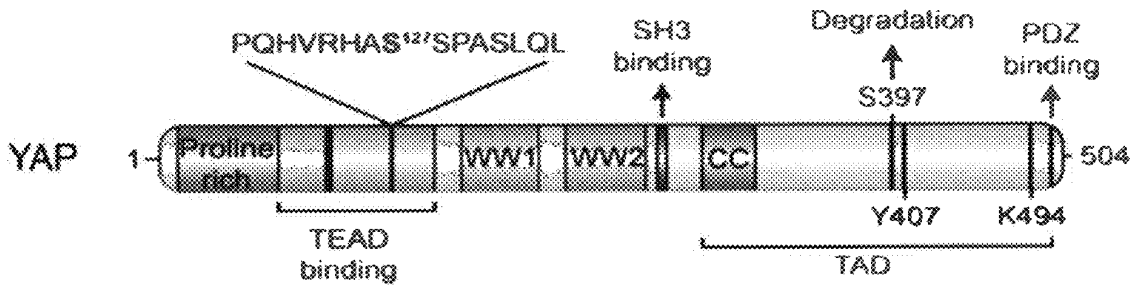


Fig. 1A

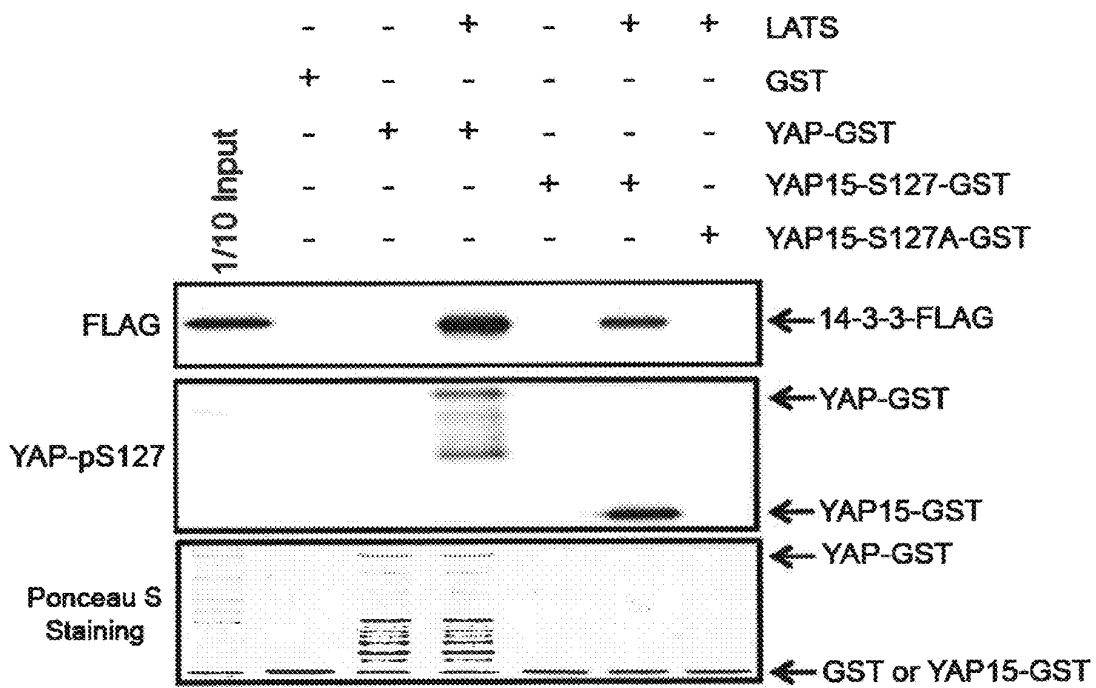


Fig. 1B

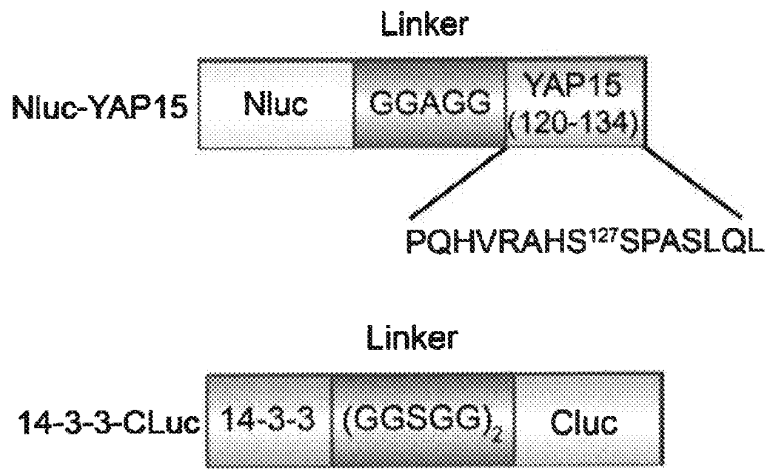


Fig. 2A

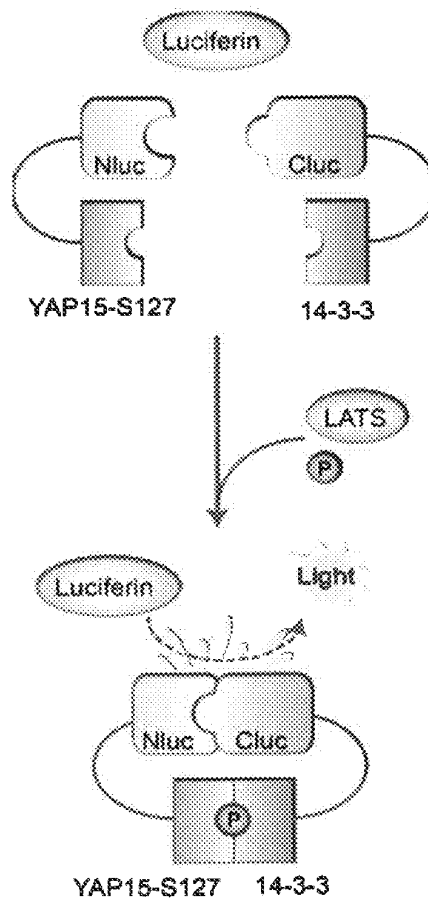


Fig. 2B

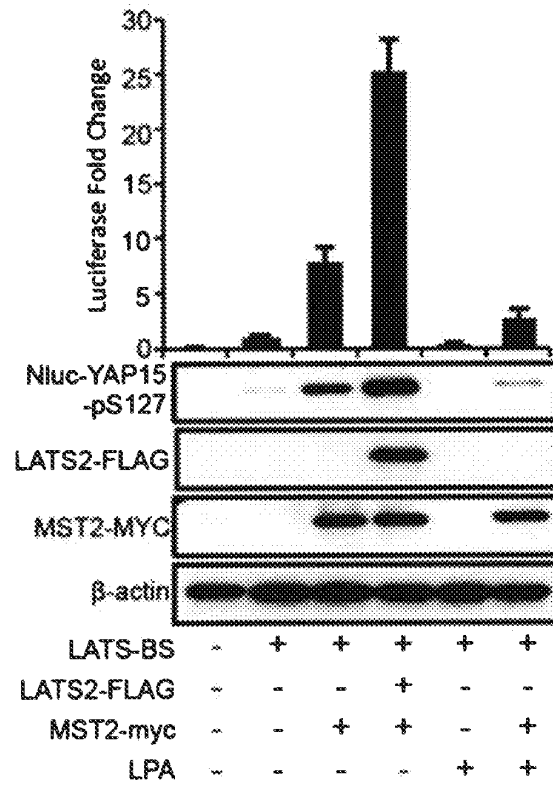


Fig. 2C

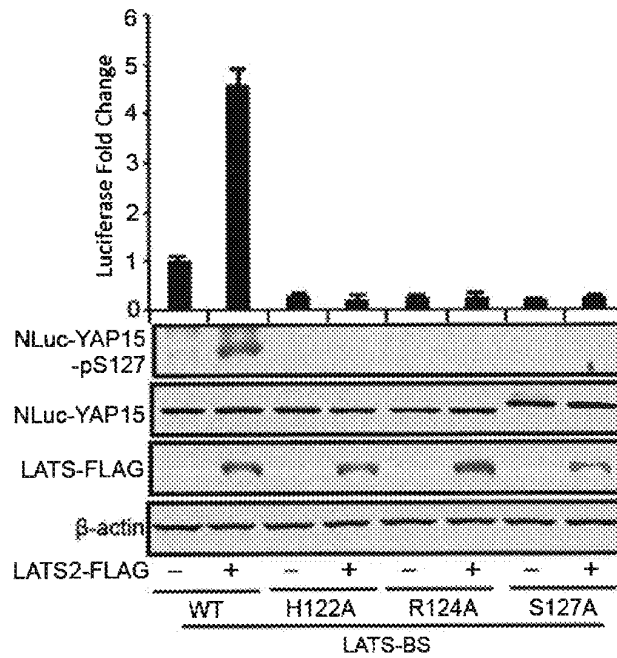


Fig. 2D

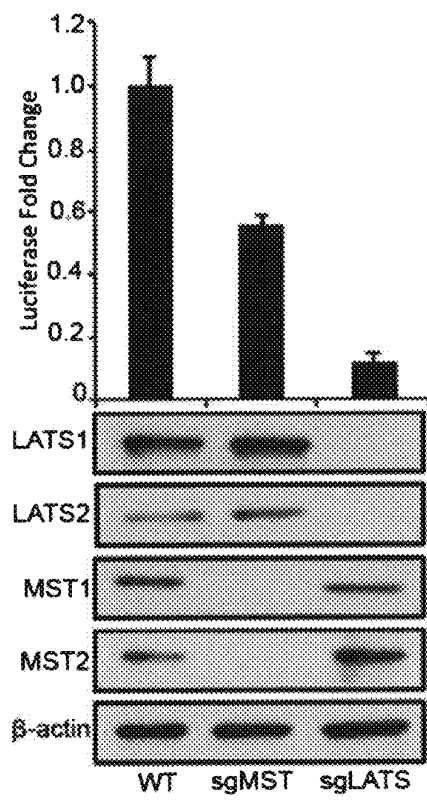


Fig. 2E

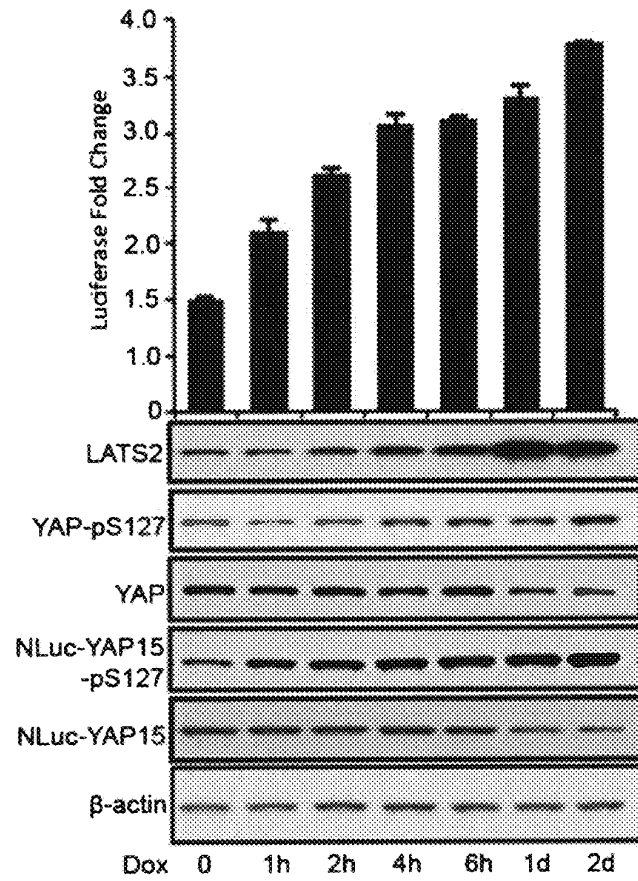


Fig. 2F

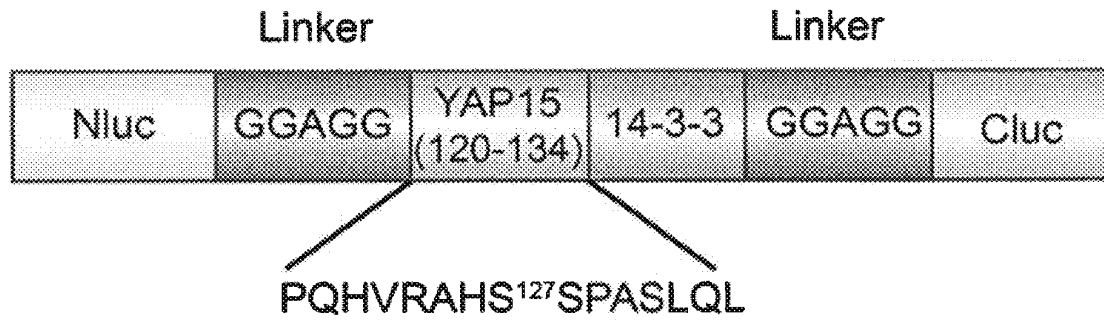


Fig. 3A

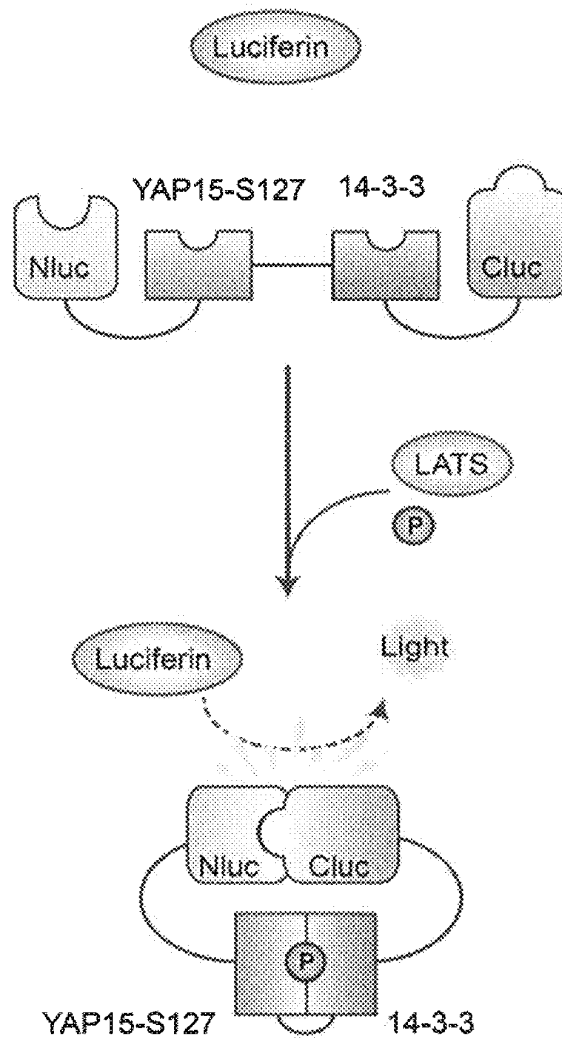


Fig. 3B

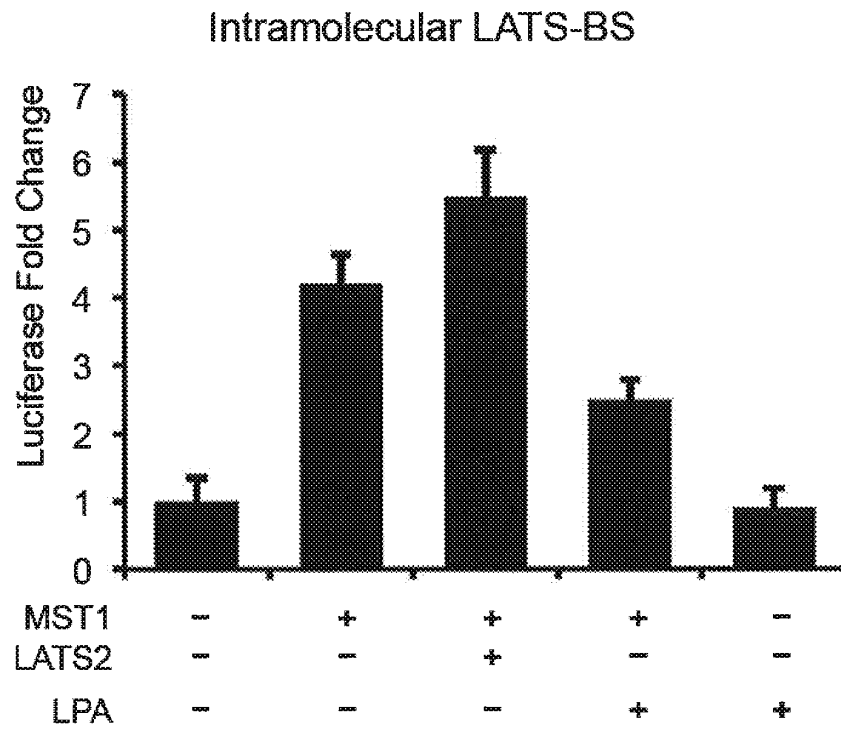


Fig. 3C

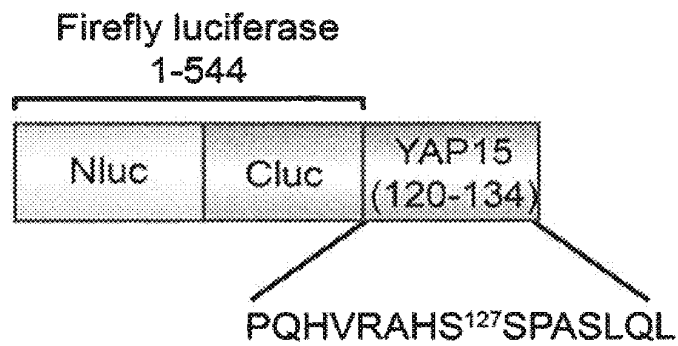


Fig. 4A

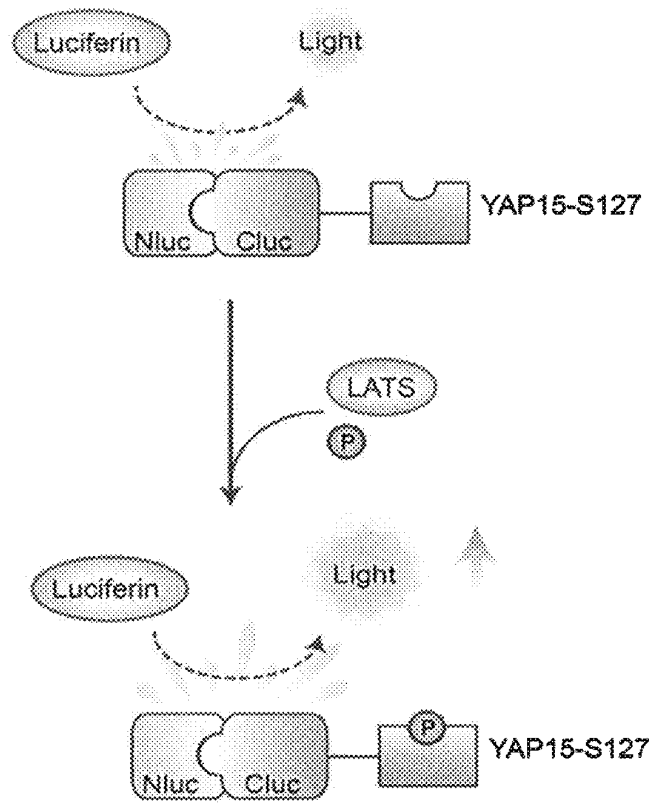


Fig. 4B

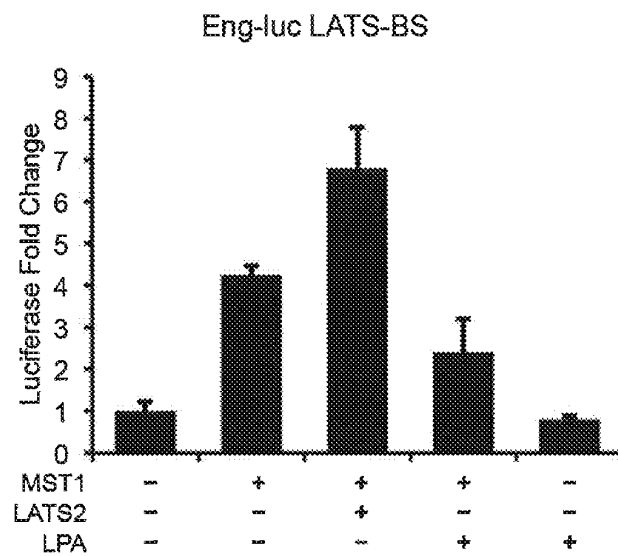


Fig. 4C

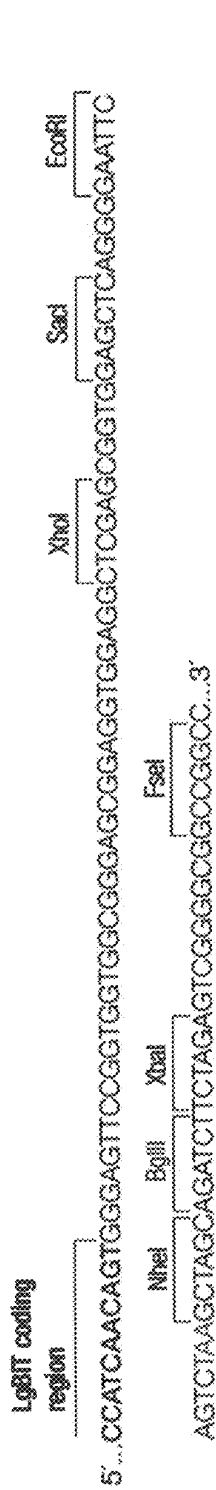


Fig. 5A

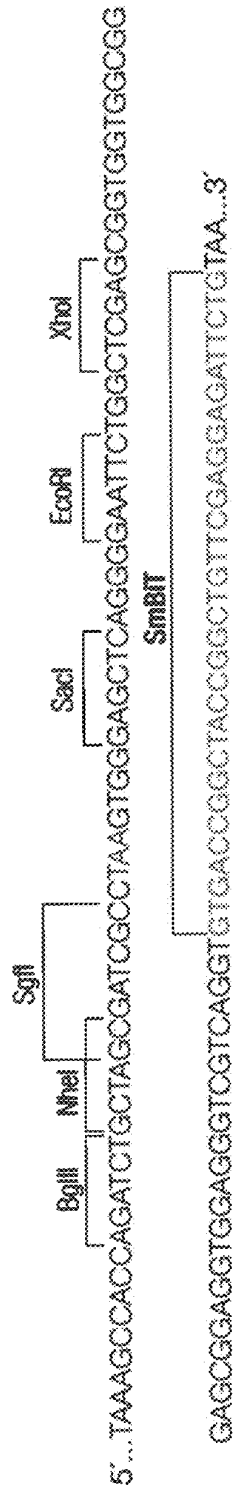


Fig. 5B

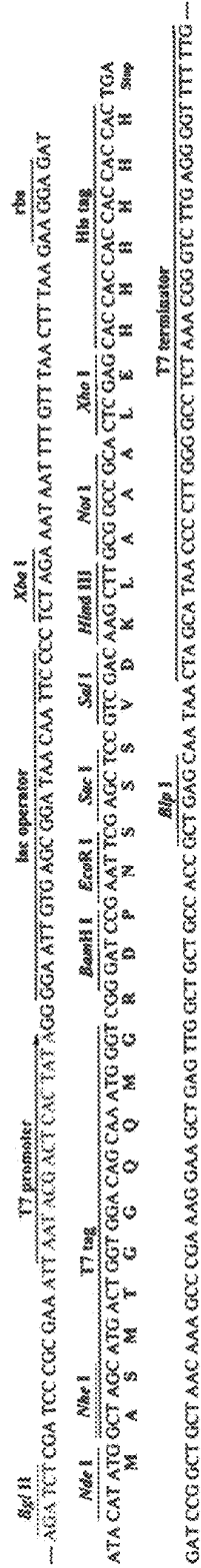


Fig. 5C

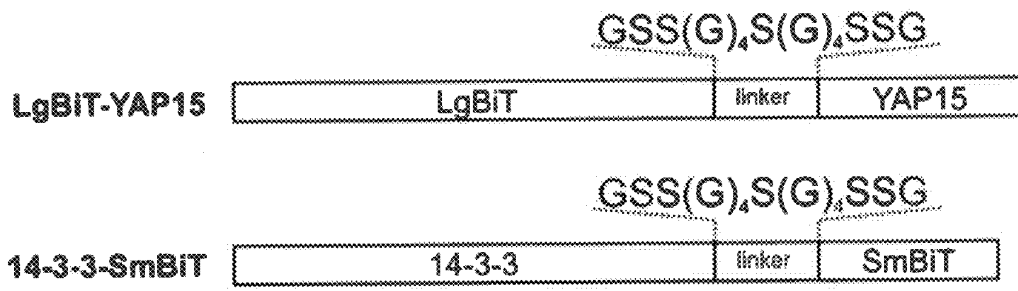


Fig. 5D

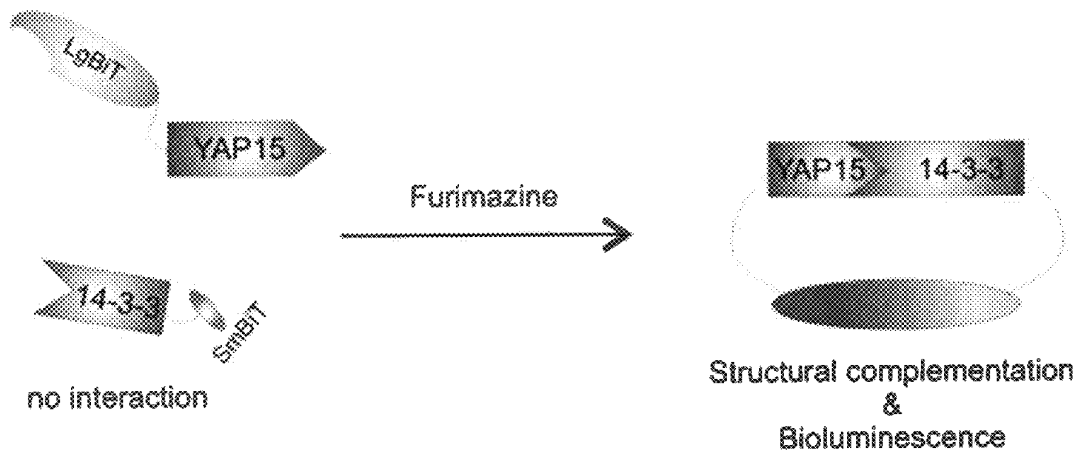


Fig. 6

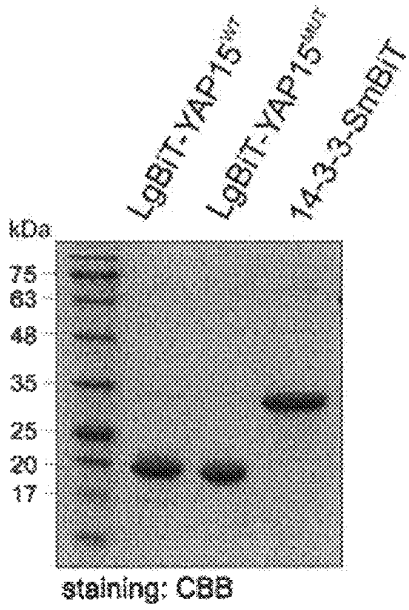


Fig. 7

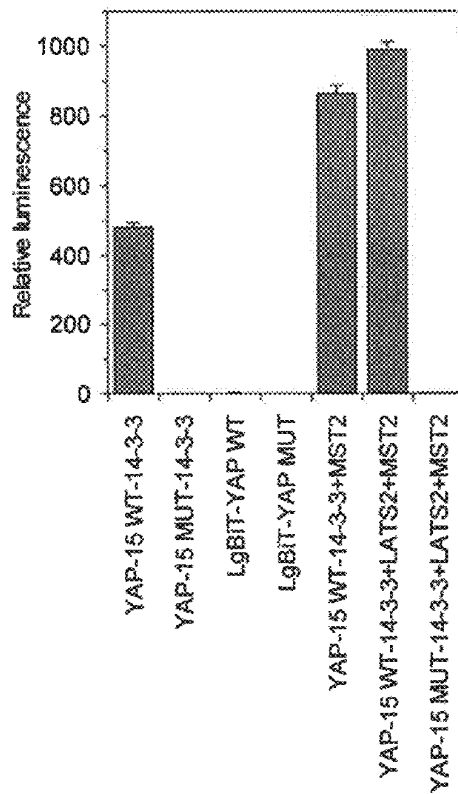


Fig. 8A

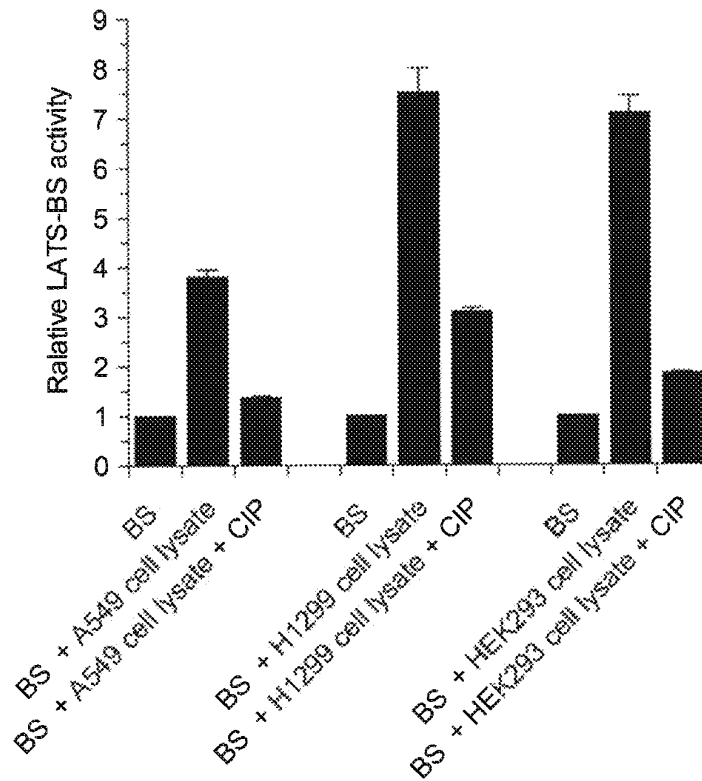


Fig. 8B

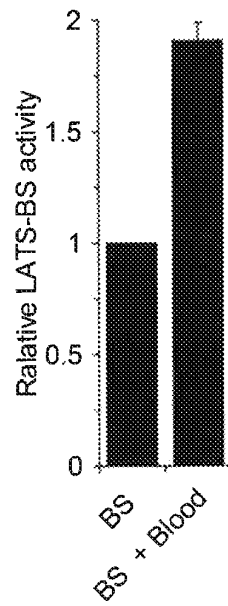


Fig. 8C

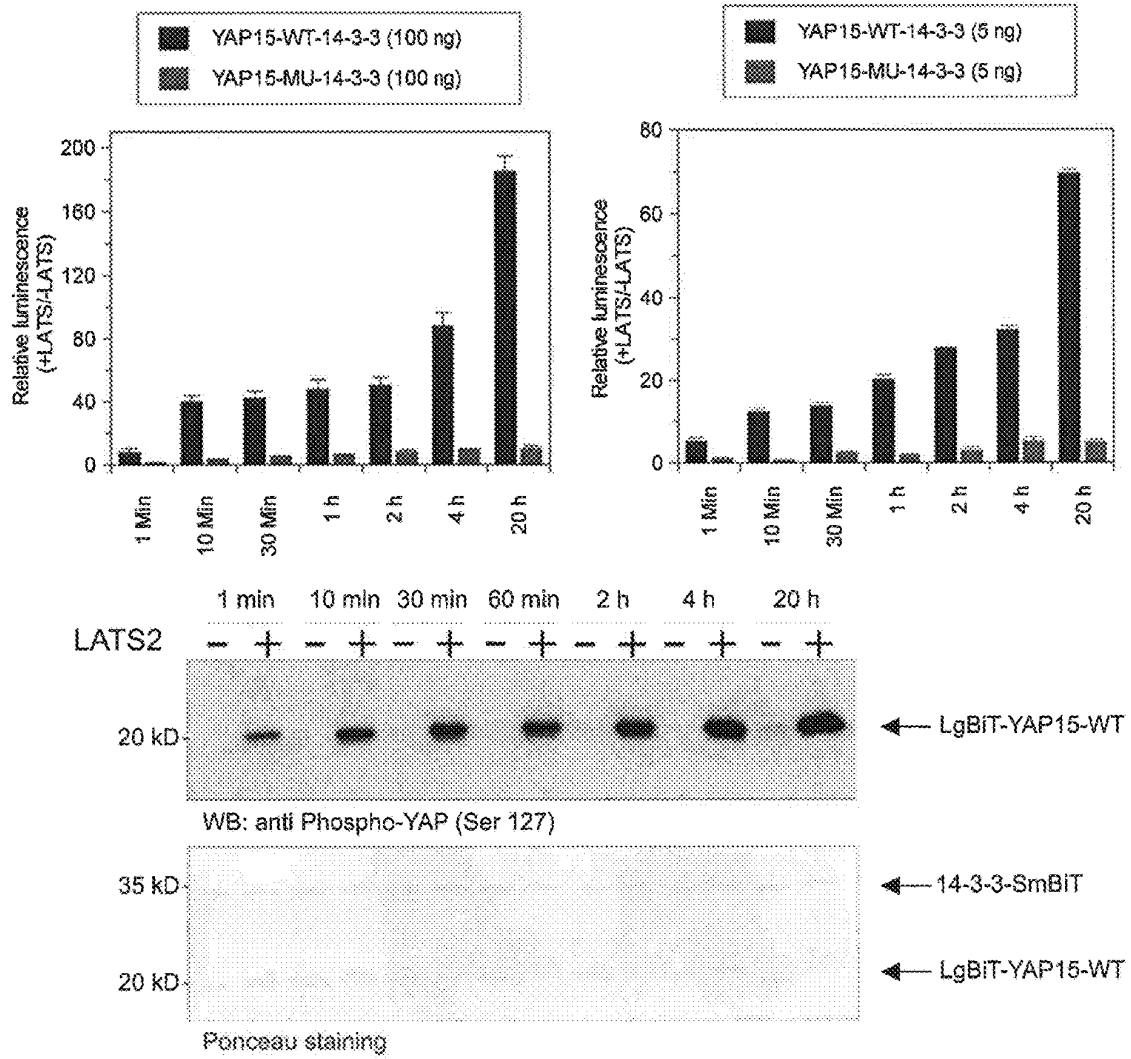


Fig. 9

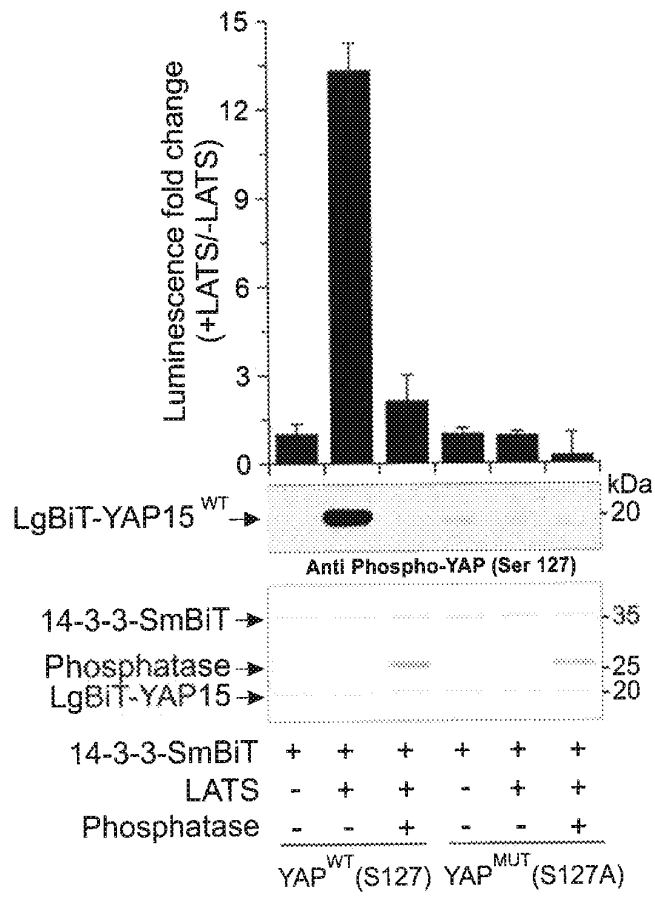


Fig. 10

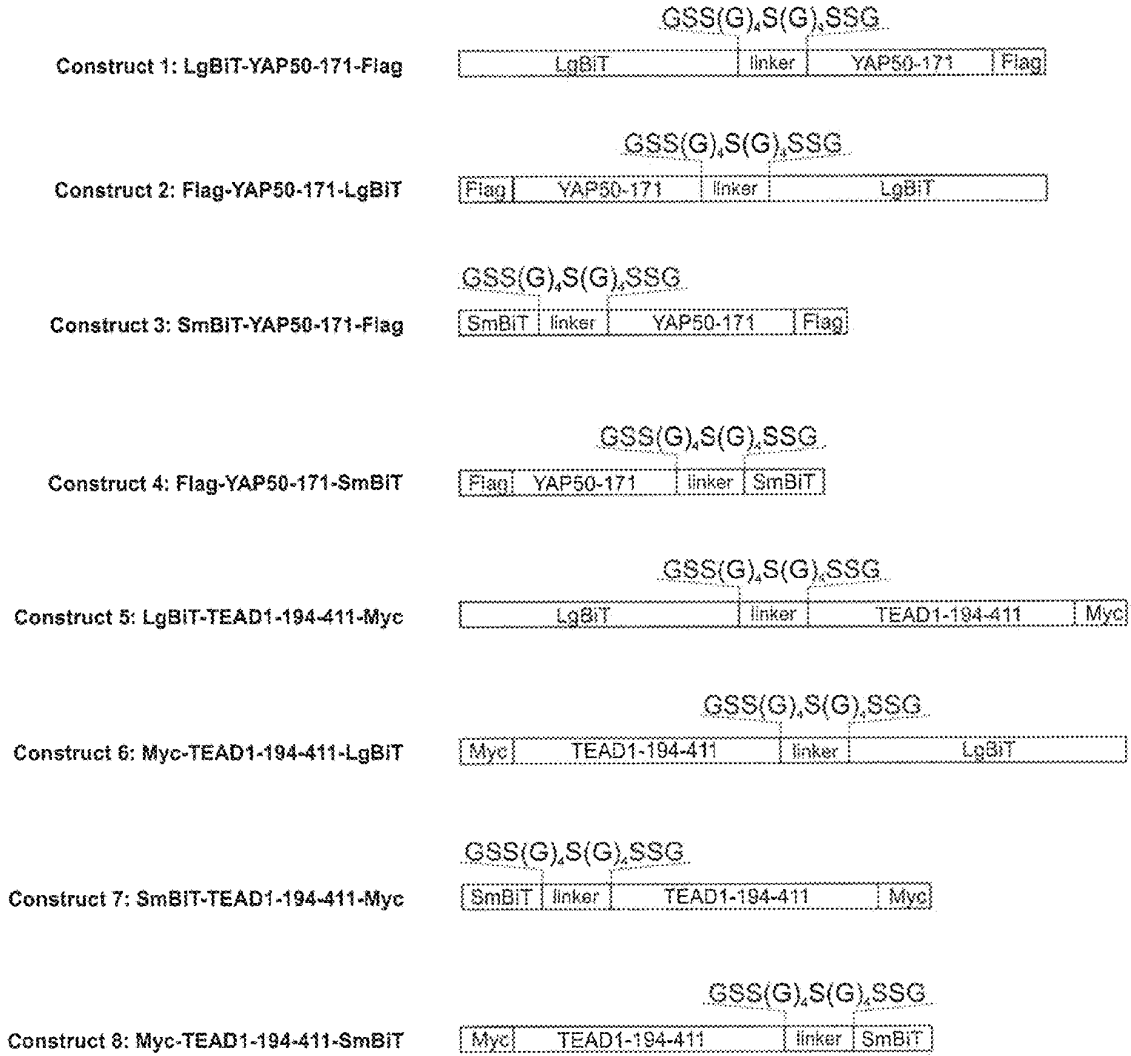


Fig. 11

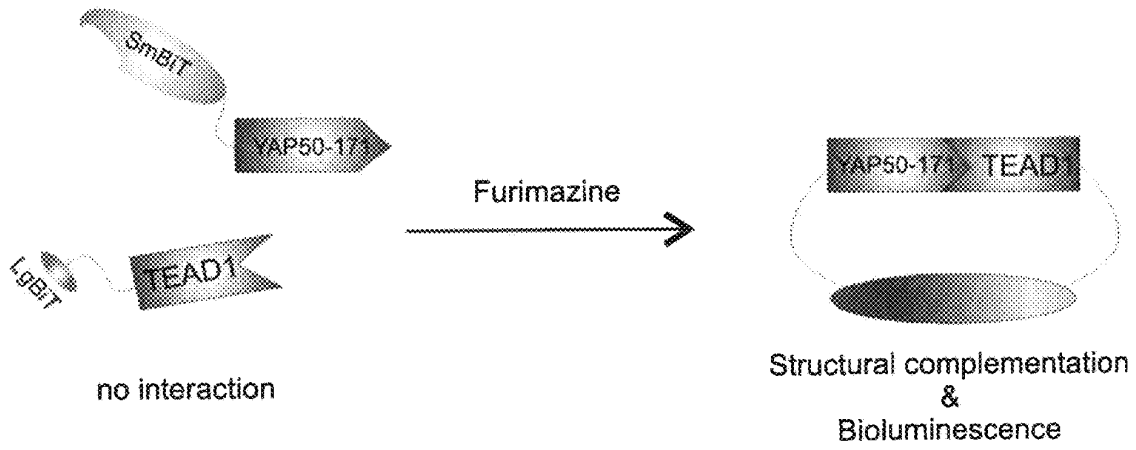


Fig. 12

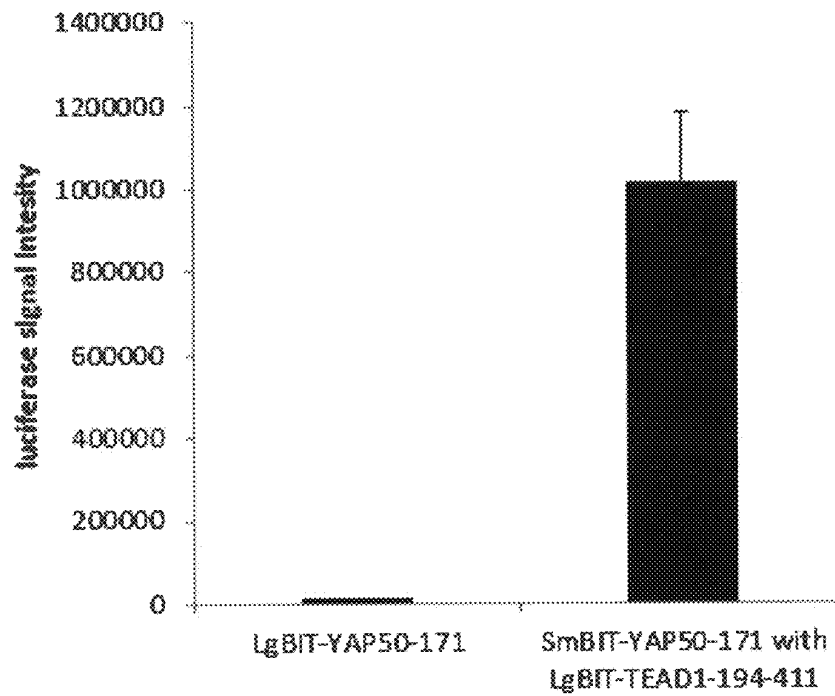


Fig. 13

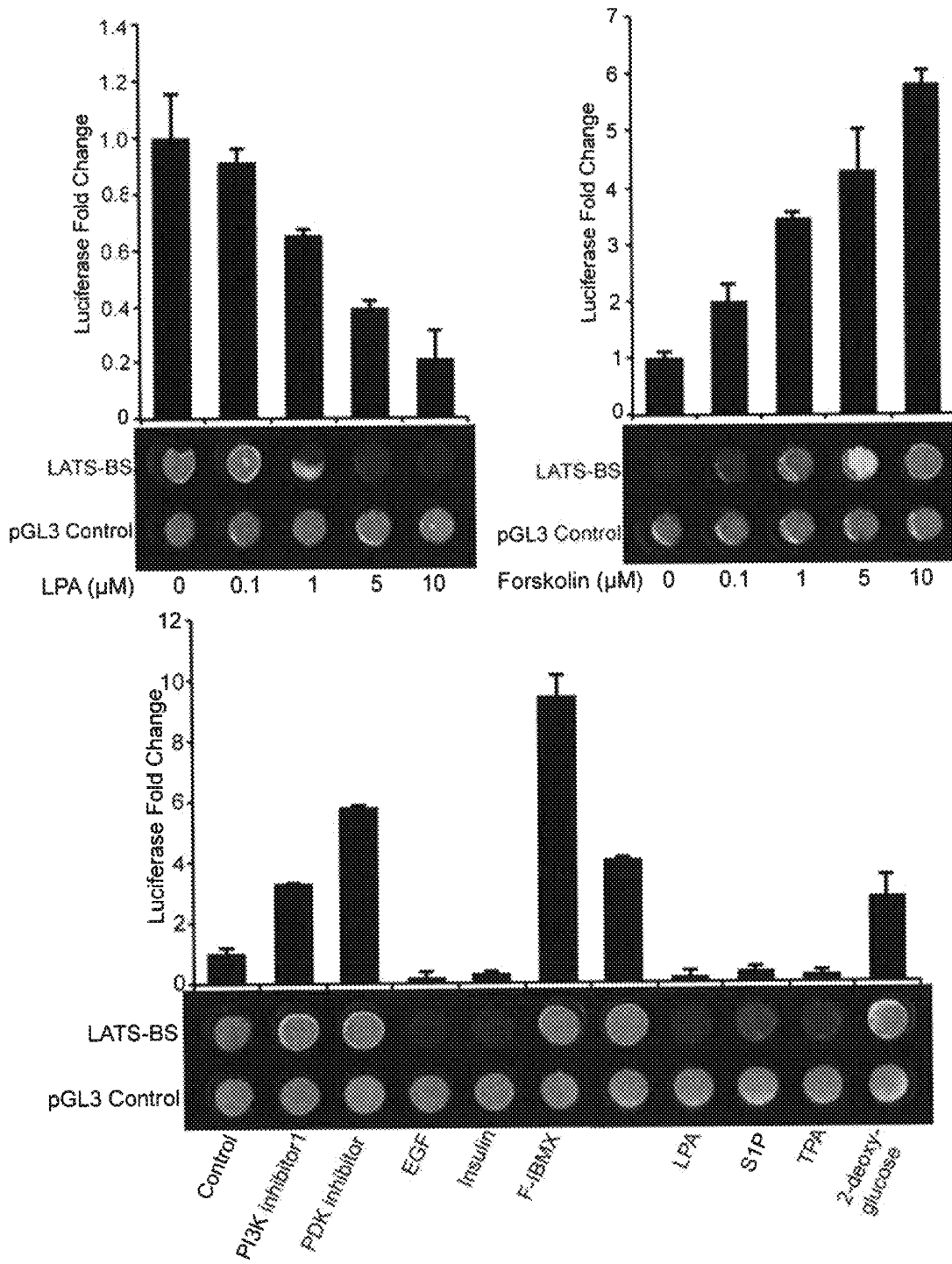


Fig. 14

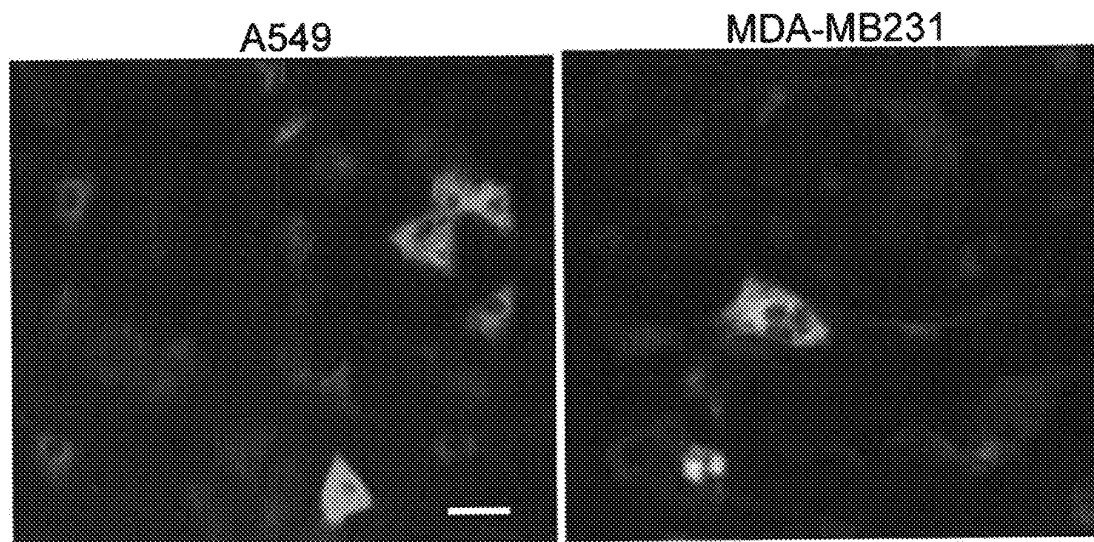


Fig. 15

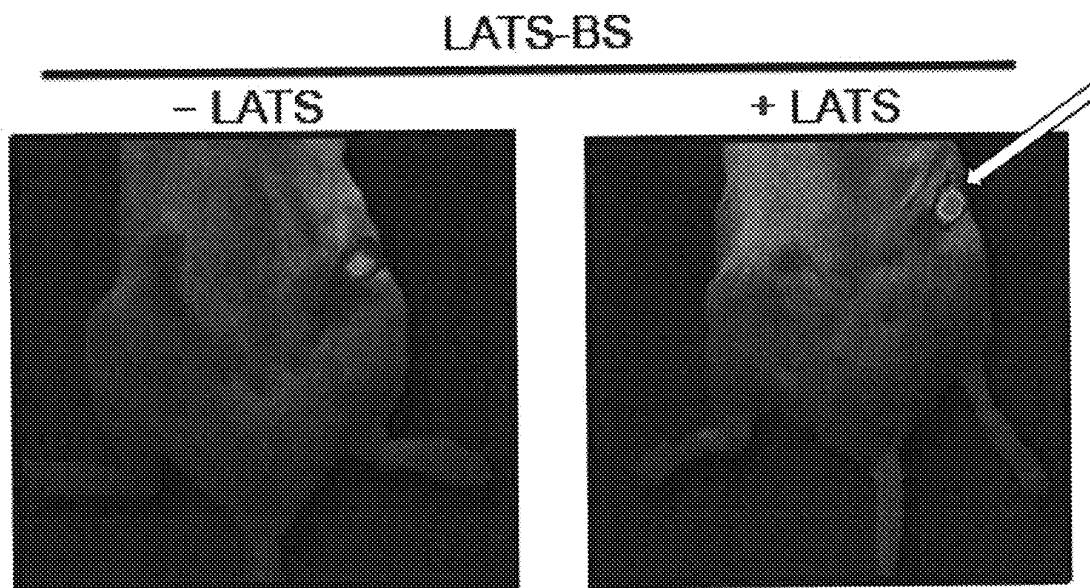


Fig. 16

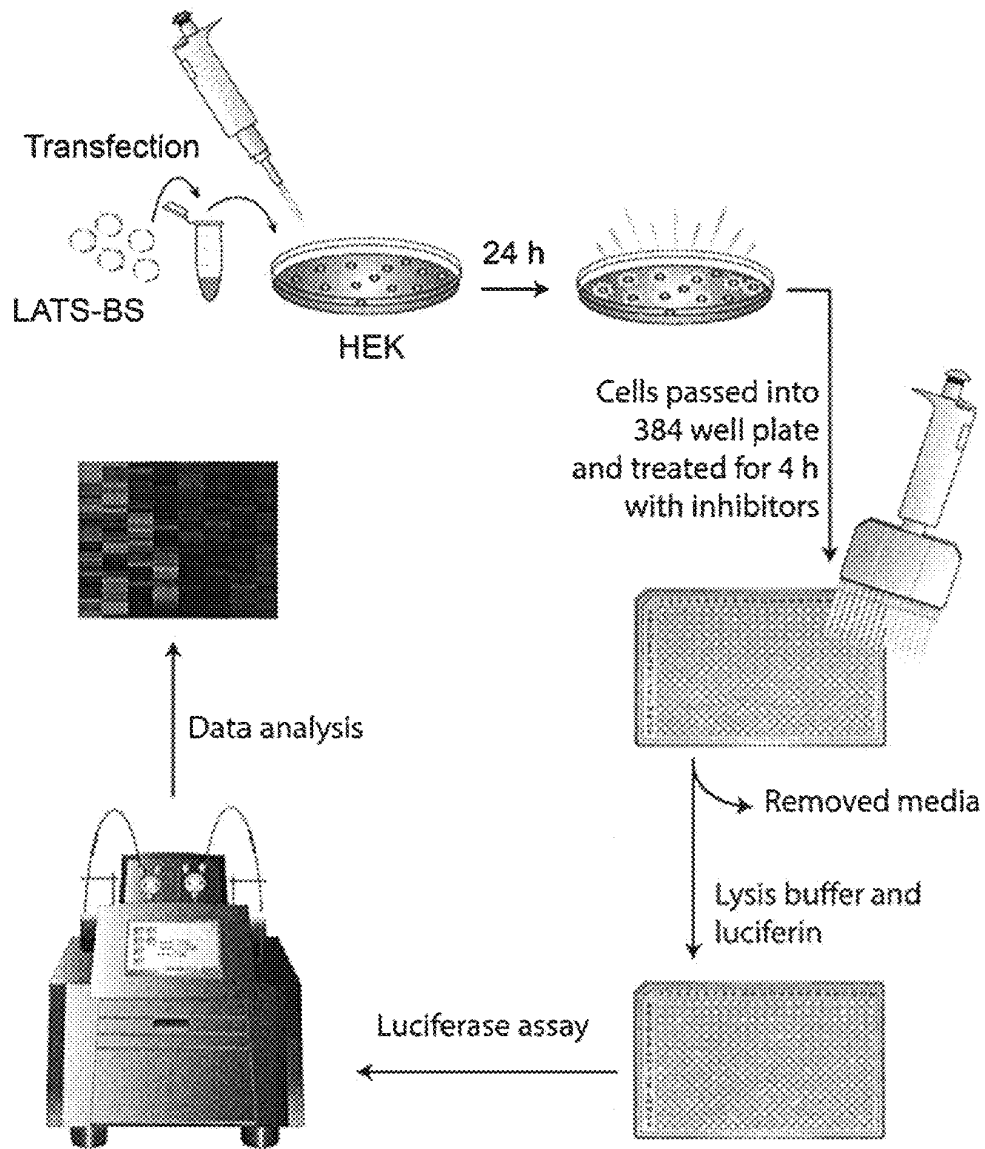


Fig. 17A

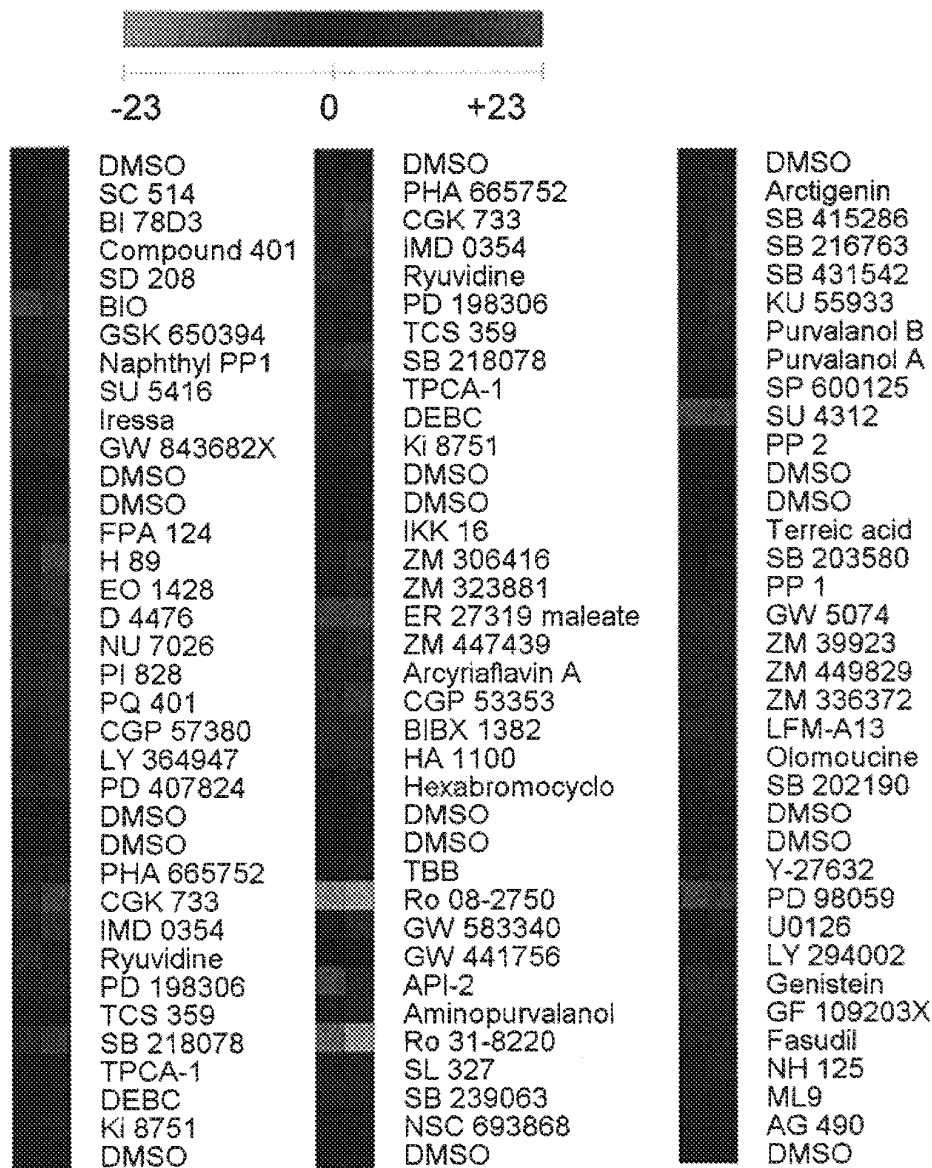


Fig. 17B

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HIPPO PATHWAY BIOLUMINESCENT BIOSENSOR

REFERENCE TO AN ELECTRONIC SEQUENCE LISTING

The contents of the electronic sequence listing (16177691sequencelistingST25-2.txt; size: 180 kB; date of creation: Aug. 19, 2022) is herein incorporated by reference in its entirety.

RELATED APPLICATION

This application claims the benefit of the filing date of Application No. 62/580,186, filed Nov. 1, 2017, the contents of which are incorporated herein by reference in their entirety.

FIELD

This invention relates to bioluminescent biosensors for non-invasively monitoring and/or quantifying in real-time, in vitro or in vivo, activity of the Hippo signaling pathway.

BACKGROUND

Detailed understanding of biochemical pathways will elucidate signaling mechanisms in physiological and pathological processes, yielding insight into approaches for controlling, treating, and preventing many diseases. The ability to gain such insight is severely limited by the complexity of such pathways and the difficulty in monitoring the activity of key components once identified.

The Hippo pathway is a signaling cascade that plays important roles in development (e.g., organ size control, 3D body shape, and early embryo development), cancer (tumorigenesis, metastasis, drug resistance, and immune evasion), regeneration medicine (stem cell renewal and differentiation and tissue homeostasis/regeneration), heart development and disease (cardiomyocyte proliferation and heart infarction/cardiac injury) and in the neuronal system (neural fate and dendrite tiling)¹⁻⁹. Dysregulation of the Hippo pathway is frequently observed in human cancers. When Hippo signaling is activated by upstream regulators, MST1/2 serine/threonine (S/T) kinases (mammalian homologs of *Drosophila* Hippo) phosphorylate/activate LATS1/2 kinases which subsequently phosphorylate/inactivate their downstream effectors, transcriptional co-activator Yes-associated protein (YAP) and its paralog transcriptional co-activator with PDZ-binding motif (TAZ). S127-phosphorylated YAP (YAP-pS127) or S89-phosphorylated TAZ (TAZ-pS89) bind to cytoplasmic protein 14-3-3 and are prevented from binding to transcription factor TEAD to trans-activate downstream gene targets in the nucleus (e.g., CTGF, CYR61, FGF1, etc.)¹⁰⁻¹⁴. Although a few regulatory factors of the Hippo pathway have been uncovered (actin dynamics, cell matrix stiffness, cell-cell contact, and lysophosphatidic acid (LPA)^{3, 6}, comprehensive regulator screens have been technically limited. An absence of available tools precludes measuring the dynamics and activity of the Hippo pathway core components in a quantitative, high-throughput and non-invasive manner.

SUMMARY

One aspect of the invention relates to a luminescent biosensor, comprising: one or more fragments of firefly or

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NanoBiT luciferase or a functional equivalent thereof; at least one fragment of human YAP or a functional equivalent thereof; and at least one vector.

In one embodiment, the biosensor comprises: a first construct comprising an N-terminal luciferase fragment (Nluc) or a functional equivalent thereof fused to the at least one YAP fragment; a second construct comprising a C-terminal luciferase fragment (Cluc) or a functional equivalent thereof fused to human cytoplasmic 14-3-3 protein or a functional equivalent thereof; wherein the first construct and the second construct are on separate vectors; wherein LATS-dependent phosphorylation of the at least one YAP fragment leads to binding with the human cytoplasmic 14-3-3 protein, which results in binding of Nluc and Cluc to produce luminescence.

In one embodiment, the biosensor comprises Nluc luciferase amino acids 1-416 of SEQ ID NO:6 or a functional equivalent thereof; Cluc luciferase amino acids 394-550 of SEQ ID NO:6 or a functional equivalent thereof; and YAP fragment including 15 amino acids (residues 120-134; SEQ ID NO:7) or a functional equivalent thereof.

In one embodiment, the biosensor comprises a single construct including: an N-terminal luciferase fragment (Nluc) or a functional equivalent thereof fused to the at least one YAP fragment; and a C-terminal luciferase fragment (Cluc) or a functional equivalent thereof fused to human cytoplasmic 14-3-3 protein; wherein LATS-dependent phosphorylation of the at least one YAP fragment leads to a conformational change and binding of Nluc and Cluc to produce luminescence.

In one embodiment, the biosensor comprises Nluc luciferase amino acids 1-416 of SEQ ID NO:6 or a functional equivalent thereof; Cluc luciferase amino acids 394-550 of SEQ ID NO:6 or a functional equivalent thereof; and YAP fragment including 15 amino acids (residues 120-134; SEQ ID NO:7) or a functional equivalent thereof.

In one embodiment, the biosensor comprises a single construct including a luciferase engineered at the C-terminal fused to the one or more YAP fragment; wherein LATS-dependent phosphorylation of the one or more YAP fragment modulates luciferase activity to increase luminescence. In one embodiment, the luciferase is engineered at the C-terminal consisting of amino acids 1-544 (SEQ ID NO:6) or a functional equivalent thereof.

In one embodiment, the biosensor comprises a first construct comprising a LgBiT luciferase fragment or a functional equivalent thereof fused to the at least one YAP fragment or a functional equivalent thereof a second construct comprising a SmBiT luciferase fragment or a functional equivalent thereof fused to human cytoplasmic 14-3-3 protein or a functional equivalent thereof; wherein the first construct and the second construct are on separate vectors; wherein binding of the at least one YAP fragment with the human cytoplasmic 14-3-3 protein and leads to binding of LgBiT and SmBiT to produce luminescence. In one embodiment, the biosensor comprises YAP fragment including 15 amino acids (residues 120-134; SEQ ID NO:7) or a functional equivalent thereof.

In one embodiment, the biosensor comprises: a first construct comprising a LgBiT luciferase fragment or a functional equivalent thereof fused to the at least one YAP fragment or a functional equivalent thereof; a second construct comprising a SmBiT luciferase fragment or a functional equivalent thereof fused to a TEAD fragment or a functional equivalent thereof, or a first construct comprising a LgBiT luciferase fragment or a functional equivalent thereof fused to a TEAD fragment or a functional equivalent

thereof; a second construct comprising a SmBiT luciferase fragment or a functional equivalent thereof fused to the at least one YAP fragment or a functional equivalent thereof; wherein the first construct and the second construct are on separate vectors; wherein interaction of the at least one YAP fragment with the TEAD fragment leads to binding of LgBiT and SmBiT to produce luminescence.

In one embodiment, the biosensor comprises: YAP fragment comprising amino acids 50-171 of SEQ ID NO:2 or a functional equivalent thereof; and TAED fragment comprising amino acids 194-411 of SEQ ID NO:50 or a functional equivalent thereof.

Another aspect of the invention relates to a method, comprising: non-invasively monitoring and/or quantifying in real-time, in vitro or in vivo, activity of the Hippo signaling pathway, comprising transfecting a cell with a luminescent biosensor as described herein, and detecting luminescence; wherein an intensity of the luminescence is indicative of amount of activity of the Hippo signaling pathway.

Another aspect of the invention relates to a method for monitoring and/or quantifying activity of the Hippo signaling pathway, comprising: treating a cell with a luminescent biosensor as described herein; and detecting luminescence of the treated cell; wherein an intensity of the luminescence is indicative of amount of activity of the Hippo signaling pathway. In one embodiment, an intensity of the luminescence is indicative of amount of LATS kinase activity in the Hippo signaling pathway. In one embodiment, an intensity of the luminescence is indicative of amount of YAP-TEAD interaction in the Hippo signaling pathway. In one embodiment, treating a cell comprises transfecting a cell with the luminescent biosensor. In one embodiment, treating a cell comprises lysing the cell and combining a cell lysate with the luminescent biosensor.

In one embodiment, the method comprises: non-invasively monitoring and/or quantifying in real-time, in vitro or in vivo, activity of LATS kinase, comprising transfecting the cell with a luminescent biosensor as described herein, and detecting luminescence; wherein an intensity of the luminescence is indicative of amount of LATS kinase activity in the Hippo signaling pathway.

In one embodiment, the method comprises: non-invasively monitoring and/or quantifying in real-time, in vitro or in vivo, YAP-TEAD interaction, comprising transfecting the cell with a luminescent biosensor as described herein, and detecting luminescence; wherein an intensity of the luminescence is indicative of amount of YAP-TEAD interaction in the Hippo signaling pathway.

Another aspect of the invention relates to a method, comprising: monitoring and/or quantifying activity of one or more proteins of the Hippo signaling pathway, comprising combining the one or more proteins with a luminescent biosensor as described herein and at least one substance, and detecting luminescence of the luminescent biosensor; wherein an intensity of the luminescence is indicative of effect of the at least one substance on activity of the one or more proteins of the Hippo signaling pathway.

In various embodiments of the above method, the at least one substance is selected from a chemical compound such as a small molecule inhibitor (e.g., molecular weight below about 500 Daltons), a large molecule inhibitor (e.g., molecular weight above about 500 Daltons), a biological agent (e.g., antibody), protein, polypeptide, peptide, DNA aptamer, microRNA, interfering RNA (shRNA, siRNA), a sugar, lipid, glycoprotein, and glycolipid.

Another aspect of the invention relates to a method for monitoring and/or quantifying activity of the Hippo signaling pathway in a biological sample obtained from a subject, comprising: treating cells of the biological sample with at least one reagent comprising the a luminescent biosensor as described herein; and detecting luminescence of the treated biological sample; wherein an intensity of the luminescence is indicative of amount of activity of the Hippo signaling pathway. In one embodiment, an intensity of the luminescence is indicative of amount of LATS kinase activity in the Hippo signaling pathway. In one embodiment, an intensity of the luminescence is indicative of amount of YAP-TEAD interaction in the Hippo signaling pathway. In various embodiments, the biological sample comprises at least one of tissue and blood. In one embodiment, the biological sample comprises blood. In one embodiment, an intensity of the luminescence is indicative of the cells being cancer cells.

Another aspect of the invention relates to a kit, comprising: a luminescent biosensor as described herein; at least one reagent; and, optionally, instructions for using the kit.

BRIEF DESCRIPTION OF THE DRAWINGS

For a greater understanding of the invention, and to show more clearly how it may be carried into effect, embodiments will be described, by way of example, with reference to the accompanying drawings, wherein:

FIG. 1A is a schematic diagram of YAP1 protein structure (SEQ ID NO:2) showing LATS phosphorylation site (S127) and the surrounding 15 amino acid sequence (YAP15; SEQ ID NO:7).

FIG. 1B is a western blot for GST pulldown assays showing results confirming that YAP15 is sufficient for interaction with cytoplasmic protein 14-3-3 in vitro.

FIG. 2A shows schematic diagrams of domain structures of a LATS intermolecular biosensor, referred to as Nluc-YAP15 (upper; SEQ ID NOS:6, 7) and 14-3-3-Cluc (lower; SEQ ID NOS:4, 6), according to an embodiment of the invention.

FIG. 2B is a schematic diagram showing the mechanism by which a LATS intermolecular biosensor determines LATS kinase activity.

FIG. 2C shows experimental results validating LATS intermolecular biosensor activity, where biosensor activity or Nluc-YAP15-S127 phosphorylation status were determined in HEK293 cells 48 hours after transfection by luciferase assay or western blot, respectively. Data are presented as mean \pm SD, n=3.

FIG. 2D shows experimental results confirming that a LATS intermolecular biosensor responds specifically to LATS kinase activity, by mutation of the LATS kinase consensus motif (HXRXXS/T; H, histidine; R, arginine; X, any amino acid; S, serine; T, threonine; SEQ ID NOS:71, 72) in Nluc-YAP15 (SEQ ID NOS:7, 8). Data are presented as mean \pm SD, n=3.

FIG. 2E shows experimental results confirming that LATS intermolecular biosensor activity is reduced by MST or LATS knockout. Data are presented as mean \pm SD, n=3.

FIG. 2F shows experimental results confirming that LATS intermolecular biosensor can be stably expressed to detect LATS kinase activity, wherein biosensor activity and phosphorylation status were monitored in a HEK293A cell line with doxycycline (Dox)-inducible LATS2 overexpression and stable LATS biosensor (LATS-BS) expression, and biosensor activity and phosphorylation status of endogenous YAP (YAP-pS127) and Nluc-YA15P-S127 (Nluc-YAP15-

pS127) were determined at the indicated times by luciferase assay and western blot, respectively. Data are presented as mean \pm SD, n=3.

FIG. 3A is a schematic diagram showing the domain structure of a LATS intramolecular biosensor based on SEQ ID NOs:6, 7, 73, according to one embodiment.

FIG. 3B is a schematic diagram showing the mechanism by which a LATS intramolecular biosensor determines LATS kinase activity.

FIG. 3C is a bar chart showing results of a validation study of an intramolecular LATS biosensor according to the embodiment of FIG. 3A.

FIG. 4A is a schematic diagram showing the domain structure of an engineered LATS biosensor based on SEQ ID NOs:6, 7, according to one embodiment.

FIG. 4B is a schematic diagram showing the mechanism by which an engineered LATS biosensor determines LATS kinase activity.

FIG. 4C is a bar chart showing results of a validation study of an engineered LATS biosensor according to the embodiment of FIG. 4A.

FIGS. 5A-5D show diagrams of multiple cloning sites of vectors (pBiT1.1-N [TK/LgBiT; 5A]; pBiT2.1-C [TK/SmBiT; 5B]; pET16b (5C)) and domain structures of constructs (5D) used to make NanoBiT (NanoLuc) biosensors based on Nluc and CLuc (SEQ ID NO:6), YAP15 (SEQ ID NO:7), LgBiT (SEQ ID NO:52), SmBiT (SEQ ID NO:54), and 14-3-3 (SEQ ID NO:4), according to embodiments of the invention.

FIG. 6 is a schematic diagram showing an overview of a NanoBiT interaction system of a LATS NanoBiT biosensor according to an embodiment of the invention.

FIG. 7 shows a coomassie brilliant blue (CBB) stained SDS-PAGE of purified proteins for a LATS NanoBiT biosensor.

FIG. 8A shows results of a NanoBiT biosensor assay of overexpressed LgBiT-YAP15 WT and mutant (MUT) and 14-3-3-SmBiT in HEK293T cells as relative luminescence to YAP15MUT-14-3-3.

FIG. 8B shows results of a NanoBiT LATS biosensor assay for cancer cells.

FIG. 8C shows results of a NanoBiT LATS biosensor assay for blood.

FIG. 9 shows results of an in vitro NanoBiT biosensor assay using purified LgBiT-YAP15 (WT and mutant), 14-3-3-SmBiT, and LATS2 kinase; upper panel shows the result of the NanoBiT assay for YAP15WT or mutant at two different concentrations of biosensor (5 and 100 ng) as a ratio of luminescence signal at different time points; lower panel shows immunoblotting analysis and ponceau staining of the respective samples with 100 ng of biosensor.

FIG. 10 shows the results of a kinase assay with purified proteins; upper panel shows the NanoBiT LATS biosensor assay for YAP15 WT and mutant (100 ng) with and without lambda phosphatase after 30 min; the lower panels show the relative immunoblotting and Ponceau staining for the respective samples.

FIG. 11 shows diagrams of domain structures of eight constructs used to make a YAP-TEAD biosensor based on LgBiT (SEQ ID NO:52), SmBiT (SEQ ID NO:54), YAP50-171 (SEQ ID NO:2), and TEAD1-194-411 (SEQ ID NO:50), according to one embodiment.

FIG. 12 shows a schematic overview of a NanoBiT interaction system of a YAP-TEAD NanoBiT biosensor according to an embodiment of the invention.

FIG. 13 shows the results of an assay of overexpressed YAP50-171 of SEQ ID NO:2 and TEAD1-194-411 of SEQ

ID NO:50 in HEK293T cells lysed with passive lysis buffer, for a biosensor with a combination of SmBiT-YAP50-171 (SEQ ID NO:2) and LgBiT-TEAD1-194-411 of SEQ ID NO:50 constructs.

FIG. 14 shows the results of an assay for analyzing LATS kinase activity under various stimuli regulating Hippo signaling by live cell luciferase imaging, using an intermolecular LATS-BS as described herein.

FIG. 15 is a photomicrograph showing the results of an experiment to determine subcellular LATS kinase activity using an intermolecular LATS-BS as described herein, obtained by bioluminescent microscopy.

FIG. 16 is a photograph showing LATS kinase activity in mice by in vivo luciferase imaging, using an intermolecular LATS-BS as described herein.

FIG. 17A is a schematic diagram showing a method for a screening assay, and FIG. 17B shows the results of a screening assay for identifying novel regulators of LATS using an intermolecular LATS-BS as described herein and a kinase inhibitor screen.

DETAILED DESCRIPTION OF EMBODIMENTS

In practicing the embodiments described herein, many conventional techniques in cell biology, molecular biology, protein biochemistry, immunology, and bacteriology are used. These techniques are well-known in the art and are provided in any number of available publications, such as *Current Protocols in Molecular Biology*, Vols. I-III, Ausubel, Ed. (1997); Sambrook et al., *Molecular Cloning: A Laboratory Manual*, Second Ed. (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., 1989). Unless specifically defined herein, all technical and scientific terms used herein generally have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs.

One aspect of the invention relates to bioluminescence-based biosensor constructs that non-invasively monitor real-time in vitro and in vivo activity of LATS kinase, the central player of the Hippo signaling pathway. A LATS biosensor (LATS-BS) as described herein quantifies LATS kinase activity by split luciferase assay, a bioluminescence-based technique that non-invasively monitors protein-protein interactions in vitro and in vivo in real-time with accurate quantification, high sensitivity, and excellent reproducibility. Embodiments of the biosensor constructs include fragments of firefly (*Photinus* sp., e.g., *Photinus pyralis*) or NanoBiT (also referred to as NanoLuc) luciferase and human YAP1. Some embodiments include human cytoplasmic protein 14-3-3 or a fragment thereof.

Another aspect of the invention relates to a method for non-invasively monitoring real-time in vitro and in vivo activity of LATS kinase. In various embodiments, the method includes using a LATS biosensor as described herein to quantify LATS kinase activity. The embodiments provide a bioluminescence-based technique for monitoring LATS kinase activity with accurate quantification, high sensitivity, and excellent reproducibility (see Examples for details).

A third aspect of the invention relates to bioluminescent biosensor constructs and methods for non-invasively monitoring YAP-TEAD interaction, a critical step in regulation of downstream target by the Hippo pathway. Embodiments of the biosensor constructs include fragments of NanoBiT luciferase and fragments of human YAP1 and TEAD1, or functional equivalents thereof, and provide a biolumines-

cent-based technique for monitoring YAP and TEAD interactions both *in vitro* and *in vivo* with high sensitivity, stability, and reproducibility.

At least eight isoforms of YAP1 are known. SEQ ID NO:1 shows the full human YAP2L isoform mRNA (accession number: AB567720) and SEQ ID NO:2 shows the amino acid sequence. The fragments used in the embodiments described herein were obtained from the YAP2L isoform of YAP1 (SEQ ID NO:2). However, the fragments used in the embodiments described herein may be obtained from any of the isoforms, or may be functional equivalents thereof. In this disclosure, the terms “YAP1” and “YAP” are used interchangeably to refer to an isoform of YAP1. SEQ ID NO:3 shows the full human 14-3-3 protein theta mRNA (accession number: P27348) and SEQ ID NO:4 shows the amino acid sequence. SEQ ID NO:5 shows the full length firefly luciferase mRNA and SEQ ID NO:6 shows the luciferase protein.

Since LATS phosphorylates S127 on YAP1 and cytoplasmic protein 14-3-3 binds specifically to phosphorylated but not un-phosphorylated S127-YAP, embodiments were constructed for monitoring LATS kinase activity by measuring the pS127-YAP/14-3-3 interaction.

In various embodiments, a LATS-BS includes a minimal YAP1 fragment that interacts with 14-3-3 in a phosphorylation-dependent manner. The full length YAP1 protein was not used to avoid confounding signals by post-translational modifications of YAP1 by other upstream regulators. In one embodiment, the minimal YAP1 fragment includes 15 amino acids (YAP15) surrounding the S127 LATS phosphorylation site (amino acids 120-134; SEQ ID NO:7; FIG. 1A). Functional equivalents may be used, such as other sizes of YAP1 fragments, such as, for example, longer (e.g., 16-20 amino acids) or shorter (e.g., 12-14 amino acids) surrounding the S127 (SEQ ID NO:2). Embodiments may include a YAP fragment with a HxRxxS motif (SEQ ID NO:71). Since H, R, and S residues but not other amino acids in the HxRxxS motif (SEQ ID NO:71) on the YAP fragment are essential for LATS biosensor function (see, e.g., FIG. 2D), variants of YAP fragments with changes of amino acids other than H/R/S may also be used. Larger fragments (e.g., 20-100 amino acids) may result in confounding signals.

Minimal YAP1 fragments were tested for interaction with 14-3-3 after phosphorylation by LATS2 kinase. Using *in vitro* GST-pulldown assays, it was found that like full-length YAP-GST, YAP15-GST could directly bind to 14-3-3 after LATS phosphorylation while a phosphorylation-mutant YAP15-S127A-GST (A, alanine) could not. FIG. 1B shows that YAP15 is sufficient for interaction with 14-3-3 *in vitro*. To collect the data, GST-tagged full length YAP (YAP-GST), YAP15 with wild type sequence (YAP15-S127-GST), or mutant YAP15 that cannot be phosphorylated by LATS (YAP15-S127A-GST) was purified from bacterial cells and 1 µg of GST fusion protein was incubated for 20 minutes at 30° C. with recombinant LATS kinase. 100 µg of cell lysate from human embryonic kidney cells (HEK293) transiently expressing 14-3-3-Flag was added and YAP or YAP15-S127 or YAP15-S127A/14-3-3 binding was assessed by GST pull-down with protein S-agarose beads, followed by western blot with anti-Flag (14-3-3-Flag) and anti-YAP-pS127 antibodies. The membrane was stained with Ponceau S to visualize the fusion proteins.

Since the TEAD family consists of four members, other TEADs (TEAD2-4) may also be used to replace TEAD1 to make biosensors similar to the YAP-TEAD1 biosensor.

Throughout this disclosure, “TEAD1” and “TEAD” are used interchangeably to refer to any one of the TEAD family members.

In the following descriptions of various embodiments of the biosensor, references to sequences and sequence listings are made. Those of ordinary skill in the art will readily appreciate that the invention is not limited to the specific sequences described, as many variants are possible without departing from the invention. For example, substitutions, mutations, deletions, and/or additions of one or more nucleotides or amino acids may be made, or may occur, without substantial effect on functional properties of a biosensor. Such a functional equivalent may have, for example, 60%, or 70%, or 80%, or 90%, or more sequence identity with a sequence described herein. Such functional equivalents are intended to be included in the embodiments of the invention.

1. LATS Biosensor

1.1 Intermolecular Biosensor

The biosensor was made by overlapping PCR using firefly luciferase as a template. YAP15 and 14-3-3 were fused with N-terminal and C-terminal luciferase fragments (Nluc and Cluc), respectively, to create a LATS-B S. As shown in FIG. 2A, for Nluc-YAP15, firefly luciferase amino acids 1-416 (N-luciferase, Nluc) (SEQ ID NO: 6) were fused to the N-terminal of YAP15 (120-134; SEQ ID NO:7) separated by a glycine/alanine linker (GGAGG; SEQ ID NO:73); and for 14-3-3-Cluc, luciferase amino acids 394-550 (C-luciferase, Cluc; SEQ ID NO:6) were fused to the C-terminal of 14-3-3 (SEQ ID NO: 4) separated by a glycine/serine linker (GGSGGGGSGG; SEQ ID NO:74). Biosensors were cloned into the BamHI/NotI sites of the pcDNA3.1/hygro (+) vector (SEQ ID NO:9, purchased from Invitrogen, Dublin, Ireland). Primers are shown in SEQ ID NOS:10-16. The full length sequences for Nluc-YAP15 and 14-3-3-Cluc in pcDNA3.1/hygro (+) vector are given in SEQ ID NOS:57 and 58, respectively, wherein the underlined portions are the main constructs and the rest is the vector.

The mechanism of action for how the LATS-BS determines LATS kinase activity is shown in FIG. 2B. At baseline, there is no interaction between YAP15 and 14-3-3 so the LATS-BS shows minimal bioluminescence activity. However, LATS-dependent phosphorylation of YAP15-S127 leads to 14-3-3 binding, luciferase complementation, and high bioluminescence signal.

In a validation study, LATS-BS was transfected alone or together with LATS2 or/and MST2 into HEK293 cells and biosensor activity or NLuc-YAP15-S127 phosphorylation status were determined 48 hours after transfection by luciferase assay or western blot, respectively. As depicted in FIG. 2C, HEK293 cells transfected with LATS-BS alone had low luciferase activity and this was correlated with a low degree of Nluc-YAP15-S127 phosphorylation. Co-transfection of LATS-BS with MST2 was associated with increases in both Nluc-YAP-S127 phosphorylation and luciferase activity, and this effect was suppressed with lysophosphatidic acid (LPA), an inhibitor of the Hippo pathway. For lysophosphatidic acid (LPA) treatment, cells were stimulated with 10 µM LPA for 1 hour before collection (n=3). LATS-BS co-expression with both MST2 and LATS2 was correlated with further increases in Nluc-YAP15-S127 phosphorylation and luciferase activity. Collectively, these observations are consistent with a model where MST2 activates

LATS2, which phosphorylates Nluc-YAP15-S127, leading to binding with Cluc-14-3-3 and reconstitution of active luciferase.

To further validate the biosensor construct model, conserved residues (H, histidine; R, arginine; S) within the LATS consensus phosphorylation motif (HxRxxS/T; x, any amino acid; SEQ ID NOs: 71, 72) on Nluc-YAP15-S127 were mutated to A (H122A, R124A, and S127A). Each individual mutation completely abolished Nluc-YAP15-S127 phosphorylation and LATS-BS luciferase activity, as shown in FIG. 2D. In addition, the basal LATS-BS signal was reduced by knockout of endogenous MST1/2 in HEK293A (50% reduction) or more dramatically by LATS1/2 knockout (HO % reduction), as shown in FIG. 2E. LATS-BS was transfected into CRISPR-Cas9-generated LATS1/2 or MST1/2 knockout HEK293A and basal biosensor activity was determined 48 hours after transfection (n=3). Furthermore, inducible expression of LATS2 in HEK293A cells stably expressing LATS-BS showed that the levels of LATS2 are correlated with the level of endogenous YAP-pS127, Nluc-YAP15-pS127 as well as with LATS-BS activity, as shown in FIG. 2F. Biosensor activity and phosphorylation status were monitored in a HEK293A cell line with doxycycline (Dox)-inducible LATS2 overexpression and stable LATS-BS expression. Cells were treated with 1 µg/mL Dox for the indicated times and biosensor activity and phosphorylation status of endogenous YAP (YAP-pS127) and Nluc-YA15P-S127 (Nluc-YAP15-pS127) were determined by luciferase assay and western blot, respectively (n=3).

This LATS biosensor was also used to examine LATS kinase activity in living cells and mice and to perform a screening assay for regulators of LATS (see details in Examples).

1.2 Intramolecular Biosensor

An intramolecular biosensor was made by overlapping PCR using firefly luciferase as a template. In one embodiment, firefly luciferase amino acids 1-416 (N-luciferase, Nluc; SEQ ID NO:6) were fused to the N-terminal of YAP15 (120-134) (SEQ ID NO:7) separated by a glycine/alanine linker (GGAGG; SEQ ID NO:73). Within the same open reading frame, luciferase amino acids 394-550 (C-luciferase, Cluc; SEQ ID NO:6) were fused to the C-terminal of 14-3-3 separated by a glycine/alanine linker. For this biosensor, LATS phosphorylates YAP15-5127 to cause a conformational change in the intramolecular LATS-BS, leading to luciferase complementation and detectable biosensor activity. Primers are shown in SEQ ID NOs:10, 16, 17, and 18.

The domain structure is shown in FIG. 3A and the mechanism of action for how the LATS-BS determines LATS kinase activity is shown in FIG. 3B. At baseline, there is no interaction between YAP15 and 14-3-3 so the LATS-BS shows minimal bioluminescence activity. However, LATS-dependent phosphorylation of YAP15-S127 leads to 14-3-3 binding, luciferase complementation, and high bioluminescence signal.

To validate the intramolecular biosensor, the biosensor was transfected alone or together with LATS2 or/and MST2 into HEK293 cells and biosensor activity was determined 48 hours after transfection by luciferase assay. For LPA treatment, cells were stimulated with 10 µM LPA, an inhibitor of

the Hippo pathway, for 1 hour before collection (n=3). Results are shown in FIG. 3C.

1.3 Engineered Biosensor

The biosensor was made by overlapping PCR using firefly luciferase as a template. In one embodiment, the C-terminal seven amino acids from firefly luciferase were removed to create Eng-luc (544 amino acids). This construct was fused to the N-terminal of YAP15 (amino acids 120-134; SEQ ID NO:7). This brings the luciferase site in close proximity to YAP15-5127 such that LATS-dependent phosphorylation of YAP-S127 modulates luciferase activity directly. Primers are shown in SEQ ID NOs:10 and 19.

The domain structure of the Eng-luc LATS biosensor according to one embodiment is shown in FIG. 4A and the mechanism of action for how the biosensor determines LATS kinase activity is shown in FIG. 4B.

For validation of the Eng-luc LATS-BS, the biosensor was transfected alone or together with LATS2 or/and MST2 into HEK293 cells and biosensor activity was determined 48 hours after transfection by luciferase assay. For LPA treatment, cells were stimulated with 10 µM LPA for 1 hour before collection (n=3). Results are shown in FIG. 4C.

1.4 NanoBiT Biosensor

For this biosensor YAP15 (aa 120-134; SEQ ID NO:7) and 14-3-3 full length (aa 1-245; SEQ ID NO:4) were used. As shown in FIG. 7-10, a YAP15 mutant was used as a negative control in these experiments.

To clone YAP15 and 14-3-3 in NanoBiT (also referred to as NanoLuc) vectors (purchased from Promega Corporation, Madison, Wis., U.S.A.), primers with EcoRI and BglII restriction sites were used. For the LgBiT-YAP15 construct, primers shown in SEQ ID NOs:20-23 were used. For the 14-3-3-SmBiT construct, primers shown in SEQ ID NOs:24-25 were used.

In the case of YAP15WT (S127; SEQ ID NO:7) and mutant (A127; SEQ ID NO:8), primers with EcoRI and BglII flanking ends were annealed first and then they were ligated into digested pBiT 1.1 N (TK-LgBiT) vector (SEQ ID NO:26; purchased from Promega Corporation) with N-terminal LgBiT domain. FIG. 5A shows the multiple cloning site. For making the 14-3-3-SmBiT construct, in order to amplify 14-3-3 gene, standard PCR using the above mentioned primers was done by using 14-3-3 as a template. PCR product was digested using EcoRI and BglII restriction enzymes and was ligated into pBiT 2.1 C (TK-SmBiT; purchased from Promega Corporation) (SEQ ID NO:27) with SmBiT (11 amino acid) sequence at the C-terminus. FIG. 5B shows the multiple cloning site.

To make LgBiT-YAP15 (WT and mutant) and 14-3-3-SmBiT constructs for protein expression and purification in *E. coli*, the primers shown in SEQ ID NOs:28-30 were used for the LgBiT-YAP15 construct, and the primers shown in SEQ ID NOs:31-32 were used for the 14-3-3-SmBiT construct. For PCR, LgBiT-YAP15 and 14-3-3-SmBiT in NanoBiT vectors were used as template. pET16b vector (SEQ ID NO:33; purchased from Novagen (Millipore (Canada) Ltd., Etobicoke, Canada) was used for overexpression of LgBiT-YAP15 (WT and mutant) and 14-3-3-SmBiT as His-tagged proteins. FIG. 5C shows the multiple cloning site.

FIG. 5D shows a schematic representation of the LgBiT-YAP15 and 14-3-3-SmBiT constructs. SEQ ID NOs:59, 60, 61, and 62 give the full length sequences for LgBiT-YAP15 in pBiT 1.1 N vector, 14-3-3-LgBiT in pBiT2.1-C vector,

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LgBiT-YAP15 in pET16b vector, and SmBiT in pET16b vector, respectively, wherein the underlined portions are the main constructs and the rest is the vector.

FIG. 6 is a schematic diagram showing an overview of the NanoBiT interaction system. YAP15 and 14-3-3 are fused to LgBiT and SmBiT, respectively. Interaction of purified fusion proteins or overexpressed proteins in the cells leads to structural complementation of LgBiT with SmBiT that consequently generates a functional enzyme with bright luminescence.

For protein expression, the *E. coli* strain CodonPlus (DE3)-RIPL was transformed and used to purify the respective proteins. *E. coli* with the respective construct were grown until an OD600 value of 0.6-0.8 and then induced with 0.3 mM isopropyl- β -D-thiogalactopyranoside (IPTG) overnight at 20° C. Protein purification was carried out by incubating cells at 4° C. with DNase I (10 μ g/ml) followed by cell lysis by sonication. Bacterial lysates were centrifuged to collect soluble fractions and His-tagged proteins were purified from the supernatant via Ni-affinity purification. After eluting and concentrating, proteins were subjected to dialysis against standard buffer containing 30 mM Tris-HCl, pH 7.5, 150 mM NaCl, 5 mM MgCl₂, and 2 mM DTT. All purified proteins were analyzed by SDS-PAGE and stored at -80° C. FIG. 7 shows coomassie brilliant blue (CBB) stained SDS-PAGE of purified proteins for the biosensor.

NanoBiT Assay for YAP15-14-3-3 in Cells.

A NanoBiT assay was prepared for YAP15-14-3-3 in cells. HEK293T cells (3×10^5) were transfected using Polyjet transfection reagent according to the manufacturer's instructions in 12-well plates by using 250 ng of each plasmid DNA per transfection. After 48 h the cells were lysed with passive lysis buffer and the NanoBiT assay of overexpressed LgBiT-YAP15 WT and mutant and 14-3-3-SmBiT was performed. Relative luminescence to YAP15MUT-14-3-3 was determined as shown in FIG. 8A.

NanoBiT Assay for YAP15-14-3-3 Using Cancer Cells.

Cancer cells (A549, H1299, and HEK293) were treated with okadaic acid for 1 h to activate LATS before lysing with passive lysis buffer. Then, 350 μ g cell lysate was untreated or treated with calf intestine phosphatase (CIP) to inactivate the biosensor, followed by LATS pulldown and measurement of LATS kinase activity in vitro using purified LATS BS. As shown in FIG. 8B, the NanoBiT LATS-BS produced a strong signal for all three types of cancer cells.

NanoBiT Assay for YAP15-14-3-3 Using Blood.

Mononuclear cells were separated from fresh human blood and then lysed with passive lysis buffer. Then, 350 μ g cell lysate was used to pull-down LATS kinase and measure its activity in vitro using purified NanoBiT LATS-BS. As shown in FIG. 8C, the NanoBiT LATS-BS produced a strong signal.

NanoBiT Assay Using Purified Proteins.

In order to test the LATS NanoBiT biosensor in vitro, a kinase assay was done using purified LgBiT-YAP15 (WT and mutant), 14-3-3-SmBiT and LATS2 as the kinase. The assay was done with two different concentrations of biosensor (100 ng and 5 ng). After 1, 10, 20, 30 min and 1, 2, 4 and 20 h luminescence was measured and also phosphorylation level was checked using WB. Results are shown in FIG. 9. The upper panel shows the result of NanoBiT assay for YAP15WT and mutant at the two different concentrations of biosensor (5 and 100 ng) as a ratio of luminescence signal in the presence to absence of LATS as a kinase in different time points. The lower panel shows immunoblotting analy-

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sis and Ponceau staining of the respective samples from the experiment with 100 ng of biosensor.

Kinase Assay with and without Phosphatase.

To confirm that the biosensor is phosphorylation dependent and works through LATS, lambda phosphatase was used and luminescence as well as phosphorylation was determined. The results show that treating with lambda phosphatase abolishes luminescence. In FIG. 10 the upper panel shows the result of an assay for the biosensor with YAP15 WT or mutant (100 ng) with and without lambda phosphatase after 30 min. The Y axis shows the ratio of luminescence in the presence of LATS and in the absence of LATS. The lower panels show the relative immunoblotting and Ponceau staining for the respective samples

2. YAP-TEAD Biosensor

YAP transcriptionally activates downstream genes by interacting with the TEAD family of transcription factors (i.e., TEAD1-4). To monitor interaction between YAP and TEAD, a NanoBiT split luciferase biosensor was developed that quantifies YAP1 and TEAD1 interaction. This biosensor is based on a YAP fragment (residues 50-171; SEQ ID NO:2)-TEAD1 fragment (residues 194-411; SEQ ID NO:50) complex, in which YAP wraps around the globular structure of TEAD1. FIG. 12 shows a schematic overview of the NanoBiT interaction system of a YAP-TEAD NanoBiT biosensor as described herein. The YAP1 mRNA and amino acid sequences are given in SEQ ID NOs:1 and 2, respectively. The TEAD1 mRNA and protein sequences are given in SEQ ID NOs:49 and 50, respectively. The Large BiT (LgBiT) mRNA and protein sequences are given in SEQ ID NOs:51 and 52, respectively. The Small BiT (SmBiT) mRNA and protein sequences are given in SEQ ID NOs:53 and 54, respectively. The vectors were pcDNA3.1/hygro(+) (SEQ ID NO:9), pcDNA3.1/hygro(+)-Flag (SEQ ID NO:55), and pcDNA3.1/hygro(+)-Myc (SEQ ID NO:56).

Eight NanoBiT split luciferase constructs were made using the primers as listed below. The domain structures of the eight constructs are shown in FIG. 11.

Construct 1:

LgBiT-YAP50-171-Flag (overlapping PCR):

SEQ ID NO:34. B1-Kozak-LgBiT-F primer (41 nucleotides):

SEQ ID NO:35. LgBiT-(GS)-R primer (54 nucleotides):

SEQ ID NO:36. (GS)-YAP50-F primer (69 nucleotides):

SEQ ID NO:37. N1-YAP171-Flag-R primer (63 nucleotides)

Construct 2:

Flag-YAP50-171-LgBiT (overlapping PCR):

SEQ ID NO:38. B1-YAP50-F primer (32 nucleotides):

SEQ ID NO:39. (GS)-YAP171-R primer (68 nucleotides):

SEQ ID NO:40. (GS)-LgBiT-F primer (66 nucleotides):

SEQ ID NO:41. N1-LgBiT-R primer (43 nucleotides):

Construct 3:

SmBiT-YAP50-171-Flag (tandem PCR):

SEQ ID NO:42. B1-Kozak-SmBiT-(GS)-F primer (98 nucleotides):

SEQ ID NO:36. (GS)-YAP50-F primer (69 nucleotides):

SEQ ID NO:37. N1-YAP171-Flag-R primer (63 nucleotides)

Construct 4:

Flag-YAP50-171-SmBiT (tandem PCR):

SEQ ID NO:38. B1-YAP50-F primer (32 nucleotides)

SEQ ID NO:39. (GS)-YAP171-R primer (68 nucleotides)

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SEQ ID NO:43. N1-SmBiT-(GS)-R primer (97 nucleotides):

Construct 5:

LgBiT-TEAD1-194-411-Myc (overlapping PCR):

SEQ ID NO:34. B1-Kozak-LgBiT-F primer (41 nucleotides)

SEQ ID NO:35. LgBiT-(GS)-R primer (54 nucleotides)

SEQ ID NO:44. (GS)-TEAD-194-F primer (73 nucleotides):

SEQ ID NO:45. N1-TEAD411-Myc-R primer (73 nucleotides):

Construct 6:

Myc-TEAD1-194-411-LgBiT (overlapping PCR)

SEQ ID NO:46. B1-TEAD194-F primer (36 nucleotides):

SEQ ID NO:47. GS-TEAD-411-R primer (69 nucleotides):

SEQ ID NO:40. (GS)-LgBiT-F primer (66 nucleotides)

SEQ ID NO:41. N1-LgBiT-R primer (43 nucleotides)

Construct 7:

SmBiT-TEAD1-194-411-Myc (tandem PCR)

SEQ ID NO:42. B1-Kozak-SmBiT-(GS)-F primer (98 nucleotides)

SEQ ID NO:48. (GS)-TEAD194-F primer (73 nucleotides):

SEQ ID NO:45. N1-TEAD411-Myc-R primer (73 nucleotides)

Construct 8: Myc-TEAD-194-411-SmBiT (tandem PCR)

SEQ ID NO:46. B1-TEAD194-F primer (36 nucleotides)

SEQ ID NO:47. GS-TEAD-411-R primer (69 nucleotides)

SEQ ID NO:43. N1-SmBiT-(GS)-R primer (97 nucleotides)

Cloning.

To make constructs 1 and 5, overlapping PCR was performed using the above primers, and they were inserted into BamHI/NotI cloning site of pcDNA3.1/hygro. For construct 1, pBiT1.1-N(TK/LgBiT) and full length YAP were used as templates to perform PCR. For construct 5, pBiT1.1-N(TK/LgBiT) and full length TEAD1 were used to perform PCR.

To make constructs 2 and 6, overlapping PCR was performed using the above primers, and they were inserted into BamHI/NotI cloning site of pcDNA3.1/hygro-Flag/Myc. For construct 2, pBiT1.1-C(TK/LgBiT) and full length YAP were used to perform PCR. For construct 6, pBiT1.1-C(TK/LgBiT) and full length TEAD1 were used to perform PCR.

To make constructs 3 and 7, tandem PCR was performed using the above primers, and they were inserted into BamHI/NotI cloning site of pcDNA3.1/hygro. For both constructs full length YAP and TEAD1 were used respectively to perform PCR.

To make construct 4 and 8, overlapping PCR was performed using the above primers, and they were inserted into BamHI/NotI cloning site of pcDNA3.1/hygro-Flag/Myc. For both constructs full length YAP and TEAD1 were used respectively to perform PCR.

SEQ ID NOs:63-70 give the full length sequences for constructs 1-8, respectively, wherein, in each sequence, the underlined portion is the main construct and the rest is the vector.

Validation.

Different combinations of the eight constructs were used in assays in order to find the best orientation for the biosensor. The assays used overexpressed YAP50-171 and TEAD1-194-411 in HEK293T cells lysed with passive lysis buffer. All combinations of SmBiT and LgBiT biosensors

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worked, but the combination of SmBiT-YAP50-171 and LgBiT-TEAD1-194-411 showed the highest signal and sensitivity (FIG. 13).

Discussion

The embodiments and experiments described herein establish the LATS biosensor embodiments as the first LATS biosensor that can accurately monitor LATS kinase activity and intensity of Hippo signaling in vitro and in vivo, and its use in a new bioluminescence (BLI) method. In addition, the embodiments and experiments described herein establish the YAP-TEAD biosensor embodiments as the first biosensor that can accurately monitor YAP and TEAD interaction, which is essential for elucidating the function of YAP in the Hippo pathway. Although BLI is widely used for reporting promoter activity and imaging tumors in mice, few studies have used it to measure protein function at the cellular level and even fewer studies have examined subcellular protein function using bioluminescence microscopy. The ability to detect LATS kinase activity in individual cells and in blood as provided by the embodiments described herein has applications for evaluating heterogeneous dynamics of LATS kinase activity in cell culture as well as for the real-time monitoring of Hippo signaling responses to various drug treatments, and in applications such as detecting Hippo pathway signaling in biological samples such as tissue and blood obtained from subjects. In particular, the results show that a biosensor as described herein may be useful for detecting cancerous cells in biological samples such as tissue. The results of in vivo experiments in mice further illustrate how LATS-BS embodiments may be used to preclinically examine the effects of a variety of drugs on LATS kinase activity in vivo.

A biosensor as described herein may be provided in a kit to measure the Hippo signaling pathway, for use in vitro and in vivo. For example, a kit may include one or more LATS biosensor such as an intermolecular biosensor, intramolecular biosensor, engineered biosensor, or NanoBiT biosensor, and/or a YAP-TEAD biosensor as described herein, optionally with one or more reagents suitable for using the kit in an assay for a specified biological sample or cell type, and instructions for proper use of the kit. The reagent may be, for example, a reagent appropriate for in vitro use or for in vivo use, a buffer, cell lysis buffer, etc.

Example

The following example provides details of the methods used to make and use an intermolecular LATS biosensor as described herein.

1. Determine activity of purified LATS protein and LATS in cells by in vitro luciferase assay (described above and shown in FIGS. 2C, 2D, 3C, 8, and 13).

2. Determine interaction of YAP and TEAD in cells by in vitro luciferase assay (described above and shown in FIG. 13).

3. Determine LATS kinase activity under various stimuli regulating Hippo signaling by live cell luciferase imaging.

For live cell imaging, LATS-BS or a pGL3-control vector were transfected into HEK293, MDA-MB-231 or A549 cells. After 48 hours, cells were trypsinized and collected in a black, clear bottomed, 96-well plate. 150 µg/mL D-luciferin (D-Luciferin, Potassium Salt, GoldBio #LUCK-250) in media was added to each well 5-10 min before imaging. Exposure time for images was approximately 3 min/plate. Imaging was performed using a LightTools Research system

(Synopsys, Ltd., Mountain View, Calif., USA) dark box and a Hamamatsu ORCA-Flash4.0 V2 digital CMOS camera over the course of 20 minutes to establish optimal peak luciferase activity. The bioluminescence of the regions of interest was analyzed for total emission flux using Image-Pro® Plus software (Media Cybernetics, Inc., Rockville, Md., USA).

Experiments were conducted to further validate the LATS intermolecular biosensor and explore potential applications for its use. The LATS-BS responded to numerous signals reported to modulate Hippo pathway activity, including cell confluency, drugs activating Hippo signaling (Forskolin, PI3K inhibitor, PDK inhibitor, F-IBMX, and 2-deoxy-glucose) and Hippo signaling inhibitors (LPA, EGF, Insulin, S1P, and TPA). The LATS-BS is activated by LATS in various cell lines (e.g., A549, MDA-MB231). Notably, in these experiments biosensor activity was measured in both cell lysates and in live cells using luciferase assay and BLI respectively. Collectively, these data illustrate the broad range of potential applications for the LATS-BS in monitoring Hippo pathway activity.

The following compound treatments were used for *in vitro* luciferase assay and live cells imaging: RAF inhibitor (GW5054, Cayman Chemical, Ann Arbor, Mich., USA), ATR inhibitor (CGK733, Cayman Chemical), PI3K inhibitor 1 (GDC0941, Cayman Chemical), PI3K inhibitor 2 (LY294002, Cayman Chemical), PDK inhibitor (GSK2334470, Cayman Chemical)—10 μ M for 4 hours; EGF-100 ng/mL for 1 hour; insulin (Sigma #91077C)—10 μ g/ml for 1 hour, F/IBMX (Forskolin, Cayman Chemical/IBMX, Cayman Chemical)—0.1-10 μ M for Forskolin and 100 μ M for IBMX for 1 hour; L- α -lysophosphatidic acid (LPA) (Sigma #L7260)—0.1-10 μ M for 1 hour, sphingosine1-phosphate (S1P)—1 μ M for 1 hour; 12-O-tetradecanoylphorbol-13-acetate (TPA) (#41745; Cell Signaling Technology, Inc., Danvers, Mass., USA)—5 nM for 1 hour; 2-deoxy glucose (#D8375, Sigma-Aldrich Canada Co., Oakville, Ontario, Canada)—25 mM for 1 hour. The results are shown in FIG. 14.

4. Determine subcellular LATS kinase activity by bioluminescent microscopy.

Using the intermolecular LATS-BS, a new method was developed for the Olympus LV200 Bioluminescence Imager, and LATS kinase activity was visualized and quantified at the individual cell level in cancer cell lines. 3.5 mM D-luciferin was added to the media culturing HEK293A, A549 or MDA-MB231 cells stably expressing LATS-BS at 5-10 min before imaging. Images were captured using Olympus LV200 Bioluminescence Imager with exposure times ranging from 30 seconds (HEK293A) to 10 min (MDA-MB-231, A549). The results are shown in FIG. 15. The difference in biosensor signal intensity among individual cells represents altered endogenous LATS kinase activity rather than differential LATS-BS expression levels since only the LATS-phosphorylated fraction of LATS-BS should emit bioluminescence. In addition, data showed that both the levels and subcellular localization of LATS-BS bioluminescence (cytoplasm where LATS is expressed) and GFP (control, nucleus/cytoplasm) were different in the same cell. This technology also allowed comparison of the heterogeneity of LATS kinase activity among cancer cell lines by assessing the distribution of luciferase activity. Further,

and of particular significance, using biophotonics BLI, LATS kinase activity was detected *in vivo* in mice. The subcellular activity of LATS kinase can be also visualized by bioluminescent imaging.

5. Measuring LATS kinase activity in mice by *in vivo* luciferase imaging.

Further, and of particular significance, using biophotonics BLI, LATS kinase activity was detected *in vivo* in mice. All mouse procedures were approved by the Queen's University Animal Care Committee (UACC) and performed in accordance with institutional policies. To visualize LATS kinase activity *in vivo*, 12-week-old female BALB/c mice were anesthetized by exposure to 1-3% isoflurane. 3×10^6 HEK293 cells transfected with an intermolecular LATS-BS alone (LATS-) or together with LATS (LATS+) were suspended in 100 μ L of sterile PBS and injected into the mammary fat pad. Two days after the injection, post-surgery mice received 150 mg/kg of D-luciferin (Cedarlane) dissolved in PBS by intraperitoneal injection. Imaging of ventral view was performed using a LightTools Research system (Encinitas, Calif.) dark box and a Hamamatsu ORCA-Flash4.0 V2 digital CMOS camera over a course of 30 minutes to establish optimal peak luciferase activity. Pseudo-colored parametric overlays of BLI with anatomical reference images were dynamically constructed for each individual animal at comparative time points. The bioluminescence (BLI) of the regions of interest (ROI) was then analyzed for total emission flux using Image Pro Plus software. The results are shown in FIG. 16, where the arrow (right panel) points to the area where high intensity luminescence (red in heatmap) was detected.

6. Identifying novel regulators of LATS by a kinase inhibitor screen.

The intermolecular LATS-BS was used to search for novel kinases regulating Hippo signaling with a small-scale kinase inhibitor screen. The LATS-BS was transfected into HEK293A. Cells were passed into a 384-well plate the following day. 48 hours after transfection, cells were treated with the Tocriscreen Kinase Inhibitor Toolbox (Tocris Bioscience #3514) with each drug administered at 10 μ M in DMSO for 4 hours in duplicate. Biosensor activity was then measured by luciferase assay. Fold change ratios were generated by comparing biosensor activity for each drug with that of DMSO-treated controls. The screening schematic and results are shown in FIGS. 17A and 17B, respectively. Of 80 kinase inhibitors screened, six kinase inhibitors activated the biosensor (i.e., inhibitors of VEGFR, MEK, GSK-3, PKB/Akt, EGFR, and CDK) while six inhibitors reduced the biosensor signal (i.e., inhibitors of TrkA, Broad, SYK, ATR/ATM, CHK1, and SGK). From these candidate LATS regulators, VEGFR1/2, GSK-3a/b, CDK4, TrkA, SYK, Broad, and SGK are novel. The screen results were confirmed by luciferase assays using the LATS-BS and an STBS-luciferase reporter that measures the transactivating function of YAP/TAZ32. The kinase inhibitors had the opposite effects on LATS-BS and STBS reporter, suggesting that the screen had identified true regulators of Hippo signaling. It is expected that future large-scale screens using the LATS-BS will identify additional new activators or inhibitors of the Hippo signaling pathway.

All cited publications are incorporated herein by reference in their entirety.

Sequences

SEQ ID NO: 1. Human YAP1 (yes-associated protein beta) isoform 2L mRNA (1,401 nucleotides) (accession number: AB567720)
ATGGATCCCGGGCAGCAGCCGCGCTCAACCGGCCCCAGGGCCAAGGGCAGCCGCTTCGC

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SEQ ID NO: 2. Human YAP1 isoform 2L protein (504 amino acids)
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 LEALFNAVMPNPKTANVPQTVPMLRKLKLPDSFFKPEPKSHSRQASTDAGTAGALTPQHVRAHSS
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 IDQTTTWQDRKAMLSQMNVTAPTSPPVQNMNNSASGPLPDGWEQAMTDGEIYYINHKNKTT
 SWLDRPLDRPFAMNQRISQSAPVKQPPPLAPQSPQGGVMGGSNSNQQQMRLLQQLQMEKERLRL
 KQQLLRQAMRNINPSTANSPKQELALRSQLPTLEQDGGTQNPVSSPGMSQELRMTTNSSDP
 FLNSGTYHSRDESTDSLMSYSVPRTPDDFLNSVDEMDTGDITINQSTLPSQQNRFDPYLEAI
 PGTNVDLGTLEGDGMNIEGELMPSLQEALSSDILNDMESVLAATKLDKESFLTWL

SEQ ID NO: 3. Human 14-3-3 protein theta mRNA (738 nucleotides)
 (accession number: P27348)
 ATGGAGAAGACTGAGCTGATCCAGAAGGCCAAGCTGGCCGAGCAGCCGAGCGCTACGAGGACA
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 CTTGCTGAAGTTGCGTGTGGTGTGATGATCGAAAACAACGATAGATAATTCCAAGGAGCTTACC
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GCACCCTCATCATGCAGTTGCTTAGAGACAACCTAACACTTTGGACATCAGACAGTGCAGGAGA
 AGAATGTGATGCGGCAGAAAGGGCTGAAAACATA

SEQ ID NO: 4. Human 14-3-3 protein theta (245 amino acids)
 MEKTELIQKAKLAEQAERYDDMATCMKAVTSQGAELNSERNLLSVAYKNVVGRRSAWRVISS
 IEQKTDTSDDKQLIKDYREKVESELRSICTTVLELDDKYLIANATHPESKVFYLMKMGDYFRY
 LAEVACGDDRKQTDIDNSQGAYQEAFDISKEMQPTHPIRLGLALNFSVFYIEILNPELACTLA
 KTAFDAIAELDLTLDNEDSYKSDSTLIMQLLRDNLTLWTSDSAGEECDAAEGAEN

SEQ ID NO: 5. Firefly (*Photinus pyralis*) luciferase mRNA (1,653
 nucleotides)
 ATGGAAGACGCCAAAAACATAAAAGAAAGCCCGCGCCATTCTATCCGCTGGAAGATGGAACCG
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SEQ ID NO: 6. Firefly (*Photinus pyralis*) luciferase protein (555
 amino acids)
 MEDAKNIKKGPAPFYPLEDGTAGEQLHKAMKRYALVPGTIAFTDAHIEVDITYAEYFEMSVRLA
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 ALIMNSGSGTGLPKGVLPHTACVRFSHARDPIFGNQIIPDTAILSVVPFHHGFGMFTTLGYL
 ICGFRVVLMYRFEELFLRSLQDYKIQSALLVPTLFSFFAKSTLIDKYDLSNLHEIASGGAPLS
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NQRGELCVRGPMIMSGYVNNPEATNALIDKDGWLHSGDIAIYWDEDEHFFIVDRLKS LIKYKGYQ

VAPAELESIL LQHPNIFDAGVAGLPDDDAGELPAAVVVLEKGMTTEKEIVDYVASQVTTAKKL

RGGVVVFVDEVPKGLTGKLDARKIREILIKAKKGGKIAV

SEQ ID NO: 7. YAP15 S127 wildtype (WT) protein fragment (15 amino acids)
PQHVRHAASPASLQL

SEQ ID NO: 8. YAP15 A127 mutant protein fragment (15 amino acids)
PQHVRHAASPASLQL

SEQ ID NO: 9. pcDNA3.1/hygro(+) vector (5,597 nucleotides)
GACGGATCGGGAGATCTCCCGATCCCCATGGTGCCTCTCAGTACAATCTGCTCTGATGCCCG

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GTTTTGCGCTGCTTCGCGATGTACGGCCAGATATACGCGTTGACATTGATTATTGACTAGTTA

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AATGACGGTAAATGGCCCGCTGGCATTATGCCCAGTACATGACCTTATGGGACTTTCCTACTT

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 ACGGAAATGTTGAATACTCATACTCTTCTTTTCAATATTATTGAAGCATTTATCAGGGTTAT
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SEQ ID NO: 10. B1-Kozak-Nluc-F primer (41 nucleotides)
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SEQ ID NO: 11. Nluc-416-Yap-15-S127- (GGAGG) -R primer (84
 nucleotides)
 TTACAACCTGCAGAGAAGCTGGAGAGGAATGAGCTCGAACATGCTGTGGGCCTCCAGCTCCTCCT
 CCATCCTTGTCATCAAGGC

SEQ ID NO: 12. N1-Yap-5-Overlapping PCR-R primer (36
 nucleotides)
 ATGATACTGCGGCCGCTTACAACCTGCAGAGAAGCTG

SEQ ID NO: 13. B1-Kozak-14-3-3-F primer (38 nucleotides)
 CTGGATCCGCCACCATTGGAAGACGCCAAAACATG

SEQ ID NO: 14. (GGGS)₂-14-3-3-R primer (51 nucleotides)
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SEQ ID NO: 15. (GGGS)₂-Cluc394-F primer (39 nucleotides)
 GGTAGTGGAGGAGGAGGTAGTGGTCTATGATTATGTCC

SEQ ID NO: 16. N1-Cluc-R primer (34 nucleotides)
 ATGAAACTGCGGCCGCTTACACGGCGATCTTCC

SEQ ID NO: 17. Nluc398-15-S127- (GGAGG) -R primer (81 nucleotides)
 CAACCTGCAGAGAAGCTGGAGAGGAATGAGCTCGAACATGCTGTGGGCCTCCAGCTCCTCCATA
 ATCATAGGACCTCTCAC

SEQ ID NO: 18. Yap15-S127-Cluc394-F primer (42 nucleotides)
 TCTCCAGCTTCTCTGAGTGGGTCCTATGATTATGTCCGGT

SEQ ID NO: 19. N1-Yap15-S127-Cluc443 (engineered C-terminus of
 luciferase) -R primer (86 nucleotides)
 ATGAAACTGCGGCCGCTTACAACCTGCAGAGAAGCTGGAGAGGAATGAGCTCGAACATGCTGTGG
 CTCTTGCCCTTATGAGGATC

SEQ ID NO: 20. EcoR1-YAP-S127-BglII-S primer (55 nucleotides)
 AATTCACCACAGCATGTTTCGAGGTCATTCCTCCTCCAGCTTCTCTGAGTTGTGAA

SEQ ID NO: 21. EcoR1-YAP-S127-BglII-AS primer (55 nucleotides)
 GATCTTCACAACCTGCAGAGAAGCTGGAGAGGAATGAGCTCGAACATGCTGTGGT

SEQ ID NO: 22. EcoR1-YAP-A127-BglII-S primer (55 nucleotides)
 AATTCACCACAGCATGTTTCGAGGTCATTCCTCCTCCAGCTTCTCTGAGTTGTGAA

SEQ ID NO: 23. EcoR1-YAP-A127-BglII-AS primer (55 nucleotides)
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SEQ ID NO: 24. BglII-14-3-3-F primer (31 nucleotides)
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SEQ ID NO: 25. ECoR1-14-3-3-R primer (34 nucleotides)
CGCCGGAATTCCCGTTTTTCAGCCCTTCTGCCGC

SEQ ID NO: 26. pBiT 1.1 N (TK-Larg BiT) whole vector (3,858 nucleotides)
GGCCTAACTGGCCGTACCTGAGTCTAAATGAGTCTTCGGACCTCGCGGGGCCGCTTAACCGG
TGGTTAGGGTTTGTCTGACCGGGGGAGGGGAAGGAACGAAACACTCTCATTCCGAGGCGGC
TCGGGTTTGGTCTTGGTGGCCACGGGCACGCAGAAGAGCGCCGCGATCCTCTTAAGCACCCC
CCGCCCTCCGTGGAGCGGGGTTTGGTCCGCGGGTGGTAACGGCGGGCGGTACTCGGGCG
GGTCGCGCGCCCCAGAGTGTGACCTTTTCGGTCTGCTCGCAGACCCCCGGGCGGCGCCCGCG
GCGCGACGGGCTCGTGGTCTTAGGCTCCATGGGACCGTATACGTGGACAGGCTCTGGAGC
ATCCGCACGACTCGCGTGATATTAGCGGAGACCTTCTGCGGGACGAGCCGGTCCAGCGGCTGA
CGCGAGCGTCGGTTGGGCGACAAACAGCAGGACGGGCGACAGGTACACTATCTTGTACCCGG
AGGCGCGAGGGACTGCAGGAGCTTCAGGGAGTGGCGCAGCTGCTTCATCCCGTGGCCCGTTGC
TCGCGTTTGTGCGCGTGTCCCGGAAGAAATATATTGCATGTCTTTAGTTCATGATGACAC
AAACCCCGCCAGCGTCTTGTTCATTGGCGAAGTCGAACACGCAGATGCAGTCGGGCGGCGCG
TCCCAGTCCACTTCGCATATTAAGGTGACGCGTGTGGCCTCGAACACCGAGCGACCTGCAGC
GACCCGCTTAAAAGCTTGGCAATCCGGTACTGTTGGTAAAGCCACCATGGTCTTCACACTCGAA
GATTCGTTGGGACTGGGAACAGACAGCCGCTACAACTGGACCAAGTCTTGAACAGGGAG
GTGTGTCCAGTTTGTGTCAGAATCTCGCCGTGTCCGTAACCTCCGATCCAAAGGATTGTCCGGAG
CGGTGAAAATGCCCTGAAGATCGACATCCATGTATCATCCCGTATGAAGTCTGAGCGCCGAC
CAAAATGGCCAGATCGAAGAGGTGTTTAAAGTGGTGTACCTGTGGATGATCATCACTTTAAGG
TGATCCCTGCCCTATGGCACACTGGTAATCGACGGGTTACGCCGAACATGTGAACATTTCCG
ACGGCCGTATGAAGGCATCGCCGTGTTGACCGGCAAAAAGATCACTGTAACAGGGACCTGTGG
AACGGCAACAAAATATCGACGAGCGCTGATCACCCCGACGGCTCCATGCTGTTCCGAGTAA
GCATCAACAGTGGGAGTTCGGTGGTGGCGGGAGCGGAGGTGGAGGTCGAGCGTGGAGCTCA
GGGAATTCAAGCTAGCAGATCTTCTAGAGTCGGGGCGCCGGCCGCTTCGAGCAGACA
TGATAAGATAGATTGATGAGTTGGACAAACCACAACACTAGAATGCAGTAAAAAATGCTTTAT
TTGTGAAATTTGTGATGCTATTGCTTTATTTGTAACATTATAAGCTGCAATAAACAAGTTAAC
AACAAATTCGATTCATTTTATGTTTCAGGTTCAGGGGAGGTGTGGGAGGTTTTTTAAAGCA
AGTAAAACCTCTACAAATGTGTAATAAATCGATAAGGATCCGTCGACCGATGCCCTTGAGAGCCT
TCAACCCAGTCAGCTCCTTCCGGTGGGCGCGGGCATGACTATCGTCGCGCACTTATGACTGT
CTTCTTTATCATGCAACTCGTAGGACAGGTGCCGGCAGCGCTCTCCGCTTCTCGCTCACTGA
CTCGTGCCTCGGTGTTCCGGTCCGCGAGCGGTATCAGCTCACTCAAAGGCGGTAATACGG
TTATCCACAGAATCAGGGATAACGCAGGAAAGAACATGTGAGCAAAGGCGCAGCAAAGGCCA
GGAACCGTAAAAGGCGCGTGTCTGGCGTTTTTCCATAGGCTCCGCCCCCTGACGAGCATCA
CAAAAATCGACGCTCAAGTCAGAGGTGGCGAAACCCGACAGGACTATAAGATACCAGGCGTTT
CCCCCTGGAAGCTCCCTCGTGCCTCTCCTGTTCGACCCCTGCGGCTTACCGGATACCTGTCCG
CCTTCTCCCTCGGGAAGCGTGGCGCTTCTCATAGCTCACGCTGTAGGTATCTCAGTTCGGT
GTAGTCTGTTCCGCTCAAGCTGGGCTGTGTGCACGAACCCCGTTACGCCGACCGCTGCGCC
TTATCCGGTAACTATCGTCTTGGTCCAAACCCGGTAAGACACGACTTATCGCCACTGGCAGCAG
CCACTGGTAAACAGGATTAGCAGAGCGAGGTATGTAGCGGTGCTACAGAGTCTTGAAGTGGTG

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GCCTAACTACGGCTACACTAGAAAGAACAGTATTTGGTATCTGCGCTCTGCTGAAGCCAGTTACC
 TTCGAAAAAGAGTTGGTAGCTCTTGATCCGGCAAACAAACCACCGCTGGTAGCGGTGGTTTTT
 TTGTTTGCAAGCAGCAGATTACGCGCAGAAAAAAGGATCTCAAGAAGATCCTTTGATCTTTTC
 TACGGGGTCTGAGGCTCAGTGAACGAAAAGTCAGGTTAAGGGATTTTGGTCATGAGATTATCA
 AAAAGGATCTTACCTAGATCCTTTTTAAATTAATAAGTTTTAAATCAATCTAAAGTATA
 ATGAGTAACTTGGTCTGACAGCGGCCCAAATGCTAAACCACTGCAGTGGTTACCAGTGTCTG
 ATCAGTGAGGCACCGATCTCAGCGATCTGCCTATTTTCGTTCCGTCATAGTGGCTGACTCCCCG
 TCGTGTAGATCACTAGGATTCGTGAGGGCTTAGCATCAGCCCCAGCGCAGCAATGATGCCGCG
 AGAGCCGCGTTACACGGCCCCGATTTGTGACGAATGAACCAGCCAGCAGGGAGGGCCGAGCGA
 AGAAGTGGTCTGCTACTTTGTCCGCTCCATCCAGTCTATGAGCTGCTGTGATGCTAGAG
 TAAGAAGTTCCCGAGTGTAGTTTCCGAAGAGTTGTGGCCATTGCTACTGGCATCGTGGTATC
 ACGCTCGTCTGTTCCGTTAGGCTTCCGTTCAACTCTGGTTCAGCGGTCAGCCGGGTACATGA
 TCACCCATATTATGAAGAAATGCAGTCAGCTCCTTAGGGCTCCGATCGTTGTGAGAGTAAAGT
 TGGCCGCGGTGTGTGCTCATGGTAATGGCAGCACTACACAATTCTTACCCTCATGGCATC
 CGTAAGATGCTTTTCCGTGACCGGGGAGTACTCAACCAAGTCGTTTTGTGAGTAGTGTATACGG
 CGACCAAGCTGCTCTTGCCCGGCTGTATACGGGACAAACCCGCGCCACATAGCAGTACTTTGA
 AAGTGTCTCATCATCGGGAATCGTCTTTCGGGGCGAAAGACTCAAGGATCTTGCCGCTATTGAG
 ATCCAGTTCGATATAGCCACTCTTGCACCCAGTTGATCTTCAGCATCTTTTACTTTCACCAGC
 GTTTCGGGGTGTGCAAAAACAGGCAAGCAAAATGCCGCAAGAAGGGAATGAGTGCACACGAA
 AATGTTGGATGCTCATACTCGTCTTTTCAATATTATTGAAGCATTTATGAGGGTTACTAGTA
 CGTCTCTCAAGGATAAGTAAGTAATATTAAGGTACGGGAGGTATTGGACAGGCCGCAATAAAAT
 ATCTTTATTTTATTACATCTGTGTGGTTTTTTGTGTGAATCGATAGTACTAACATACGCT
 CTCCATCAAAAACAAAACGAAACAAAACAACTAGCAAAATAGGCTGTCCCCAGTGCAGTGCAG
 GTGCCAGAACATTTCTCT

SEQ ID NO: 27. pBiT 2.1 C (TK-SmBiT) whole vector (3,423
 nucleotides)

GGCCTAACTGGCCGTAACCTGAGTCTAAATGAGTCTTCGGACCTCGCGGGGCGCTTAAGCGG
 TGGTTAGGGTTTGTCTGACCGGGGGAGGGGAAGGAACGAAACACTCTCATTGAGGCGGC
 TCGGGGTTTGGTCTTGGTGGCCACGGGCACGCAGAGAGCGCCGATCCTCTTAAGCACCCCG
 CCGCCCTCCGTGAGCGGGGTTTGGTCGGCGGTGGTAACTGGCGGGCCGCTGACTCGGGCG
 GGTGCGCGCCCGCAGAGTGTGACCTTTTCGGTCTGCTCGGAGACCCCGGGCGGCGCCCGCG
 GCGGCGACGGCTCGTGGTCTTAGGCTCCATGGGACCGTATACGTGGACAGGCTCTGGAGC
 ATCCGCACGACTCGGTTGATATTACCGGAGACCTTGTGCGGGACGAGCCGGTCACGCGGTGA
 CGCGGAGCTCCGTTGGGCGACAAACACCAGGACGGGACAGGTACACTATCTTGTACCCGG
 AGGCGCGAGGGACTGACGAGGCTTCAGGGAGTGGCGAGCTGCTTCATCCCGTGGCCCGTTGC
 TCGGTTTGTGCGGTTGCTCCCGGAAGAAATATATTGATGCTTTTAGTCTATGATGACAC
 AAACCCCGCCAGCGCTTGTATTGGCGAAGTCGAACACGCAGATGCACTCGGGCGGCGCGG
 TCCCAGTCCACTTCGCATATTAAAGTGACGCGTGTGGCTCGAACACCGAGCGACCTGCAGC
 GACCCGCTTAAAGCTTGGCAATCCGTTACTGTGGTAAAGCCACCAGATCTGCTAGCGATCGCC
 TAAGTGGGAGCTCAGGGAAATCTGGCTCGAGCGGTGGTGGCGGAGCGGAGTGGAGGGTCTGT
 CAGGTGTGACCGCTACCGCTGTTTCGAGGAGATCTGTAATCTAGAGTCCGGGCGGCGGCGG

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CTCGAGCAGACATGATAAGATACATTGATGAGTTTGGACAAACCACAAC TAGAATGCAGTGAA
 AAAAAATGCTTTATTTGTGAAATTTGTGATGCTATTGCTTTATTTGTAACCATTATAAGCTGCAA
 TAAACAAGTTAAACAACAACAATTGCATTCATTTTATGTTTCAGGTTTCAGGGGGAGGTGTGGGAG
 GTTTTTAAAGCAAGTAAAAGCTCTACAAATGTGGTAAAATCGATAAGGATGCGTCGACCCGATG
 CCCTTGAGAGCCTTCAACCAGTCAGCTCCTTCCGGTGGGCGCGGGCATGACTATCGTCGCCG
 CAGTTATGACTGTCTTCTTATCATGCAACTCGTAGGACAGGTGCCGGCAGCGCTTCCGCTT
 CCTCGCTCACTGACTCGCTCGCTCGTTCGGCTGCGGCGAGCGGTATCAGCTCACTCAA
 GGCGGTAATACGGTTATCCACAGAATCAGGGGATAACGCAGGAAAGAACATGTGAGCAAAAGGC
 CAGCAAAAGGCCAGGAACCGTAAAAAGGCCGCTTGCTGGCGTTTTTCCATAGGCTCCGCCCC
 CTGACGAGCATCAAAAAATCGACGCTCAAGTCAGAGGTGGCGAAACCCGACAGGACTATAAAG
 ATACCAGGCGTTTTCCCTGGAAGCTCCCTCGTGCCTCTCTGTTCGGACCTCGCGCTTACC
 GGATACCTGTCCGCTTCTCCCTTCCGGAAGCGTGGCGCTTCTCATAGCTCAGCTGTAGGT
 ATCTCAGTTCGGGTAGGTGTTTCGCTCCAAGCTGGGCTGTGTGCACGAACCCCGTTCAGCC
 CGACCGCTGCGCTTATCCGGTAACTATCGTCTTGTAGTCCAACCCGGTAAAGACAGACTTATCG
 CCACTGGCAGCAGCACTGGTAAACAGGATTAGCAGAGCGAGGTATGTAGGCGGTGTACAGAGT
 TCTTGAAGTGGTGGCCTAACTACGGCTACACTAGAAGAACAGTATTTGGTATCTGCGCTCTGCT
 GAAGCCAGTTACCTTCGGAAAAAGAGTTGGTAGCTCTTGATCCGGCAAAACAAACCCCGTGGT
 AGCGGTGGTTTTTTTGTTCAGCAGCAGATTACGCGCAGAAAAAAGGATCTCAAGAAGATC
 CTTTGATCTTTTCTACGGGTCTGACGCTCAGTGAACGAAAACTCACGTTAAGGGATTTTGGT
 CATGAGATTATCAAAAAGGATCTTACCTAGATCCTTTAAATTA AAAATGAAGTTTTAAATCA
 ATCTAAAGTATATATGAGTAACTTGGTCTGACAGCGCCGCAATGTAAACCACTGCAGTGG
 TTACCAGTGTGATCAGTGAAGCAGGATCTCAGCGATCTGCCTATTTTCGTTCCGCTAGTGTG
 GCCTGACTCCCGCTCGTGTAGATCACTACGATTCTGTGAGGGCTTACCATCAGGCCCCAGCGCAG
 CAATGATGCCGCGAGAGCCGCTTACCGGCCCGATTTGTGAGCAATGAACCAGCCAGCAGG
 GAGGCCGAGCGAAGAGTGGTCTGCTACTTTGTCCGCTCCATCCAGTCTATGAGCTGCTGT
 CGTGATGCTAGAGTAAGAAGTTCGCCAGTGAAGTTCGGAAGAGTTGTGGCCATTGCTACTG
 GCATGGTGGTATCAGCTCGTTCGGTATGGCTTCGTTCAACTCTGGTCCCAGCGGTCAAG
 CCGGTCACATGATCACCATATATGAAGAAATGCAGTCAGCTCCTTAGGGCCTCCGATCGTT
 GTCAGAAGTAAAGTTGGCCGCTGTGTCGCTCATGGTAATGGCAGCACTACACAATCTCTTA
 CCGTCATGCCATCCGTAAGATGCTTTTCCGTGACCGCGAGTACTCAACAGTCTTTTGTGA
 GTAGTGATACCGCGACCAAGCTGCTGTTGCCGCGCTCTATACGGGACAACCCGCGCCACAT
 AGCAGTACTTTGAAAGTGTCTCATCATCGGGAATCGTCTTCCGGGCGGAAAGACTCAAGGATCT
 TGCCGCTATTGAGATCCAGTTCGATATAGCCCACTCTTGCAACCCAGTGTATCTTCAGCATCTT
 TACTTTCACCGCTTTCCGGGTGTGCAAAAACAGGCAAGCAAAATGCCGCAAGAAGGGAATG
 AGTGCACACGAAAATGTTGGATGCTCATACTCGTCTTTTTTCAATATTATGAAGCATTATC
 AGGGTTACTAGTACGCTCTCAAGGATAAGTAAGTAATATTAAGGTACGGGAGGTATTGGACAG
 GCCGCAATAAAATATCTTTATTTTACATCTGTGTGTTGGTTTTTTGTGTGAATCGATAGT
 ACTAACATACGCTCTCCATCAAAACAAAACGAAACAAAACAACTAGCAAAATAGGCTGTCCC
 AGTGCAAGTGCAGGTGCCAGAACATTTCTCT

SEQ ID NO: 28. NdeI-LgBiT-YAP15-F primer (38 nucleotides)
 GGAATTCATATGATGGTCTTCACACTCGAAGATTCGT

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SEQ ID NO: 29. B1-LgBiT-YAP15-R primer (40 nucleotides)
CGCGGGATCCTTACAACCTGCAGAGAAGCTGGAGAGGAATG

SEQ ID NO: 30. B1-LgBiT-YAP15A127-R primer (43 nucleotides)
CGCGGGATCCTTACAACCTGCAGAGAAGCTGGAGACGCATGAGC

SEQ ID NO: 31. NdeI-14-3-3-SmBiT-F primer (38 nucleotides)
GGAATTCATATGATGGAGAAGACTGAGCTGATCCAGAA

SEQ ID NO: 32. B1-14-3-3-SmBiT-R primer (40 nucleotides)
CGCGGGATCCTTACAGAATCTCCTCGAACAGCCGGTAGCC

SEQ ID NO: 33. pET 16b (6 his N-terminal) whole vector (5,711 nucleotides)
TCTCATGTTTGACAGCTTATCATCGATAAGCTTAAATGCGGTAGTTTATCACAGTTAAATTGC
TAACGCAGTCAGGCACCGTGTATGAAATCTAACAATGCGCTCATCGTCATCCTCGGCACCGTCA
CCCTGGATGCTGTAGGCATAGGCTTGGTTATGCGCGTACTGCCGGCCCTTTCGGGATATCCG
GATATAGTTCCTCTTTCAGCAAAAAACCCCTCAAGACCCGTTTAGAGGCCCAAGGGTTATG
CTAGTTATTGCTCAGCGGTGGCAGCAGCAACTCAGCTTCCTTTCGGGCTTGTAGCAGCCGG
ATCCTCGAGCATATGACGACCTTCGATATGGCCGCTGCTGTGATGATGATGATGATGATGATGA
TGATGGCCCATGTTATATCTCCTTCTTAAAGTTAAACAAAATTATTTCTAGAGGGGAATTGTTA
TCCGCTCACAATTCCTTATAGTGAGTCGATTAATTTTCGGGGATCGAGATCTCGATCCTCTA
CGCCGGACGCATCGTGGCCGGCATCACCGCGCCACAGGTGCGGTTGCTGGCGCCTATATCGCC
GACATCACCGATGGGAAGATCGGGCTCGCCACTTCGGGCTCATGAGCGCTTGTTCGCGTGG
GTATGGTGGCAGGCCCGTGGCCGGGGACTGTTGGGCGCCATCTCCTTGCATGCACCATTCCT
TGCGCGCGGCTGCTCAACGGCCTCAACCTACTACTGGGCTGCTTCTAATGCAGGAGTCGCAT
AAGGGAGAGCGTCGAGATCCCGACACCATCGAATGGCGCAAAACCTTTCGCGGTATGGCATGA
TAGCGCCCGGAAGAGAGTCAATTCAGGGTGGTGAATGTGAAACAGTAACGTTATACGATGTCG
CAGAGTATGCCGCTGTCTTTATCAGACCGTTTCCCGCGTGGTGAACCAGGCCAGCCACGTTTC
TGCAGAAAACGCGGAAAAAGTGAAGCGCGATGGCGGAGCTGAATTACATTCCTCAACCGCGTG
GCACAACAACCTGGCGGGCAACAGTCGTTGCTGATTGGCGTTGCCACCTCCAGTCTGGCCCTGC
ACGCGCCGTCGCAAAATGTCGCGGCGATTAAATCTCGCGCCGATCAACTGGGTGCCAGCGTGGT
GGTGTGATGGTAGAACGAAGCGCGCTCGAAGCCTGTAAAGCGCGGTGCACAATCTTCTCGCG
CAACGCGTCAGTGGGCTGATCATTAACTACTCCGCTGGATGACCAGGATGCCATTGCTGTGGAAG
CTGCCTGCACATAATGTTCCGGCGTTATTTCTTGATGTCCTGACCAGACCCATCAACAGTAT
TATTTTCTCCCATGAAGACGGTACGCGACTGGGCGTGGAGCATCTGGTCGCATTGGGTCAACAG
CAAAATCGCGCTGTTAGCGGGCCATTAAAGTTCGTCTCGCGCGCTCTGCTGTGGTGGCTGGC
ATAAATATCTCACTCGCAATCAAATTCAGCCGATAGCGGAACGGGAAGGCGACTGGAGTGCAT
GTCCGGTTTTCAACAAACCATGCAAAATGCTGAATGAGGGCATCGTCCACATGCGATGCTGGTT
GCCAACGATCAGATGGCGCTGGGCGCAATGCGCGCCATTACCGAGTCCGGGCTGCGCGTGGTG
CGGATATCTCGGTAGTGGGATACGACGATACCGAAGACAGCTCATGTTATATCCGCGGTTAAC
CACCATCAACAGGATTTTCGCTGCTGGGCAAAACAGCGTGGACCGCTTGTGCAACTCTCT
CAGGGCCAGGCGGTGAAGGGCAATCAGCTGTTGCCCGTCTCACTGGTGAAAAGAAAAACCCC
TGGCGCCCAATACGCAAAACCGCTCTCCCCGCGGTTGGCCGATTCATTAATGCAGCTGGCACG
AGAGGTTTTCCGACTGGAAGCGGGCAGTGAGCGCAACGCAATTAATGTAAGTTAGCTCACTCA
TTAGGCACCGGATCTCGACCGATGCCCTTGAGAGCGTTCAACCCAGTCAGCTCCTTCCGGTGG
GCGCGGGCATGACTATCGTCGCGCACTTATGACTGTCTTCTTTATCATGCAACTCGTAGGAC
AGGTGCCGCGACGCTCTGGGTCAATTTTCGGCGAGGACCGCTTTCGCTGGAGCGGACGATGAT

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CGGCCTGTGCTTGGGTATTTCGGAATCTTGCACGCCCTCGCTCAAGCCTTCGTCACTGGTCCC
GCCACCAAACGTTTCGGCGAGAAGCAGGCCATTATCGCCGGCATGGCGGCCGACGCGTGGGCT
ACGTCTTGTGCGGTTTCGGCGACGCGAGGCTGGATGGCGTTCGCCATTATGATTCTTCTCGCTTC
CGCGGCATCGGGATGCCCGCTTGCAGGCCATGCTGTCCAGGCAGGTAGATGACGACCATCAG
GGACAGCTTCAAGGATCGCTCGCGCTCTTACCAGCCTAACTTCGATCACTGGACCGTGATCG
TCACGGCGATTTATGCCGCTCGGCGAGCACATGGAACGGGTTGGCATGGATTGTAGGCGCCGC
CCTATACCTTGTCTGCTCCCGGTTGCGTCGCGGTGCATGGAGCCGGGCACCTCGACCTGA
ATGGAAGCCGGCGCACCTCGCTAACGGATTACCACTCCAAGAATTGGAGCCAATCAATTCTT
GCGGAGAACTGTGAATGCGCAAACCAACCCTTGGCAGAACATATCCATCGCGTCCGCCATCTCC
AGCAGCCGACGCGGCATCTCGGCGAGCCTTGGGTCCTGGCCACGGGTGCGCATGATCGTGC
TCTGTGTTGAGGACCCGGCTAGGCTGGCGGGTTCCTTACTGGTTAGCAGAATGAATCACC
GATACGCGAGCAAACGTTGAAGCGACTGTGCTGCAAAAAGTCTGCGACCTGAGCAACAACATGA
ATGGTCTTCGGTTTCGGTTCGTAAAGTCTGGAACCGGAAAGTCAAGCGCTGACCATTA
TGTTCCGGATCTGCATCGCAGGATGCTGCTGGCTACCTGTGGAACACCTACATCTGTATTAAC
GAAGCGCTGGCATTGACCTGAGTGATTTTCTCTGGTCCCGCCGCATCCATACCGCCAGTTGT
TTACCTCACAACTTCCAGTAACCGGCATGTTTATCATCAGTAACCCGTATCGTGAGCATCC
TCTCTGTTTTCATCGGTATCATTACCCCCATGAACAGAAATCCCCCTTACACGGAGGCATCAGT
GACCAAACAGGAAAAACCGCGCTTAACATGGCCCGCTTTATCAGAAGCCAGACATTAACGCTT
CTGGAGAACTCAACAGAGTGGACCGGATGAACAGGCAGACATCTGTGAATCGCTTCACGACC
ACGCTGATGAGCTTTACCGCAGTGCCTCGCGGTTTCGGTGTGACGGTGAACCTCTGACA
CATGCAGTCCCGGAGACGGTACAGCTTGTCTGTAAGCGGATGCCGGAGCAGACAAGCCCGT
CAGGGCGGCTCAGCGGTGTTGGCGGTGTCGGGGCGCAGCCATGACCCAGTACGTAGCGATA
GCGGAGTGATACTGGCTTAACTATGCGGCATCAGAGCAGATTGACTGAGAGTGCACCATATA
TGCGGTGTGAATAACCGCACAGATGCGTAAGGAGAAAAATCCGCATCAGGCGCTGTTCCGGTTC
CTCGCTCACTGACTCGCTCGCTCGGTCGTTTCGGCTGCGGCGAGCGGTATCAGCTCACTCAAAG
GCGGTAATACGGTTATCCACAGAATCAGGGGATAACGCGGAAAGAACATGTGAGCAAAAGGCC
AGCAAAAGGCAGGAACCGTAAAAAGCCGCTTGCCTGGCGTTTTTCCATAGGCTCCGCCCC
TGACGAGCATCACAAAATCGACGCTCAAGTCAGAGGTGGCGAAACCCGACAGGACTATAAAGA
TACCAGCGTTTTCCCTGGAAGCTCCCTCGTGCCTCTCTGTTCCGACCTGCCGCTTACCG
GATACCTGTCCGCTTTCTCCCTTCGGGAAGCGTGGCGCTTCTCATAGCTCACGCTGATAGGTA
TCTCAGTTCGGTGTAGTCTGCTCCAGCTGGGCTGTGTGCACGAACCCCGTTAGCCC
GACCGCTGCGCCTTATCCGGTAAGTATGGTCTTGAGTCCAACCCGGTAAGACACGACTTATCGC
CACTGGCAGCAGCCACTGGTAACAGGATTAGCAGAGCGAGGTATGTAGGCGGTGCTACAGAGTT
CTTGAAGTGGTGGCCTAACTACGGCTACACTAGAAGGACAGTATTTGGTATCTGCGCTCTGCTG
AAGCCAGTTACCTTCGGAAGAGTTGGTAGCTCTTGATCCGGCAAACAACCCCGCTGGTA
GCGGTGGTTTTTTGTTTGAAGCAGCAGATTACGCGCAGAAAAAAGGATCTCAAGAAGATCC
TTTGATCTTTCTACGGGGTCTGACGCTCAGTGGAAACGAAACTCACGTTAAGGGATTTTGGTC
ATGAGATTATCAAAAAGGATCTTACCTAGATCCTTTTAAATTAATAAATGAAGTTTAAATCAA
TCTAAAGTATATATAGTAAACTTGGTCTGACAGTTACCAATGCTTAATCAGTGAGGCACCTAT
CTGAGCGATCTGCTATTTTCGTTTATCCATAGTTGCCTGACTGCCCGTGTAGATAACTACG

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ATACGGGAGGGCTTACCATCTGGCCCCAGTGTGCAATGATACCGGGAGACCCACGCTCACCGG
 CTCCAGATTTATCAGCAATAAACAGCCAGCCGGAAGGGCCGAGCGCAGAAGTGGTCTTGC AAC
 TTTATCCGCCCTCCATCCAGTCTATTAATTTGTTGCCGGGAAGCTAGAGTAAGTAGTTCCGCAGTT
 AATAGTTTGCACAAAGTTGTTGCCATTGCTGCAGGCATCGTGGTGTACGCTCGTCTTGGTA
 TGGCTTCATTACAGTCCGGTCCCAACGATCAAGGCGAGTTACATGATCCCCATGTTGTGCAA
 AAAAGCGGTTAGTCTCTCGGTCTCCGATCGTTGTGAGAAGTAAGTTGGCCGAGTGTATCA
 CTCATGGTTATGGCAGCACTGCATAATCTCTTACTGTGCATGCCATCCGTAAGATGCTTTTCTG
 TGACTGGTGTAGTACTCAACCAAGTCAATCTGAGAATAGTGTATGCGGCGACCGAGTTGCTCTG
 CCCGGCGTCAACACGGGATAATACCGGCCACATAGCAGAACTTTAAAAGTGCTCATATTGGA
 AACGTTCTTCGGGGCGAAAACCTCTCAAGGATCTTACCGCTGTTGAGATCCAGTTCGATGTAAC
 CCCTCGTGCACCACTGATCTTCAGCATCTTTACTTTTCCAGCAGCGTTTCTGGGTGAGCAA
 AACAGGAAGGCAAAATGCCGCAAAAAGGGAATAAGGGCGACACGAAATGTTGAATACTCATA
 CTCTTCTTTTTCAATATTATTGAAGCATTATCAGGGTTATTGTCTCATGAGCGGATACATAT
 TTGAATGTATTAGAAAAATAAACAAATAGGGGTTCCGCGCACATTTCCCGAAAAGTGCCACC
 TGACGTCTAAGAAACCATATTATCATGACATTAACCTATAAAAAATAGGCGTATCACGAGGCC
 TTTCGTCTTCAAGAA

SEQ ID NO: 34. B1-Kozak-LgBiT-F primer (41 nucleotides)
 CTGGATCCGCCGCCACCATGGTCTTTCACACTCGAAGATTTC

SEQ ID NO: 35. LgBiT-(GS)-R primer (54 nucleotides)
 ACCGCTCGAGCCTCCACCTCCGCTCCGCCACCACCGAACTCCACTGTTGAT

SEQ ID NO: 36. (GS)-YAP50-F primer (69 nucleotides)
 GGGAGTTCGGTGGTGGCGGAGCGGAGGTGGAGGCTCGAGCGGTCCGGGCATCAGATCGTGC
 ACGTC

SEQ ID NO: 37. N1-YAP171-Flag-R primer (63 nucleotides)
 ATGAAACTGCGGCCGCTTGTGTGATCGTCTTTGTAGTCTACATCATCAGGTATCTCAAAA

SEQ ID NO: 38. B1-YAP50-F primer (32 nucleotides)
 CTGGATCCGCCGGGCATCAGATCGTGCACGTC

SEQ ID NO: 39. (GS)-YAP171-R primer (68 nucleotides)
 ACCTGACGACCTCCACCTCCGCTCCGCCACCACCGCTCGAGCTACATCATCAGGTATCTCA

AAAG

SEQ ID NO: 40. (GS)-LgBiT-F primer (66 nucleotides)
 GGCTCGAGCGGTGGTGGCGGAGCGGAGGTGGAGGGTGTGAGGTGTTTTCACACTCGAAGATT

TC

SEQ ID NO: 41. N1-LgBiT-R primer (43 nucleotides)
 ATGAAACTGCGGCCGCTTAACTGTTGATGGTTACTCGGAACAG

SEQ ID NO: 42. B1-Kozak-SmBiT-(GS)-F primer (98 nucleotides)
 CTGGATCCGCCGCCACCATGGTGTGACCGCTACCGGCTGTTGAGGAGATTCTCGGAGTTCCGG

TGGTGGCGGAGCGGAGGTGGAGGCTCGAGCGGT

SEQ ID NO: 43. N1-SmBiT-(GS)-R primer (97 nucleotides)
 ATGAAACTGCGGCCGCTTAGAGAATCTCTCGAACAGCCGGTAGCCGTCACACTGACGACCC

TCCACCTCCGCTCCGCCACCACCGCTCGAGCC

SEQ ID NO: 44. (GS)-TEAD-194-F primer (73 nucleotides)
 GGGAGTTCGGTGGTGGCGGAGCGGAGGTGGAGGCTCGAGCGGTGAGCCTGCATCGGCCCCAG

CTCCCTCAG

SEQ ID NO: 45. N1-TEAD411-Myc-R primer (73 nucleotides)
 ATGAAACTGCGGCCGCTTACAGATCTCTTCTGAGATGAGTTTTTGTTCATTTGAACTTCAAA

CACACAGGC

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SEQ ID NO: 46. B1-TEAD194-F primer (36 nucleotides)
CTGGATCCGAGCCTGCATCGGCCCCAGCTCCCTCAG

SEQ ID NO: 47. GS-TEAD-411-R primer (69 nucleotides)
ACCTGACGACCCCTCCACCTCCGCTCCC GCCACCACCCTCGAGCCATTTGAAACTTCAAACACA
CAGGC

SEQ ID NO: 48. (GS)-TEAD194-F primer (73 nucleotides)
GGGAGTTCCGGTGGTGGCGGGAGCGGAGGTGGAGGCTCGAGCGGTGAGCCTGCATCGGCCCCAG
CTCCCTGAG

SEQ ID NO: 49. TEAD1_HUMAN transcriptional enhancer factor TEF-1
(accession number P28347) mRNA (1,281 nucleotides)
ATTGAGCCAGCAGCTGGAGCGGCAGTGAGAGCCCTGCCGAAAACATGGAAAGGATGAGTGACT
CTGCAGATAAGCCAATTGACAATGATGCAGAAGGGGCTGGAGCCCCGACATCGAGCAAACCTT
TCAGGAGGCCCTGGCTATCTATCCACCATGTGGGAGGAGGAAAATCATCTTATCAGACGAAGGC
AAAAATGTATGGTAGGAATGAATTGATAGCCAGATACATCAAACCTCAGGACAGGCAAGACGAGGA
CCAGAAAAACAGGTGTCTAGTCACATTCAGGTTCTTGCCAGAAGGAAAATCTCGTGATTTTCATTTC
CAAGCTAAAGGATCAGACTGCAAAGGATAAGGCCCTGCAGCACATGGCGGCCATGTCCCTCAGCC
CAGATCGTCTCGGCCACTGCGATTATAAGAAGCTGGGGCTGCC TGGGATTCCACGCCCGACCT
TCCCAGGGGCGCCGGGTTCTGGCCGGGAATGATTCAAACAGGGCAGCCAGGATCCTCACAGA
CGTCAAGCCTTTTGTGCAGCAGGCCCTACCCCATCCAGCCAGCGGTACAGCCCCCATTCAGGG
TTTGACCTGCATCGGCCCCAGCTCCCTCAGTCCCTGCCTGGCAAGGTCGCTCCATTGGCACAA
CCAAGCTTCGCTGTGGAATTTTCAGCTTTTCTCGAGCAGCAGGAGACCAGACTCGTACAA
CAAACACCTCTTCGTGCACATTGGGCATGCCAACCATTTCTTACAGTGACCCATTGCTTGAATCA
GTGGACATTCGTGAGATTTATGACAAATTTCTGAAAAGAAAGGTGGCTTAAAGGAACTGTTTG
GAAAGGGCCCTCAAATGCCTTCTCCTCGTAAAATTTGGGCTGATTTAAACTGCAATATTCA
AGATGATGGTGGGCTTTTATGGTGTAAACAGTCAGTACGAGAGTTCTGAAAATATGACAGTC
ACCTGTTCCACCAAAGTTTCTCCTTTGGGAAGCAAGTAGTAGAAAAAGTAGAGACGGAGTATG
CAAGGTTTGAGAATGGCCGATTTGTATACCGAATAAACCGCTCCCAATGTGTGAATATATGAT
CAACTTCATCCACAAGCTCAAACACTTACCAGAGAAATATATGATGAACAGTGTTTTGGAAAAC
TTCACAATTTTATTGGTGGTAACAAACAGGGATACACAAGAACTCTACTCTGCATGGCCGTGTG
TGTTTGAAGTTTCAAATAGTGAACACGGAGCACAAACATCATATTTACAGGCTTGTAAGGACTG
A

SEQ ID NO: 50. TEAD1_HUMAN protein (426 amino acids)
MEPSSWSGESPAENMERMSDSADKPIDNDAEGVWSPDIEQSFQEALAIYPPCGRRKIILSDEG
KMYGRNELIARYTKLRTGRTRKQVSSHIVLARRKSRDFHSLKLDQTAKD KALQHMAAMSSA
QIVSATAIHNKLG LPLGIPRPTFPGAPGFWPGMIQTGQPGSSQDVKPFVQOAYPIQPAVTAPIG
FEPASAPAPSVPAWQGRSIGTTKLRLEFSAFLEQQRDPDSYNKHLFVHIGHANHSYS DPLES
VDIRQIYDKPPEKKGGLKELFGKGPQNAFFLVKFWADLNCNIQDDAGAFYGVTSQYESSNMVT
TCSTKVCSPFGKQVVEKVETBYARFENGRFVYRINRSPMCEYMINFIHKLKHLPEKYMMSVLEN
FTILLVVVTRNDTQETLLCMACVFEVSNSEHGAQHIIYRLVKD

SEQ ID NO: 51. Large BiT (LgBiT) mRNA (477 nucleotides)
ATGGTCTTCACTCGAAGATTTCTGTTGGGACTGGGAACAGACAGCCGCTACAACTGGACC
AAGTCTTGAACAGGGAGGTGTGTCCAGTTTGTCTGCAGAATCTCGCCGTGTCGGTAACTCCGAT
CCAAAGGATTTGTCGGAGCGGTGAAAATGCCCTGAAGATCGACATCCATGTGCATCATCCCGTAT
GAAGTCTGAGCGCCGACCAATGGCCAGATCGAAGAGGTGTTTAAAGTGGTGTACCTGTGG

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ATGATCATCACTTTAAGGTGATCCTGCCCTATGGCACACTGGTAATCGACGGGGTTACGCCGAA
 CATGCTGAACATTTTCGGACGGCCGTATGAAGGCATCGCCGTGTTTCGACGGCAAAAAGATCACT
 GTAACAGGGACCCCTGTGGAACGGCAACAAAATTATCGACGAGCGCCTGATCACCCCGACGGCT
 CCATGCTGTTCCGAGTAACCATCAACAGT

SEQ ID NO: 52. Large BiT (LgBiT) protein (159 amino acids)
 MVFTLEDFVGDWEQTAAYNLDQVLEQGGVSSLQNLAVSVTPIQRIVRSGENALKIDIHVIIPIY
 EGLSADQMAQIEEVFKVVPVDDHHFKVILPYGTLVIDGVTNMLNYFGRPYSGIAVFDGKKIT
 VTGTLWNGNKIIDERLITPDGSMLEFRVTINS

SEQ ID NO: 53. Small BiT (SmBiT) mRNA (36 nucleotides)
 ATGGTGACCGGCTACCGGCTGTTTCGAGGAGATTCTC

SEQ ID NO: 54. Small BiT (SmBiT) protein (11 amino acids)
 MVTGYRLFEIL

SEQ ID NO: 55. pcDNA3.1/hygro(+)-Flag vector (5,490 nucleotides)
 GACGGATCGGGAGATCTCCCGATCCCCATGGTGCCTCTCAGTACAATCTGCTCTGATGCCCG
 ATAGTTAAGCCAGTATCTGCTCCCTGCTTGTGTGTTGGAGGTCGCTGAGTAGTGCAGCAGCAA
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 TTTTGCCTGCTTCGCGATGTACGGGCCAGATATACGCGTTGACATTGATTATTGACTAGTTAT
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 GTATGTTCCCATAGTAAAGCCAAATAGGGACTTCCATTGACGTCAATGGGTGGAGTATTTACGG
 TAACTGCCCACTTGGCAGTACATCAAGTGTATCATATGCAAGTACGCCCCCTATTGACGTCA
 ATGACGGTAAATGGCCCGCTGGCATTATGCCAGTACATGACCTTATGGGACTTTCCTACTTG
 GCAGTACATCTACGTATTAGTCATCGCTATTACCATGGTGTGCGGTTTGGCAGTACATCAAT
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 GTTTGTTTTGGCACCAAAATCAACGGGACTTTCAAAATGTGTAACAACCTCCGCCCATGAC
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 AGCGTTTAAACTTAAGCTTGGTACCATTGACTACAAGACGATGACGGTGATTATAAAGATCAT
 GACATCTACCTGATGTTTCTGGTACTGCCAGGATCCACTAGTCCAGTGTGGTGGAAATCTGCAG
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SEQ ID NO: 56 pcDNA3.1/hygro(+)-Myc vector (5,455 nucleotides)
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SEQ ID NO: 57. Intermolecular biosensor Nluc-YAP15 in pcDNA3.1/
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SEQ ID NO: 58. Intermolecular biosensor 14-3-3-Cluc in pcDNA3.1/
 hygro(+) vector (6,621 nucleotides)

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SEQ ID NO: 59. NanoBiT Biosensor: LgBiT-YAP15 in pBiT 1.1 N
 vector (3,890 nucleotides)
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SEQ ID NO: 60. NanoBiT Biosensor: 14-3-3-LgBiT in pBiT2.1-C
vector (4,131 nucleotides)
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SEQ ID NO: 61. NanoBiT Biosensor: LgBiT-YAP15 in pET16b vector
(6,291 nucleotides)
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TTTTGCCTTCCTGTTTTTGTCCACCAGAAAACGCTGGTGAAAAGTAAAAGATGCTGAAGATCAGT
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CCCCGAAGAACGTTTTTCCAATGATGAGCACTTTTAAAGTTCTGCTATGTGGCGCGTATTATCC
CGTGTGACGCCGGCAAGAGCAACTCGGTCGCCCATACACTATTCTCAGAATGACTTGGTTG
AGTACTCACCAGTCACAGAAAAGCATCTTACGGATGGCATGACAGTAAGAGAATTATGCAGTGC
TGCCATAACCATGAGTGATAACACTGCGGCCAACTTACTTCTGACAACGATCGGAGGACCGAAG
GAGCTAACCGCTTTTTTGCACAACATGGGGGATCATGTAACCTCGCCTTGATCGTTGGGAACCGG
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TAAGCCCTCCCGTATCGTAGTTATCTACACGACGGGGAGTCAGGCAACTATGGATGAACGAAAT
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TTTTGATAATCTCATGACAAAATCCCTAACGTGAGTTTTTCGTTCCACTGAGCGTCAGACCCC
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CAATGCCAGCGCTTCGTTAATAACAGATGATAGGTGTTCCACAGGGTAGCCAGCAGCATCTGCCA
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GAAACCGAAGACCATTCATGTTGTTGCTCAGGTCGACAGCGTTTTGACGACGAGTCTGCTCAC

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SEQ ID NO: 62. NanoBiT Biosensor: SmBiT in pET16b vector
(6,531 nucleotides)
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 GAA

SEQ ID NO: 63. YAP-TEAD NanoBiT biosensor construct 1: LgBiT-
 YAP50-171-Flag in pcDNA3.1-hygro vector (6,297 nucleotides)
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SEQ ID NO: 64. YAP-TEAD NanoBiT biosensor construct 2: Flag-
 YAP50-171-LgBiT in pcDNA3.1-hygro vector (6,270 nucleotides)
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 SEQ ID NO: 65. YAP-TEAD NanoBiT biosensor construct 3: SmBiT-
 YAP50-171-Flag in pcDNA3.1-hygro vector (5,856 nucleotides)
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SEQ ID NO: 66. YAP-TEAD NanoBiT biosensor construct 4: Flag-YAP50-171-SmBiT in pcDNA3.1-hygro vector (5,829 nucleotides)
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GCAGGTTCTCCGGCGCTGGGTGGAGAGGCTATTCGGCTATGACTGGGCACAACAGACAATCG
GCTGCTCTGATGCCCGCTGTTCCGGCTGTGAGCGCAGGGGCCCGGTTCTTTTTGTCAAGAC
CGACTGTCCGGTCCCTGAATGAACTGCAGGACGAGGCAGCGCGGCTATCGTGGCTGGCCACG
ACGGCGTTCTTCGCGCAGCTGTGCTCGACGTGTCTACTGAAGCGGAAGGACTGGCTGTAT
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GCGAAACATCGCATCGAGCGAGCACGTACTCGGATGGAAGCCGGTCTTGTGATCAGGATGATC
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CTGCATTAATGAATCGCCAACCGCGGGGAGAGGCGGTTTGCATATTGGGCGCTTCCGCTT
CCTCGCTCACTGACTCGCTCGGTCGTTCCGGTGCAGGCGAGCGGTATCAGCTCACTCAA
GGCGGTAATACGGTTATCCACAGAATCAGGGGATAACGACAGAAAGAACATGTGAGCAAAAGGC
CAGCAAAAAGCCAGAAACGTAATAAAGCCGCTGTGCGGTTTTTCCATAGGCTCCGCCCCC
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TAAAGTATATATGAGTAAACTTGGTCTGACAGTTACCAATGCTTAATCAGTGAGGCACCTATCT
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 CCAGATTTATCAGCAATAAACCCAGCCAGCCGGAAGGGCCGAGCGCAGAAGTGGTCTGCAACTT
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 ACGTCTCTCGGGGCAAAAAGTCTCAAGGATCTTACCGCTGTTGAGATCCAGTTCGATGTAACCC
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 ACGTC

SEQ ID NO: 67. YAP-TEAD NanoBiT biosensor construct 5: LgBiT-
 TEAD1-194-411-Myc in pcDNA3.1-hygro vector (6,592 nucleotides)
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 GTTTTGCGCTGCTTCGCGATGTACGGGCCAGATATACGCGTTGACATTGATTATTGACTAGTTA
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CCAGATCGAAGAGGTGTTAAGGTGGTGTACCCTGTGGATGATCATCACTTTAAGGTGATCCTG
CCCTATGGCACTGTTAATCGACGGGTTACGCCGAACATGCTGAACTATTTCCGACGGCCGT
ATGAAGGCATCGCCGTGTTCCGACGGCAAAAAGATCACTGTAAACAGGGACCCCTGTGAAACGGCAA
CAAAATTATCGACGAGCGCTGATCACCCCGACGGCTCCATGCTGTCCGAGTAAACCATCAAC

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AGTGGGAGTTCGGTGGTGGCGGGAGCGGAGGTGGAGGCTCGAGCGGTTGAGCCTGCATCGGCC
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SEQ ID NO: 68. YAP-TEAD NanoBiT biosensor construct 6: Myc-TEAD1-194-411-LgBiT in pcDNA3.1-hygro vector (6,559 nucleotides)
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 ACACGGAAATGTGAATACTCATACTTTCCTTTTCAATATTATGAAGCATTATCAGGGTT
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 CACATTTCCCGAAAAGTGCCACCTGACGTC

SEQ ID NO: 69. YAP-TEAD NanoBiT biosensor construct 7: SmBiT-
 TEAD1-194-411-Myc in pcDNA3.1-hygro vector (6,151 nucleotides)
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EQUIVALENTS

While the invention has been described with respect to illustrative embodiments thereof, it will be understood that various changes may be made to the embodiments without departing from the scope of the invention. Accordingly, the described embodiments are to be considered merely exemplary and the invention is not to be limited thereby.

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 Gln Met Arg Leu Gln Gln Leu Gln Met Glu Lys Glu Arg Leu Arg Leu
 305 310 315
 Lys Gln Gln Glu Leu Leu Arg Gln Ala Met Arg Asn Ile Asn Pro Ser
 325 330 335
 Thr Ala Asn Ser Pro Lys Cys Gln Glu Leu Ala Leu Arg Ser Gln Leu
 340 345 350
 Pro Thr Leu Glu Gln Asp Gly Gly Thr Gln Asn Pro Val Ser Ser Pro
 355 360 365
 Gly Met Ser Gln Glu Leu Arg Thr Met Thr Thr Asn Ser Ser Asp Pro
 370 375 380
 Phe Leu Asn Ser Gly Thr Tyr His Ser Arg Asp Glu Ser Thr Asp Ser
 385 390 395 400
 Gly Leu Ser Met Ser Ser Tyr Ser Val Pro Arg Thr Pro Asp Asp Phe
 405 410 415
 Leu Asn Ser Val Asp Glu Met Asp Thr Gly Asp Thr Ile Asn Gln Ser
 420 425 430
 Thr Leu Pro Ser Gln Gln Asn Arg Phe Pro Asp Tyr Leu Glu Ala Ile
 435 440 445
 Pro Gly Thr Asn Val Asp Leu Gly Thr Leu Glu Gly Asp Gly Met Asn
 450 455 460
 Ile Glu Gly Glu Glu Leu Met Pro Ser Leu Gln Glu Ala Leu Ser Ser
 465 470 475 480
 Asp Ile Leu Asn Asp Met Glu Ser Val Leu Ala Ala Thr Lys Leu Asp
 485 490 495
 Lys Glu Ser Phe Leu Thr Trp Leu
 500

<210> SEQ ID NO 3

<211> LENGTH: 738

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<212> TYPE: DNA

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 3

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cgcaacctgc tctccgtggc ctacaagaac gtggtcgggg gccgcaggtc cgcttgagg    180
gtcatctcta gcctcgagca gaagaccgac acctccgaca agaagttgca gctgattaag    240
gactatcggg agaaagtgga gtccgagctg agatccatct gcaccacggt gctggaattg    300
ttggataaat atttaatagc caatgcaact aatccagaga gtaaggtctt ctatctgaaa    360
atgaagggtg attacttccg gtaccttgct gaagttgctg gtggtgatga tcgaaaacaa    420
acgatagata attcccaagg agcttaccaa gaggcatttg atataagcaa gaaagagatg    480
caaccacac acccaatccg cctgggggett gctcttaact tttctgtatt ttactatgag    540
attcttaata acccagagct tgctgcacg ctggctaaaa cggcttttga tgaggccatt    600
gctgaacttg atacctgaa tgaagactca tacaagaca gcacctcat catgcagttg    660
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gaaggggctg aaaactaa                                     738

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<210> SEQ ID NO 4

<211> LENGTH: 245

<212> TYPE: PRT

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 4

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Met Glu Lys Thr Glu Leu Ile Gln Lys Ala Lys Leu Ala Glu Gln Ala
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Glu Arg Tyr Asp Asp Met Ala Thr Cys Met Lys Ala Val Thr Glu Gln
 20                25                30

Gly Ala Glu Leu Ser Asn Glu Glu Arg Asn Leu Leu Ser Val Ala Tyr
 35                40                45

Lys Asn Val Val Gly Gly Arg Arg Ser Ala Trp Arg Val Ile Ser Ser
 50                55                60

Ile Glu Gln Lys Thr Asp Thr Ser Asp Lys Lys Leu Gln Leu Ile Lys
 65                70                75                80

Asp Tyr Arg Glu Lys Val Glu Ser Glu Leu Arg Ser Ile Cys Thr Thr
 85                90                95

Val Leu Glu Leu Leu Asp Lys Tyr Leu Ile Ala Asn Ala Thr Asn Pro
 100               105               110

Glu Ser Lys Val Phe Tyr Leu Lys Met Lys Gly Asp Tyr Phe Arg Tyr
 115               120               125

Leu Ala Glu Val Ala Cys Gly Asp Asp Arg Lys Gln Thr Ile Asp Asn
 130               135               140

Ser Gln Gly Ala Tyr Gln Glu Ala Phe Asp Ile Ser Lys Lys Glu Met
 145               150               155               160

Gln Pro Thr His Pro Ile Arg Leu Gly Leu Ala Leu Asn Phe Ser Val
 165               170               175

Phe Tyr Tyr Glu Ile Leu Asn Asn Pro Glu Leu Ala Cys Thr Leu Ala
 180               185               190

Lys Thr Ala Phe Asp Glu Ala Ile Ala Glu Leu Asp Thr Leu Asn Glu
 195               200               205

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Asp Ser Tyr Lys Asp Ser Thr Leu Ile Met Gln Leu Leu Arg Asp Asn
 210 215 220
 Leu Thr Leu Trp Thr Ser Asp Ser Ala Gly Glu Glu Cys Asp Ala Ala
 225 230 235 240
 Glu Gly Ala Glu Asn
 245

<210> SEQ ID NO 5
 <211> LENGTH: 1653
 <212> TYPE: DNA
 <213> ORGANISM: *Photinus pyralis*

<400> SEQUENCE: 5

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 accgctggag agcaactgca taagctatg aagagatacg ccttggttcc tggacaatt 120
 gcttttacag atgcacatat cgaggtggac atcacttacg ctgagtactt cgaatgtcc 180
 gttcgggttg cagaagctat gaaacgatat gggctgaata caaatcacag aatcgtcgt 240
 tgcagtgaaa actctcttca attctttatg ccggtgttgg gcgcttatt tatcggagt 300
 gcagttgcgc ccgcaagca catttataat gaacgtgaat tgctcaacag tatgggcatt 360
 tgcgagccta ccgtggtgtt cgtttccaaa aaggggttgc aaaaaatttt gaacgtgcaa 420
 aaaaagctcc caatcatcca aaaaattatt atcatggatt ctaaacgga ttaccagga 480
 tttcagtcga tgtacacggt cgtcacatct catctacctc ccggttttaa tgaatacga 540
 tttgtgccag agtctctcga tagggacaag acaattgcac tgatcatgaa ctctctgga 600
 tctactggtc tgccctaaagg tgcgctctg cctcatagaa ctgcctcgtg gagattctcg 660
 catgccagag atcctatctt tggcaatcaa atcattccgg atactgcgat ttaagtgtt 720
 gttccattcc atcacggttt tggatgttt actacactcg gatatttgat atgtggattt 780
 cgagtcgtct taatgtatag attgaagaa gagctgttcc tgaggagcct tcaggattac 840
 aagattcaaa gtgcgctgct ggtgccaacc ctattctcct tcttcgcaa aagcactctg 900
 attgacaaat acgatttatc taatttacac gaaattgctt ctggtggcgc tcccctctct 960
 aaggaagtcg gggaagcggg tgccaagagg ttccatctgc caggtatcag gcaaggatat 1020
 gggctcactg agactacatc agctattctg attacaccg agggggatga taaaccgggc 1080
 gcggtcggta aagttgttcc attttttgaa gcgaaggttg tggatctgga taccgggaaa 1140
 acgctgggcg ttaatcaaaag aggcgaactg tgtgtgagag gtcctatgat tatgtccggt 1200
 tatgtaaaca atccggaagc gaccaacgcc ttgattgaca aggatggatg gctacattct 1260
 ggagacatag cttactggga cgaagacgaa cacttcttca tctgtgaccg cctgaagtct 1320
 ctgattaagt acaaaggcta tcaggtggct cccgctgaat tggaaatccat cttgtcccaa 1380
 caccocaaaca tcttcgacgc aggtgtcgca ggtcttcccg acgatgacgc cggatgaactt 1440
 cccgccgcgc ttgtgttttt ggagcacgga aagacgatga cggaaaaaga gatcgtggat 1500
 tacgtcgcca gtcaagtaac aaccgcgaaa aagttgcgcy gaggagtgtt gtttgtggac 1560
 gaagtaccga aaggtcttac cggaaaactc gacgcaagaa aaatcagaga gatcctcata 1620
 aaggccaaga agggcggaaa gatcgccgtg taa 1653

<210> SEQ ID NO 6
 <211> LENGTH: 550
 <212> TYPE: PRT
 <213> ORGANISM: *Photinus pyralis*

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<400> SEQUENCE: 6

Met Glu Asp Ala Lys Asn Ile Lys Lys Gly Pro Ala Pro Phe Tyr Pro
 1 5 10 15
 Leu Glu Asp Gly Thr Ala Gly Glu Gln Leu His Lys Ala Met Lys Arg
 20 25 30
 Tyr Ala Leu Val Pro Gly Thr Ile Ala Phe Thr Asp Ala His Ile Glu
 35 40 45
 Val Asp Ile Thr Tyr Ala Glu Tyr Phe Glu Met Ser Val Arg Leu Ala
 50 55 60
 Glu Ala Met Lys Arg Tyr Gly Leu Asn Thr Asn His Arg Ile Val Val
 65 70 75 80
 Cys Ser Glu Asn Ser Leu Gln Phe Phe Met Pro Val Leu Gly Ala Leu
 85 90 95
 Phe Ile Gly Val Ala Val Ala Pro Ala Asn Asp Ile Tyr Asn Glu Arg
 100 105 110
 Glu Leu Leu Asn Ser Met Gly Ile Ser Gln Pro Thr Val Val Phe Val
 115 120 125
 Ser Lys Lys Gly Leu Gln Lys Ile Leu Asn Val Gln Lys Lys Leu Pro
 130 135 140
 Ile Ile Gln Lys Ile Ile Ile Met Asp Ser Lys Thr Asp Tyr Gln Gly
 145 150 155 160
 Phe Gln Ser Met Tyr Thr Phe Val Thr Ser His Leu Pro Pro Gly Phe
 165 170 175
 Asn Glu Tyr Asp Phe Val Pro Glu Ser Phe Asp Arg Asp Lys Thr Ile
 180 185 190
 Ala Leu Ile Met Asn Ser Ser Gly Ser Thr Gly Leu Pro Lys Gly Val
 195 200 205
 Ala Leu Pro His Arg Thr Ala Cys Val Arg Phe Ser His Ala Arg Asp
 210 215 220
 Pro Ile Phe Gly Asn Gln Ile Ile Pro Asp Thr Ala Ile Leu Ser Val
 225 230 235 240
 Val Pro Phe His His Gly Phe Gly Met Phe Thr Thr Leu Gly Tyr Leu
 245 250 255
 Ile Cys Gly Phe Arg Val Val Leu Met Tyr Arg Phe Glu Glu Glu Leu
 260 265 270
 Phe Leu Arg Ser Leu Gln Asp Tyr Lys Ile Gln Ser Ala Leu Leu Val
 275 280 285
 Pro Thr Leu Phe Ser Phe Phe Ala Lys Ser Thr Leu Ile Asp Lys Tyr
 290 295 300
 Asp Leu Ser Asn Leu His Glu Ile Ala Ser Gly Gly Ala Pro Leu Ser
 305 310 315 320
 Lys Glu Val Gly Glu Ala Val Ala Lys Arg Phe His Leu Pro Gly Ile
 325 330 335
 Arg Gln Gly Tyr Gly Leu Thr Glu Thr Thr Ser Ala Ile Leu Ile Thr
 340 345 350
 Pro Glu Gly Asp Asp Lys Pro Gly Ala Val Gly Lys Val Val Pro Phe
 355 360 365
 Phe Glu Ala Lys Val Val Asp Leu Asp Thr Gly Lys Thr Leu Gly Val
 370 375 380
 Asn Gln Arg Gly Glu Leu Cys Val Arg Gly Pro Met Ile Met Ser Gly
 385 390 395 400

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Tyr Val Asn Asn Pro Glu Ala Thr Asn Ala Leu Ile Asp Lys Asp Gly
 405 410 415
 Trp Leu His Ser Gly Asp Ile Ala Tyr Trp Asp Glu Asp Glu His Phe
 420 425 430
 Phe Ile Val Asp Arg Leu Lys Ser Leu Ile Lys Tyr Lys Gly Tyr Gln
 435 440 445
 Val Ala Pro Ala Glu Leu Glu Ser Ile Leu Leu Gln His Pro Asn Ile
 450 455 460
 Phe Asp Ala Gly Val Ala Gly Leu Pro Asp Asp Asp Ala Gly Glu Leu
 465 470 475 480
 Pro Ala Ala Val Val Val Leu Glu His Gly Lys Thr Met Thr Glu Lys
 485 490 495
 Glu Ile Val Asp Tyr Val Ala Ser Gln Val Thr Thr Ala Lys Lys Leu
 500 505 510
 Arg Gly Gly Val Val Phe Val Asp Glu Val Pro Lys Gly Leu Thr Gly
 515 520 525
 Lys Leu Asp Ala Arg Lys Ile Arg Glu Ile Leu Ile Lys Ala Lys Lys
 530 535 540
 Gly Gly Lys Ile Ala Val
 545 550

<210> SEQ ID NO 7
 <211> LENGTH: 15
 <212> TYPE: PRT
 <213> ORGANISM: Homo sapiens

<400> SEQUENCE: 7

Pro Gln His Val Arg His Ala Ser Ser Pro Ala Ser Leu Gln Leu
 1 5 10 15

<210> SEQ ID NO 8
 <211> LENGTH: 15
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Synthesized

<400> SEQUENCE: 8

Pro Gln His Val Arg His Ala Ala Ser Pro Ala Ser Leu Gln Leu
 1 5 10 15

<210> SEQ ID NO 9
 <211> LENGTH: 5597
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Vector

<400> SEQUENCE: 9

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 ccgcatagtt aagccagtat ctgctccctg cttgtgtggt ggaggtcgct gagtagtgcg 120
 cgagcaaat ttaagtaca acaaggcaag gcttgaccga caattgcatg aagaatctgc 180
 ttagggtag gcggtttgcg ctgcttcgcg atgtacgggc cagatatacg cgttgacatt 240
 gattattgac tagtatttaa tagtaataca ttacggggtc attagttcat ageccatata 300
 tggagtccg cgttacataa cttacggtaa atggcccggc tggtgaccg cccaacgacc 360
 cccgccatt gacgtcaata atgacgtatg ttcccatagt aacgccaata gggactttcc 420

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attgacgtca atgggtggag tatttacggt aaactgcca cttggcagta catcaagtgt	480
atcatatgcc aagtacgccc cctattgacg tcaatgacgg taaatggccc gcctggcatt	540
atgccagta catgacctta tgggactttc ctacttggca gtacatctac gtattagtca	600
tcgctattac catggtgatg cggttttggc agtacatcaa tgggcgtgga tagcggtttg	660
actcacgggg atttccaagt ctccacccca ttgacgtcaa tgggagtttg ttttggcacc	720
aaaatcaacg ggactttcca aaatgctgta acaactccgc cccattgacg caaatgggcy	780
gtaggcgtgt acgggtggag gtctatataa gcagagctct ctggctaact agagaaccca	840
ctgcttactg gcttatcgaa attaatacga ctactatag ggagacccaa gctggctagc	900
gtttaaactt aagcttggtg ccgagctcgg atccactagt ccagtgtggt ggaattctgc	960
agatatccag cacagtggcg gccctcggag tctagagggc ccgtttaaac ccgctgatca	1020
gcctcgaatg tgccttctag ttgccagcca tctgttgttt gccctcccc cgtgccttcc	1080
ttgacctgga aaggtgccac tcccactgtc ctttcctaataaaaatgagga aattgcatcg	1140
cattgtctga gtagggtgca ttctattctg ggggggtggg tggggcagga cagcaagggg	1200
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gcgaaagaa ccagctgggg ctctaggggg tatccccacg cgcctgtag cygcgcatta	1320
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aaaaaacttg attagggtga tggttcacgt agtgggcat cgcctgata gacggttttt	1560
cgcccttga cgttggagtc cacgttcttt aatagtggac tcttgttcca aactggaaca	1620
acaactcaacc ctatctcggg ctattctttt gattataag ggattttgcc gatttcggcc	1680
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tgtgtcagtt aggggtgga aagtccccag gctccccagc aggcagaagt atgcaaagca	1800
tgcactcaaa ttagtacga accaggtgtg gaaagtcccc aggcctccca gcaggcagaa	1860
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atcagagctt ggttgacggc aatttcgatg atgcagcttg ggcgcagggt cgatgcgacg	3000
caatcgctccg atccggagcc gggactgtcg ggcgtacaca aatcgcccgc agaagcgcgg	3060
ccgtctggac cgatggctgt gtagaagtac tgcgcatag tggaaaccga cgcgccagca	3120
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gttgtggttt gtccaaactc atcaatgtat cttatcatgt ctgtataccg tcgacctcta	3420
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gctccaagct gggctgtgtg cacgaacccc ccgttcagcc cgaccgctgc gccttatccg	4140
gtaactatcg tcttgagtc aacccggtaa gacacgactt atcgccaact gcagcagcca	4200
ctggtaacag gattagcaga gcgaggtatg taggcggtgc tacagagttc ttgaagtggc	4260
ggcctaacta cggctacact agaagaacag tatttggtat ctgcgctctg ctgaagccag	4320
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tcatgagatt atcaaaaagg atcttcacct agatcctttt aaattaaaaa tgaagtttta	4560
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aggcacctat ctacagcadc tgtctatctt gttcatccat agttgcctga ctccccctg	4680
tgtagataac taogatacgg gagggtttac catctggccc cagtgctgca atgataaccg	4740
gagacccacg ctacccggct ccagatttat cagcaataaa ccagccagcc ggaagggccg	4800
agcgcagaag tggctctgca actttatccg cctccatcca gcttattaat tgttgccggg	4860
aagctagagt aagtagttcg ccagttaata gtttgcgcaa cgttggttgc attgctacag	4920
gcacgtgggt gtcacgctcg tcgtttggtg tggttcatt cagctccggc tcccaacgat	4980
caaggcaggt tacatgatcc cccatggtgt gcaaaaaagc ggttagctcc ttcggtctc	5040
cgatcgttgt cagaagtaag ttggccgcag tgttatact catggttatg gcagcactgc	5100
ataattctct tactgtcatg ccataccgtaa gatgcttttc tgtgactggt gagtactcaa	5160

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ccaagtcatt ctgagaatag tgtatgcggc gaccgagttg ctcttgcccg gcgtcaatac 5220
gggataatac cgccccacat agcagaactt taaaagtgt catcattgga aaacgttctt 5280
cgggcgcaaa actctcaagg atcttaccgc tgttgagatc cagttcgatg taaccacctc 5340
gtgcacccaa ctgatcttca gcatctttta ctttcaccag cgtttctggg tgagcaaaaa 5400
caggaagcca aaatgccga aaaaaggaa taaggcgac acggaatgt tgaatactca 5460
tactcttct ttttcaatat tattgaagca tttatcaggg ttattgtctc atgagcggat 5520
acatatttga atgtatttag aaaaataaac aaataggggt tccgcgcaca tttccccgaa 5580
aagtgccacc tgacgtc 5597

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<210> SEQ ID NO 10
<211> LENGTH: 41
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

```

```
<400> SEQUENCE: 10
```

```
ctggatccgc cgccaccatg gaagacgcca aaaacataaa g 41
```

```

<210> SEQ ID NO 11
<211> LENGTH: 84
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

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```
<400> SEQUENCE: 11
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```

ttacaactgc agagaagctg gagaggaatg agctcgaaca tgctgtgggc ctccagctcc 60
tctccatcc ttgtcaatca aggc 84

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<210> SEQ ID NO 12
<211> LENGTH: 36
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

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<400> SEQUENCE: 12
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atgaaactgc ggccgcttac aactgcagag aagctg 36
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```

<210> SEQ ID NO 13
<211> LENGTH: 38
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

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```
<400> SEQUENCE: 13
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```
ctggatccgc cgccaccatg gagaagactg agctgatc 38
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```

<210> SEQ ID NO 14
<211> LENGTH: 51
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

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<400> SEQUENCE: 14
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```
actacctct cctccactac ctctctctcc gttttcagcc cettctgccc c 51
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<210> SEQ ID NO 15
 <211> LENGTH: 39
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Primer

 <400> SEQUENCE: 15

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<210> SEQ ID NO 16
 <211> LENGTH: 34
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Primer

 <400> SEQUENCE: 16

 atgaaactgc ggccgcttac acggcgatct ttcc 34

<210> SEQ ID NO 17
 <211> LENGTH: 81
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Primer

 <400> SEQUENCE: 17

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<210> SEQ ID NO 18
 <211> LENGTH: 42
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Primer

 <400> SEQUENCE: 18

 tctccagctt ctctgcagtt gggctctatg attatgtccg gt 42

<210> SEQ ID NO 19
 <211> LENGTH: 86
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Primer

 <400> SEQUENCE: 19

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 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
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<213> ORGANISM: Artificial Sequence
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 <400> SEQUENCE: 22
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 <400> SEQUENCE: 23
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<210> SEQ ID NO 24
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 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Primer

 <400> SEQUENCE: 24
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<210> SEQ ID NO 25
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 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Primer

 <400> SEQUENCE: 25
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 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Vector

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<210> SEQ ID NO 27

<211> LENGTH: 3423

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Vector

<400> SEQUENCE: 27

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<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

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<400> SEQUENCE: 28

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<400> SEQUENCE: 31

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<210> SEQ ID NO 32

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<212> TYPE: DNA

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<220> FEATURE:

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<400> SEQUENCE: 32

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<210> SEQ ID NO 33

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agcaaaaggc caggaaccgt aaaaaggcgc cgctgctggc gtttttccat aggctccgc	3900
cccctgacga gcatcacaaa aatcgacgct caagtcaag gtggcgaac ccgacaggac	3960
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gctcacgctg taggtatctc agttcgggtg aggtcgttcg ctccaagctg ggctgtgtgc	4140
acgaaccccc cgttcagccc gaccgctgcg ccttatccgg taactatcgt cttgagtcca	4200
acccgtaag acacgactta tcgccactgg cagcagccac tggtaacagg attagcagag	4260
cgaggatgt aggcgggtg acagagttct tgaagtgggt gccctaactc ggctacacta	4320
gaaggacagt atttggtatc tgcgctctgc tgaagccagt taccttcgga aaaagagttg	4380
gtagctcttg atccggcaaa caaacaccg ctggtagcgg tgggtttttt gtttgcaagc	4440
agcagattac gcgcagaaaa aaaggatctc aagaagatcc tttgatcttt tctacggggt	4500
ctgacgctca gtggaacgaa aactcacgtt aagggtttt ggtcatgaga ttatcaaaaa	4560
ggatcttcc ctagatcctt ttaaattaaa aatgaagttt taaatcaatc taaagtatat	4620
atgagtaaac ttggtotgac agttaccaat gcttaatcag tgaggcacct atctcagcga	4680
tctgtctatt tcgttcaccc atagttgcct gactccccgt cgtgtagata actacgatac	4740
gggagggtt accatctggc cccagtgctg caatgatacc gcgagaccca cgtcaccgg	4800
ctccagattt atcagcaata aaccagccag ccggaagggc cgagcgcaga agtggctcctg	4860

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caactttatc cgctccatc cagtctatta attggtgccg ggaagctaga gtaagtagtt 4920
cgccagttaa tagtttgccg aacgttggtg ccattgctgc aggcacgtg gtgtcacgct 4980
cgtcgtttgg tatggettca ttcagctccg gttcccaacg atcaaggcga gttacatgat 5040
cccccatggt gtgcaaaaaa gcggtagct ccttcggtec tccgatcggt gtcagaagta 5100
agttggccgc agtgttatca ctcatggta tggcagcact gcataattct cttactgtca 5160
tgccatccgt aagatgcttt tctgtgactg gtgagtactc aaccaagtca ttctgagaat 5220
agtgtatgcg gcgaccgagt tgctcttgcc cggcgtcaac acgggataat accgcgccac 5280
atagcagaac tttaaaagtg ctcatcattg gaaaacgttc ttcggggcga aaactctcaa 5340
ggatccttacc gctggtgaga tccagttcga tgtaaccac tegtgcacc aactgatctt 5400
cagcatcttt tactttcacc agcgtttctg ggtgagcaaa aacaggaagg caaaatgccg 5460
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attattgaag catttatcag ggttattgtc tcatgagcgg atacatattt gaatgtattt 5580
agaaaaataa acaaataggg gttccgcgca catttccccg aaaagtgccca cctgacgtct 5640
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gtcttcaaga a 5711

```

```

<210> SEQ ID NO 34
<211> LENGTH: 41
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

```

```
<400> SEQUENCE: 34
```

```
ctggatccgc cgccaccatg gtcttcacac tcgaagattt c 41
```

```

<210> SEQ ID NO 35
<211> LENGTH: 54
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

```

```
<400> SEQUENCE: 35
```

```
accgctcgag cctccacctc cgtctccgcc accaccggaa ctcccactgt tgat 54
```

```

<210> SEQ ID NO 36
<211> LENGTH: 69
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

```

```
<400> SEQUENCE: 36
```

```
gggagttccg gtggtggcgg gagcggaggt ggaggctcga gcggtgccgg gcatcagatc 60
```

```
gtgcacgctc 69
```

```

<210> SEQ ID NO 37
<211> LENGTH: 63
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

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<400> SEQUENCE: 37
atgaaactgc ggccgcttg tcgtcatcgt cttttagtc tacatcatca ggtatctcaa 60
aag 63

<210> SEQ ID NO 38
<211> LENGTH: 32
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 38
ctggatccgc cgggcacag atcgtgcacg tc 32

<210> SEQ ID NO 39
<211> LENGTH: 68
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 39
acctgacgac cctccacctc cgtcccccc accaccgctc gagcctacat catcaggtat 60
ctcaaaaag 68

<210> SEQ ID NO 40
<211> LENGTH: 66
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 40
ggctcgagcg gtggtggcgg gagcggaggt ggagggtcgt caggtgtctt cacactcgaa 60
gatttc 66

<210> SEQ ID NO 41
<211> LENGTH: 43
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 41
atgaaactgc ggccgcttaa ctgttgatgg ttactcggaa cag 43

<210> SEQ ID NO 42
<211> LENGTH: 98
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 42
ctggatccgc ccaccacatg gtgaccggct accggctgtt cgaggagatt ctccggagtt 60
ccggtggtgg cgggagcggg ggtggaggct cgagcggg 98

<210> SEQ ID NO 43
<211> LENGTH: 97
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:

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<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 43

atgaaactgc ggcgcttag agaatctcct cgaacagccg gtagccggtc acacctgacg 60

accctccacc tccgctccc caccaccgc tcgagcc 97

<210> SEQ ID NO 44

<211> LENGTH: 73

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 44

gggagtccg gtggtggcgg gagcggaggt ggaggctcga gcggtgagcc tgcacggcc 60

ccagtcctc cag 73

<210> SEQ ID NO 45

<211> LENGTH: 73

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 45

atgaaactgc ggcgcttac agatcctctt ctgagatgag tttttgttca tttgaaactt 60

caaacacaca ggc 73

<210> SEQ ID NO 46

<211> LENGTH: 36

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 46

ctggatccga gcctgcatcg gccccagctc cctcag 36

<210> SEQ ID NO 47

<211> LENGTH: 69

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 47

acctgacgac cctccaccctc cgctcccgc accaccgctc gagccatttg aaacttcaaa 60

cacacaggc 69

<210> SEQ ID NO 48

<211> LENGTH: 73

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Primer

<400> SEQUENCE: 48

gggagtccg gtggtggcgg gagcggaggt ggaggctcga gcggtgagcc tgcacggcc 60

ccagtcctc cag 73

<210> SEQ ID NO 49

<211> LENGTH: 1281

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<212> TYPE: DNA

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 49

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gactctgcag ataagccaat tgacaatgat gcagaagggg tctggagccc cgacatcgag    120
caaagctttc aggaggccct ggctatctat ccaccatgtg ggaggaggaa aatcatctta    180
tcagacgaag gcaaaaatgta tggtaggaat gaattgatag ccagatacat caaactcagg    240
acaggcaaga cgaggaccag aaaacaggtg tctagtcaca ttcaggttct tgccagaagg    300
aaatctcgtg attttcattc caagctaaag gatcagactg caaaggataa ggccctgcag    360
cacatggcgg ccatgtcctc agcccagatc gtctcggccca ctgccattca taacaagctg    420
gggctgcctg ggattccacg cccgaccttc ccaggggcgc cggggttctg gccgggaatg    480
attcaaacag ggcagccagg atcctcacia gacgtcaagc cttttgtgca gcaggcctac    540
cccatccagc cagcgggtcac agccccattt ccagggtttg agcctgcacg ggccccagct    600
ccctcagtcg ctgcctggca aggtcgctcc attggcacia ccaagcttct cctggtggaa    660
ttttcagctt ttctcgagca gcagcgagac ccagactcgt acaacaacia cctcttcgtg    720
cacattgggc atgccaacca ttcttacagt gaccatttgc ttgaatcagt ggacattcgt    780
cagatttatg acaaatcttc tgaaaagaaa ggtggcttaa aggaactgtt tggaaagggc    840
cctcaaaatg ccttcttctc cgtaaaatc tgggctgatt taaactgcaa tattcaagat    900
gatgctgggg ctttttatgg tgtaaccagt cagtacgaga gttctgaaaa tatgacagtc    960
acctgttcca ccaaagtttg ctcttttggg aagcaagtag tagaaaaagt agagacggag   1020
tatgcaaggt ttgagaatgg ccgatttcta taccgaataa accgctcccc aatgtgtgaa   1080
tatatgatca acttcatcca caagctcaaa cacttaccag agaaatatat gatgaacagt   1140
gttttgaaaa acttcacaaat tttattggtg gtaacaacia gggatcacaca agaaactcta   1200
ctctgcatgg cctgtgtggt tgaagtttca aatagtgaac acggagcaca acatcatatt   1260
tacaggcttg taaaggactg a                                     1281

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<210> SEQ ID NO 50

<211> LENGTH: 426

<212> TYPE: PRT

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 50

```

Met Glu Pro Ser Ser Trp Ser Gly Ser Glu Ser Pro Ala Glu Asn Met
 1             5             10             15

Glu Arg Met Ser Asp Ser Ala Asp Lys Pro Ile Asp Asn Asp Ala Glu
 20             25             30

Gly Val Trp Ser Pro Asp Ile Glu Gln Ser Phe Gln Glu Ala Leu Ala
 35             40             45

Ile Tyr Pro Pro Cys Gly Arg Arg Lys Ile Ile Leu Ser Asp Glu Gly
 50             55             60

Lys Met Tyr Gly Arg Asn Glu Leu Ile Ala Arg Tyr Ile Lys Leu Arg
 65             70             75             80

Thr Gly Lys Thr Arg Thr Arg Lys Gln Val Ser Ser His Ile Gln Val
 85             90             95

Leu Ala Arg Arg Lys Ser Arg Asp Phe His Ser Lys Leu Lys Asp Gln
100            105            110

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Thr Ala Lys Asp Lys Ala Leu Gln His Met Ala Ala Met Ser Ser Ala
 115 120 125

Gln Ile Val Ser Ala Thr Ala Ile His Asn Lys Leu Gly Leu Pro Gly
 130 135 140

Ile Pro Arg Pro Thr Phe Pro Gly Ala Pro Gly Phe Trp Pro Gly Met
 145 150 155 160

Ile Gln Thr Gly Gln Pro Gly Ser Ser Gln Asp Val Lys Pro Phe Val
 165 170 175

Gln Gln Ala Tyr Pro Ile Gln Pro Ala Val Thr Ala Pro Ile Pro Gly
 180 185 190

Phe Glu Pro Ala Ser Ala Pro Ala Pro Ser Val Pro Ala Trp Gln Gly
 195 200 205

Arg Ser Ile Gly Thr Thr Lys Leu Arg Leu Val Glu Phe Ser Ala Phe
 210 215 220

Leu Glu Gln Gln Arg Asp Pro Asp Ser Tyr Asn Lys His Leu Phe Val
 225 230 235 240

His Ile Gly His Ala Asn His Ser Tyr Ser Asp Pro Leu Leu Glu Ser
 245 250 255

Val Asp Ile Arg Gln Ile Tyr Asp Lys Phe Pro Glu Lys Lys Gly Gly
 260 265 270

Leu Lys Glu Leu Phe Gly Lys Gly Pro Gln Asn Ala Phe Phe Leu Val
 275 280 285

Lys Phe Trp Ala Asp Leu Asn Cys Asn Ile Gln Asp Asp Ala Gly Ala
 290 295 300

Phe Tyr Gly Val Thr Ser Gln Tyr Glu Ser Ser Glu Asn Met Thr Val
 305 310 315 320

Thr Cys Ser Thr Lys Val Cys Ser Phe Gly Lys Gln Val Val Glu Lys
 325 330 335

Val Glu Thr Glu Tyr Ala Arg Phe Glu Asn Gly Arg Phe Val Tyr Arg
 340 345 350

Ile Asn Arg Ser Pro Met Cys Glu Tyr Met Ile Asn Phe Ile His Lys
 355 360 365

Leu Lys His Leu Pro Glu Lys Tyr Met Met Asn Ser Val Leu Glu Asn
 370 375 380

Phe Thr Ile Leu Leu Val Val Thr Asn Arg Asp Thr Gln Glu Thr Leu
 385 390 395 400

Leu Cys Met Ala Cys Val Phe Glu Val Ser Asn Ser Glu His Gly Ala
 405 410 415

Gln His His Ile Tyr Arg Leu Val Lys Asp
 420 425

<210> SEQ ID NO 51
 <211> LENGTH: 477
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Synthesized

<400> SEQUENCE: 51

atggtcttca cactcgaaga ttctgttggg gactgggaac agacagccgc ctacaacctg 60

gaccaagtcc ttgaacaggg aggtgtgtcc agtttgetgc agaattctgc cgtgtccgta 120

actccgatcc aaaggattgt cgggagcggg gaaaatgccc tgaagatcga catccatgtc 180

atcatcccgat atgaaggtct gagcgccgac caaatggccc agatcgaaga ggtgtttaag 240

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gtggtgtacc ctgtggatga tcatcacttt aagtgatcc tgcctatg cacactggta 300
atcgacgggg ttacgccgaa catgctgaac tatttcggac ggccgatga aggcacgcc 360
gtgttcgacg gcaaaaagat cactgtaaca gggaccctgt ggaacggcaa caaaattatc 420
gacgagcgcc tgatcacccc cgacggctcc atgctgttcc gagtaacct caacagt 477

```

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<210> SEQ ID NO 52
<211> LENGTH: 159
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthesized

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<400> SEQUENCE: 52

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```

Met Val Phe Thr Leu Glu Asp Phe Val Gly Asp Trp Glu Gln Thr Ala
1           5           10          15
Ala Tyr Asn Leu Asp Gln Val Leu Glu Gln Gly Gly Val Ser Ser Leu
          20          25          30
Leu Gln Asn Leu Ala Val Ser Val Thr Pro Ile Gln Arg Ile Val Arg
          35          40          45
Ser Gly Glu Asn Ala Leu Lys Ile Asp Ile His Val Ile Ile Pro Tyr
          50          55          60
Glu Gly Leu Ser Ala Asp Gln Met Ala Gln Ile Glu Glu Val Phe Lys
65          70          75          80
Val Val Tyr Pro Val Asp Asp His His Phe Lys Val Ile Leu Pro Tyr
          85          90          95
Gly Thr Leu Val Ile Asp Gly Val Thr Pro Asn Met Leu Asn Tyr Phe
          100         105         110
Gly Arg Pro Tyr Glu Gly Ile Ala Val Phe Asp Gly Lys Lys Ile Thr
          115         120         125
Val Thr Gly Thr Leu Trp Asn Gly Asn Lys Ile Ile Asp Glu Arg Leu
          130         135         140
Ile Thr Pro Asp Gly Ser Met Leu Phe Arg Val Thr Ile Asn Ser
145         150         155

```

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<210> SEQ ID NO 53
<211> LENGTH: 36
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthesized

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```

<400> SEQUENCE: 53

```

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atggtgaccg gctaccggct gttcaggag attctc 36

```

```

<210> SEQ ID NO 54
<211> LENGTH: 11
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthesized

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```

<400> SEQUENCE: 54

```

```

Met Val Thr Gly Tyr Arg Leu Phe Glu Ile Leu
1           5           10

```

```

<210> SEQ ID NO 55
<211> LENGTH: 5490
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:

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-continued

<223> OTHER INFORMATION: Vector

<400> SEQUENCE: 55

gacggatcgg gagatctccc gatcccctat ggtgcactct cagtacaatc tgctctgatg	60
ccgcatagtt aagccagtat ctgctccctg cttgtgtgtt ggaggtcgct gagtagtgcg	120
cgagcaaaat ttaagctaca caaggcaagg cttgaccgac aattgcatga agaactcgct	180
tagggtagg cgttttgcgc tgcttcgcga tgtacgggcc agatatacgc gttgacattg	240
attattgact agttattaat agtaatcaat tacggggcca ttagttcata gcccatatat	300
ggagtccgc gttacataac ttaacgtaaa tggcccgcct ggctgaccgc ccaacgaccc	360
ccgcccattg acgtcaataa tgacgtatgt tcccatagta acgccaatag ggactttcca	420
ttgacgtcaa tgggtggagt atttacggta aactgcccac ttggcagtac atcaagtgt	480
tcatatgcca agtaacgccc ctattgacgt caatgacggc aaatggccc cctggcatta	540
tgcccagtac atgaccttat gggactttcc tacttggcag tacatctacg tattagtc	600
cgctattacc atgggtgatgc ggttttggca gtacatcaat gggcgtggat agcggtttga	660
ctcacgggga tttccaagtc tcccacctat tgacgtcaat gggagtttgt tttggcacca	720
aaatcaacgg gactttccaa aatgtcgtaa caactccgcc ccattgacgc aaatggcgg	780
taggcgtgta cgggtggagg tctatataag cagagctctc tggctaacta gagaaccac	840
tgcttactgg cttatcgaaa ttaatacgac tcaactatagg gagacccaag ctggctagcg	900
tttaactta agcttggtag catggactac aaagacgatg acggtgatta taaagatcat	960
gacatctacc tgatgtttct ggtactgcca ggatccacta gtccagtgtg gtggaattct	1020
gcagatatcc agcacagtg cgcccgctcg agtctagagg gcccgtttaa acccgctgat	1080
cagcctcgac tgtgcctct agtggccagc catctgttgt ttgcccctcc cccgtgcctt	1140
ccttgaccct ggaaggtagc actcccactg tcctttccta ataaaatgag gaaattgcat	1200
cgcatgtct gagtaggtgt cattctattc tgggggtgg ggtggggcag gacagcaagg	1260
gggaggattg ggaagacaat agcaggcatg ctggggatgc ggtgggctct atggcttctg	1320
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cctattggtt aaaaaatgag ctgatttaac aaaaatttaa cgcgaattaa ttctgtgaa	1800
tgtgtgctag ttaggggtg gaaagtcccc aggctcccca gcaggcagaa gtatgcaaa	1860
catgcctc aattagtcag caaccaggtg tggaaagtcc ccaggctccc cagcaggcag	1920
aagtatgcaa agcatgcatc tcaattagtc agcaaccata gtcccgcctc taactccgc	1980
catcccgc ctaactccgc ccagttccgc ccattctccg ccccatggct gactaatttt	2040
ttttatttat gcagaggcgc aggcgcctc tgcctctgag ctattccaga agtagtgagg	2100
aggctttttt ggaggcctag gcttttgcaa aaagctccc ggagcttga tatccatttt	2160
cggatctgat caagagacag gatgaggatc gtttcgcgat attgaacaag atggattgca	2220
cgcaggttct ccggccgctt ggggtggagag gctattcggc tatgactggg cacaacagac	2280

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aatcgggtgc	tctgatgccc	ccgtgttccc	gctgtcagcg	cagggggccc	cggttctttt	2340
tgtaagacc	gacctgtccg	gtgccctgaa	tgaactgcag	gacgaggcag	cgcggtatc	2400
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aagggactgg	ctgctattgg	gcgaagtgcc	ggggcaggat	ctcctgtcat	ctcaccttgc	2520
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ggctacctgc	ccattcgacc	accaagcga	acatcgcac	gagcgagcac	gtactcggat	2640
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ccgtcgacct	ctagctagag	cttggcgtaa	tcatggctcat	agctgtttcc	tgtgtgaaat	3360
tgttatccgc	tcacaattcc	acacaacata	cgagccggaa	gcataaagtg	taaagcctgg	3420
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gataacgcag	gaaagaacat	gtgagcaaaa	ggccagcaaa	aggccaggaa	ccgtaaaaag	3720
gccgcgttgc	tggcgttttt	ccataggctc	cgccccctg	acgagcatca	caaaaatcga	3780
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<213> ORGANISM: Artificial Sequence

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<223> OTHER INFORMATION: Vector

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<223> OTHER INFORMATION: Construct

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<210> SEQ ID NO 58
<211> LENGTH: 6621
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Construct

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<400> SEQUENCE: 58

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<210> SEQ ID NO 59

<211> LENGTH: 3890

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Construct

<400> SEQUENCE: 59

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<210> SEQ ID NO 60

<211> LENGTH: 4131

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Construct

<400> SEQUENCE: 60

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<220> FEATURE:

<223> OTHER INFORMATION: Construct

<400> SEQUENCE: 61

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 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: Construct

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<210> SEQ ID NO 63
<211> LENGTH: 6297
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
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<223> OTHER INFORMATION: Construct

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<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Construct

<400> SEQUENCE: 65

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<210> SEQ ID NO 66
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<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
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<211> LENGTH: 6592

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Construct

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<211> LENGTH: 6559

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Construct

<400> SEQUENCE: 68

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<210> SEQ ID NO 69

<211> LENGTH: 6151

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Construct

<400> SEQUENCE: 69

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<210> SEQ ID NO 70
<211> LENGTH: 6118
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Construct

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<400> SEQUENCE: 70

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The invention claimed is:

1. A DNA construct comprising a nucleic acid sequence encoding a fusion protein comprising a fragment of firefly luciferase fused to at least one fragment of YAP.

2. The DNA construct of claim 1, wherein the fragment of firefly luciferase comprises amino acids 1-416 of SEQ ID NO:6 and is N-terminal to the at least one fragment of YAP comprising amino acids 120-134 of SEQ ID NO:2.

3. The DNA construct of claim 1, wherein the fragment of firefly luciferase comprises amino acids 1-544 of SEQ ID NO:6 and is N-terminal to the at least one fragment of YAP comprising amino acids 120-134 of SEQ ID NO:2.

4. A DNA construct comprising a nucleic acid sequence encoding a fusion protein comprising a fragment of firefly luciferase fused to at least one fragment of 14-3-3 protein, wherein the at least one fragment of 14-3-3 protein is capable of binding to YAP.

5. The DNA construct of claim 4, wherein the at least one fragment of 14-3-3 protein comprises SEQ ID NO:4 and is N-terminal to the fragment of firefly luciferase comprising amino acids 394-550 of SEQ ID NO:6.

6. A DNA construct comprising a nucleic acid sequence encoding a fusion protein comprising a fragment of NanoBiT luciferase fused to at least one fragment of YAP.

7. The DNA construct of claim 6, wherein the fragment of NanoBiT luciferase is LgBiT comprising amino acid sequence SEQ ID NO:52 and is N-terminal to the at least one fragment of YAP comprising amino acids 120-134 of SEQ ID NO:2.

8. A DNA construct comprising a nucleic acid sequence encoding a fusion protein comprising a fragment of NanoBiT luciferase fused to at least one fragment of 14-3-3

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protein, wherein the at least one fragment of 14-3-3 protein is capable of binding to YAP.

9. The DNA construct of claim 8, wherein the at least one fragment of 14-3-3 protein comprises SEQ ID NO:4 and is N-terminal to the fragment of NanoBiT luciferase that is SmBiT comprising amino acid sequence SEQ ID NO:54.

10. A DNA construct comprising a nucleic acid sequence encoding a fusion protein comprising a fragment of NanoBiT luciferase that is LgBiT comprising amino acid sequence SEQ ID NO:52 and a fragment of YAP comprising amino acids 50-171 of SEQ ID NO:2.

11. A DNA construct comprising a nucleic acid sequence encoding a fusion protein comprising a fragment of NanoBiT luciferase that is SmBiT comprising amino acid sequence SEQ ID NO:54 and a fragment of YAP comprising amino acids 50-171 of SEQ ID NO:2.

12. A DNA construct comprising a nucleic acid sequence encoding a fusion protein comprising a fragment of NanoBiT luciferase fused to at least one fragment of TEAD protein, wherein the at least one fragment of TEAD protein is capable of binding to YAP.

13. The DNA construct of claim 12, wherein the fragment of NanoBiT luciferase is LgBiT comprising amino acid sequence SEQ ID NO:52 and the at least one fragment of TEAD protein comprises amino acids 194-411 of SEQ ID NO:50.

14. The DNA construct of claim 12, wherein the fragment of NanoBiT luciferase is SmBiT comprising amino acid sequence SEQ ID NO:54 and the at least one fragment of TEAD protein comprises amino acids 194-411 of SEQ ID NO:50.

* * * * *