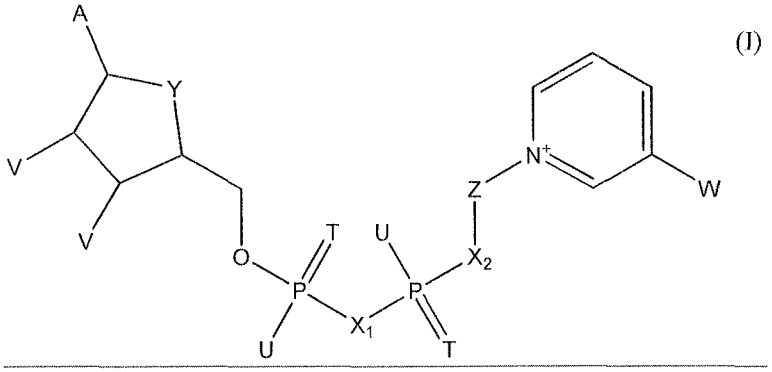
SUMMARY

Reagent materials and associated test elements are provided. In one embodiment, a test element having dual functionality includes a first coenzyme-dependent enzyme or a substrate for the first enzyme, a second coenzyme-dependent enzyme or a substrate for the second enzyme, and a coenzyme selected from the group consisting of thio-NAD, thio-NADP, and a compound according to formula (I) (hereinafter defined). In one ~~aspect~~embodiment, the first analyte is hydroxybutyrate and the first enzyme is a hydroxybutyrate dehydrogenase, and the second analyte is glucose and the second enzyme is a glucose dehydrogenase or a glucose oxidase. In one aspect, there is provided a test element configured for determining first and second analytes, comprising: a first coenzyme-dependent enzyme or a substrate for the first enzyme, wherein the first analyte is hydroxybutyrate and the first coenzyme-dependent enzyme is a hydroxybutyrate dehydrogenase; a second coenzyme-dependent enzyme or a substrate for the second enzyme, wherein the second analyte is glucose and the second coenzyme-dependent enzyme is a glucose dehydrogenase or a glucose oxidase; and a coenzyme selected from the group consisting of thio-NAD, thio-NADP, and a compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

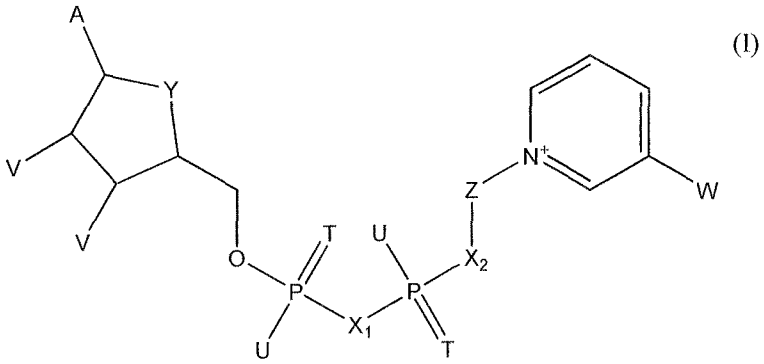
Y = NH, S, O, or CH_2,

Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X_2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

or a salt or optionally a reduced form thereof. Other aspects of the subject application are directed to unique reagent materials.

In one embodiment, a test element configured for determining first and second analytes includes a first coenzyme-dependent enzyme or a substrate for the first enzyme and a second coenzyme-dependent enzyme or a substrate for the second enzyme. The test element also includes a coenzyme selected from the group consisting of thio-NAD, thio-NADP, and a compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

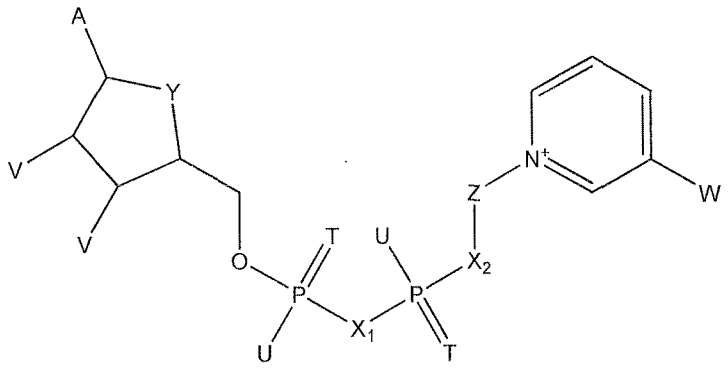
Y = NH, S, O, or CH_2,

Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X_2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

or a salt or optionally a reduced form thereof.

In one form of this embodiment, the first analyte is hydroxybutyrate and the first enzyme is a hydroxybutyrate dehydrogenase. In one ~~aspect~~ embodiment of this form, the hydroxybutyrate dehydrogenase is 3-hydroxybutyrate dehydrogenase. In another embodiment ~~aspect~~ of this form, the second enzyme is a dehydrogenase selected from the group consisting of glucose dehydrogenase, lactate dehydrogenase, malate dehydrogenase, glycerol dehydrogenase, alcohol dehydrogenase, sorbitol dehydrogenase, and an amino acid dehydrogenase comprising L-amino acid dehydrogenase. In still another embodiment ~~aspect~~ of this form, the second analyte is glucose and the second enzyme is a glucose dehydrogenase or a glucose oxidase. In a further embodiment~~aspect~~, the coenzyme is a compound according to formula (I)



(I)

in which

A = adenine,

T = in each case denotes O,

U = in each case denotes OH,

V = in each case denotes OH,

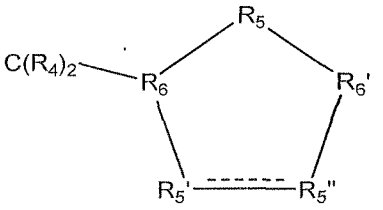
W = $CON(R)_2$ in which R denotes H,

X_1 = O,

X_2 = O,

Y = O, and

Z = a carbocyclic 5-membered ring of the general formula (II)



(II)

in which a single bond is present between R5' and R5", and in which

R4 = H,

R5' = CHOH,

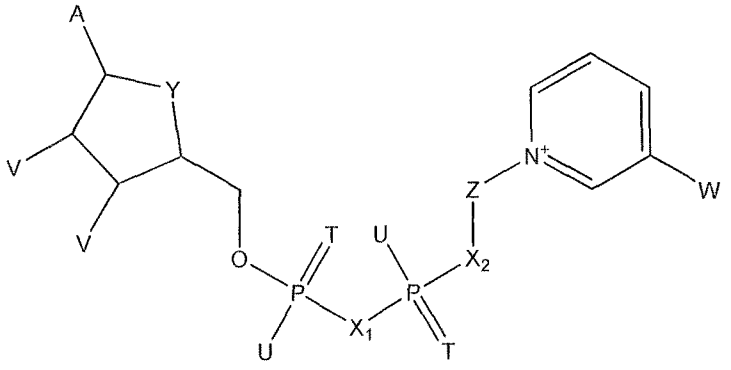
R5" = CHOH,

R5 = $CR4_2$,

R6 = CH, and

R6' = CH.

In yet another further embodiment~~aspect~~, the coenzyme is a compound according to formula (I)



(I)

in which

A = adenine,

T = in each case denotes O,

U = in each case denotes OH,

V = in a first case denotes OH and in a second case denotes a phosphate group,

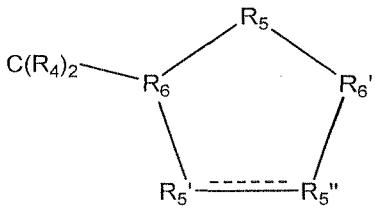
W = $CON(R)_2$ in which R denotes H,

X_1 = O,

$X_2 = O$,

Y = O, and

Z = a carbocyclic 5-membered ring of the general formula (II)



(II)

in which a single bond is present between R5' and R5", and in which

R4 = H,

R5' = CHOH,

R5" = CHOH,

$R5 = CR4_2$,

R6 = CH, and

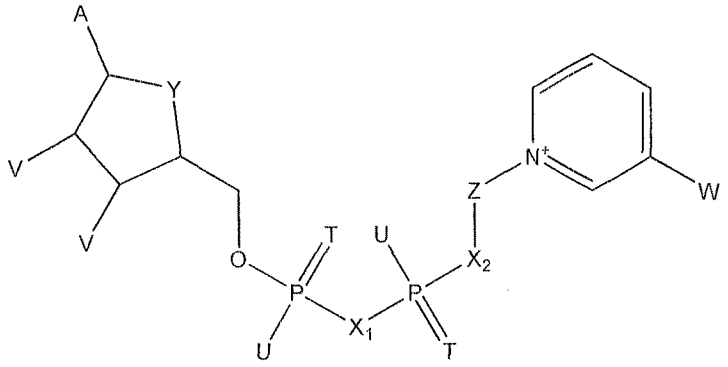
R6' = CH.

In still another further embodimentaspeet, the coenzyme is thio-NAD. In another further embodimentaspeet, the coenzyme is thio-NADP.

In a further form of this embodiment, the test element includes a first reagent material which includes the first enzyme or the substrate for the first enzyme, and the coenzyme selected from the group consisting of thio-NAD, thio-NADP and the compound according to formula (I) or a salt or optionally a reduced form thereof. In one embodiment aspect of this form, the test element also includes a second reagent material which includes the second enzyme or the substrate for the second enzyme, and a coenzyme selected from the group consisting of FAD, NAD, NADP and the compound according to formula (I) or a salt or optionally a reduced form thereof. In a further embodimentaspeet, the test element includes a test strip configured to carry the first and second reagent materials. In yet another further embodimentaspeet, the test strip includes a first electrode system associated with the first reagent material and a second electrode system associated with the second reagent material. In another embodiment aspect of this form, the first reagent material further includes one of

nitrosoaniline, potassium ferricyanide, and a combination of a phenazine derivative and hexaammineruthenium chloride.

In another ~~embodiment~~aspect, there is provided a reagent material, ~~includes~~ comprising 3-hydroxybutyrate dehydrogenase and a coenzyme compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

Y = NH, S, O, or CH_2,

Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X_2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

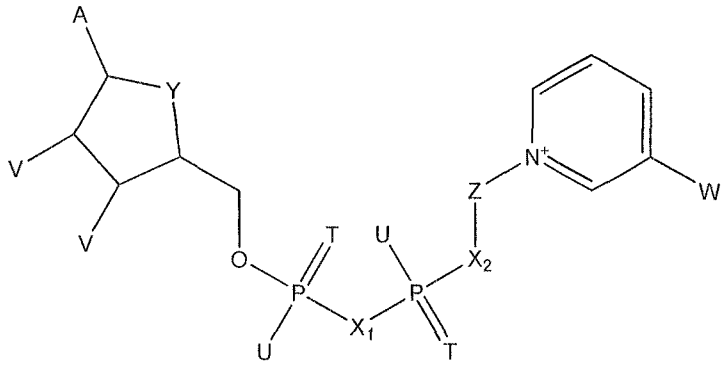
or a salt or optionally a reduced form thereof.

In one form of this embodiment, the coenzyme compound is according to formula (I)

R6' = CH.

In a further form, the reagent material further includes one of nitrosoaniline, potassium ferricyanide, and a combination of a phenazine derivative and hexaammineruthenium chloride.

In another form of this embodiment, a test element includes a test strip carrying the reagent material for determining a first analyte. In another aspect, there is provided a test element, comprising a test strip carrying a first reagent material as defined herein for determining a first analyte, wherein the first analyte is hydroxybutyrate. In one embodiment ~~aspect~~ of this form, the test strip further carries a second reagent material for determining a second analyte. In a further embodiment~~aspect~~, the second reagent material includes a dehydrogenase enzyme selected from the group consisting of glucose dehydrogenase, lactate dehydrogenase, malate dehydrogenase, glycerol dehydrogenase, alcohol dehydrogenase, sorbitol dehydrogenase, and an amino acid dehydrogenase comprising L-amino acid dehydrogenase. In yet another further embodiment~~aspect~~, the second reagent material includes a coenzyme selected from the group consisting of FAD, NAD, NADP and a compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

Y = NH, S, O, or CH_2,

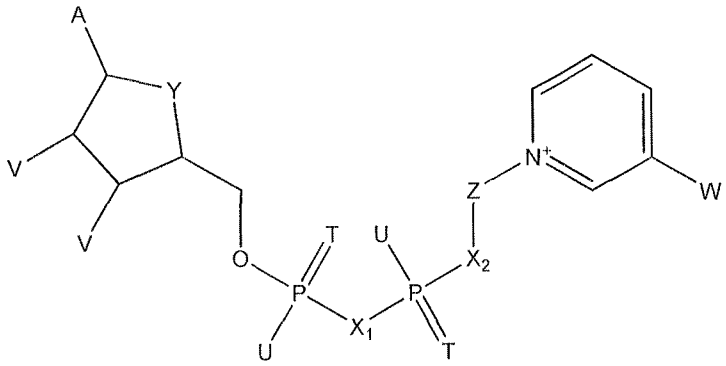
Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

or a salt or optionally a reduced form thereof.

In still another further embodimentaspect, the test strip is configured for electrochemical determination of the first and second analytes.

In another aspect, there is provided a method for determining first and second analytes in a sample, comprising the steps of: providing a test element as defined herein; contacting the test element with the sample; detecting the first analyte; and detecting the second analyte. In yet another embodiment, a method for determining first and second analytes in a sample includes providing a test element configured for determining first and second analytes and that includes a first coenzyme-dependent enzyme or a substrate for the first enzyme, a second coenzyme-dependent enzyme or a substrate for the second enzyme, and a coenzyme selected from the group consisting of thio-NAD, thio-NADP, and a compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

Y = NH, S, O, or CH_2,

Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X_2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

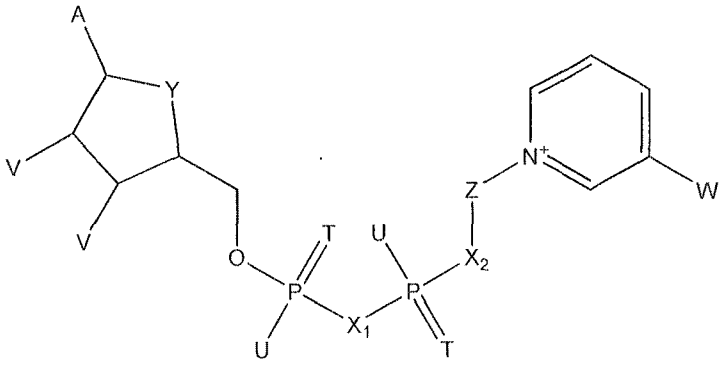
or a salt or optionally a reduced form thereof;

contacting the test element with the sample; detecting the first analyte; and detecting the second analyte.

In one form of this embodiment, the first analyte is hydroxybutyrate and the second analyte is glucose. In one embodiment ~~aspect~~ of this form, the steps of detecting the first analyte and detecting the second analyte are performed simultaneously. In another embodiment ~~aspect~~ of this form, the steps of detecting the first analyte and detecting the second analyte are completed within five seconds after contacting the test element with the sample.

In ~~yet~~ another ~~embodiment~~aspect, there is provided a method includes the steps of providing a test element as defined herein configured for determining glucose and ketone values in a sample; contacting the test element with the sample; and determining the glucose and ketone values in the sample within 7.5 seconds after contacting the test element with the sample. In one form, the test element includes a first reagent material for determining the glucose value and a second reagent material for determining the ketone value. In one embodiment ~~aspect~~ of this form, the second reagent material includes a hydroxybutyrate dehydrogenase. In another form, the step of determining glucose and ketone values in the sample is completed within 5 seconds after contacting the test element with the sample. In yet another form, the glucose and ketone values are determined within 2 seconds of one another during the determining step. In still another form, the sample comprises blood.

In one form of this method, the test element includes a first coenzyme-dependent enzyme or a substrate for the first enzyme and a second coenzyme-dependent enzyme or a substrate for the second enzyme. The test element also includes a coenzyme selected from the group consisting of thio-NAD, thio-NADP, and a compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

Y = NH, S, O, or CH_2,

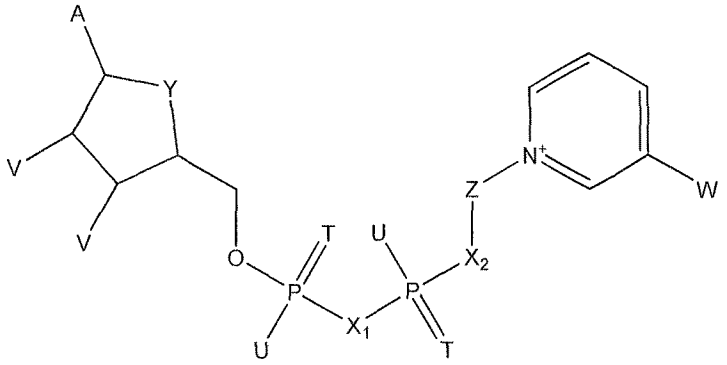
Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X_2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

or a salt or optionally a reduced form thereof.

In one embodimentaspeet, the first analyte is hydroxybutyrate and the first enzyme is a hydroxybutyrate dehydrogenase. In a further embodimentaspeet, the hydroxybutyrate dehydrogenase is 3-hydroxybutyrate dehydrogenase. In a further embodimentaspeet, the second enzyme is a dehydrogenase selected from the group consisting of glucose dehydrogenase, lactate dehydrogenase, malate dehydrogenase, glycerol dehydrogenase, alcohol dehydrogenase, sorbitol dehydrogenase, and an amino acid dehydrogenase comprising L-amino acid dehydrogenase. In still another embodimentaspeet, the second analyte is glucose and the second enzyme is a glucose dehydrogenase or a glucose oxidase. In a further embodimentaspeet, the coenzyme is a compound according to formula (I)

In yet another further embodimentaspeet, the coenzyme is a compound according to formula (I)



(I)

in which

A = adenine,

T = in each case denotes O,

U = in each case denotes OH,

V = in a first case denotes OH and in a second case denotes a phosphate group,

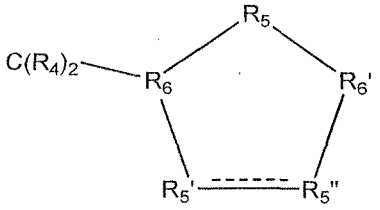
W = $CON(R)_2$ in which R denotes H,

X_1 = O,

X_2 = O,

Y = O, and

Z = a carbocyclic 5-membered ring of the general formula (II)



(II)

in which a single bond is present between R5' and R5", and in which

R4 = H,

R5' = CHOH,

R5" = CHOH,

$R5 = CR4_2$,

R6 = CH, and

R6' = CH.

In still another further embodimentaspect, the coenzyme is thio-NAD. In another further embodimentaspect, the coenzyme is thio-NADP.

In a further embodimentaspect, the test element includes a first reagent material which includes the first enzyme or the substrate for the first enzyme, and the coenzyme selected from the group consisting of thio-NAD, thio-NADP and the compound according to formula (I) or a salt or optionally a reduced form thereof. In a further embodimentaspect, the test element also includes a second reagent material which includes the second enzyme or the substrate for the second enzyme, and a coenzyme selected from the group consisting of FAD, NAD, NADP and the compound according to formula (I) or a salt or optionally a reduced form thereof. In a further embodimentaspect, the test element includes a test strip configured to carry the first and second reagent materials. In yet another further embodimentaspect, the test strip includes a first electrode system associated with the first reagent material and a second electrode system associated with the second reagent material. In another embodimentaspect, the first reagent material further includes one of nitrosoaniline, potassium ferricyanide, and a combination of a phenazine derivative and hexaammineruthenium chloride.

Another aspect of the present application is a unique technique for measuring the presence and/or concentration of multiple analytes in test samples. Other aspects and embodiments include unique methods, systems, devices, kits, assemblies, equipment, and/or apparatus related to analyte detection in a sample.

Further aspects, embodiments, forms, features, benefits, objects, and advantages shall become apparent from the detailed description and figures provided herewith.

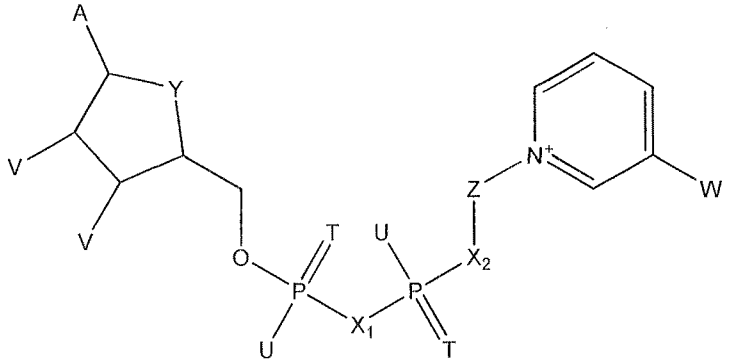
Claims

1. A test element configured for determining first and second analytes, comprising:

a first coenzyme-dependent enzyme or a substrate for the first enzyme, wherein the first analyte is hydroxybutyrate and the first coenzyme-dependent enzyme is a hydroxybutyrate dehydrogenase;

a second coenzyme-dependent enzyme or a substrate for the second enzyme, wherein the second analyte is glucose and the second coenzyme-dependent enzyme is a glucose dehydrogenase or a glucose oxidase; and

a coenzyme selected from the group consisting of thio-NAD, thio-NADP, and a compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

Y = NH, S, O, or CH_2,

Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X_2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

or a salt or optionally a reduced form thereof.

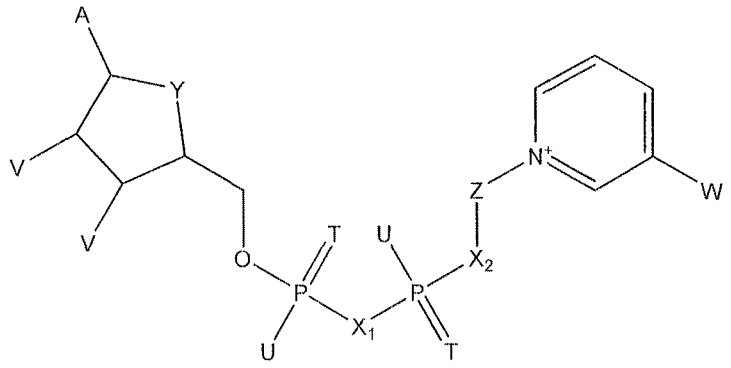
~~2. The test element of claim 1, wherein the first analyte is hydroxybutyrate and the first enzyme is a hydroxybutyrate dehydrogenase.~~

~~3~~2. The test element of claim ~~2~~1, wherein the hydroxybutyrate dehydrogenase is 3-hydroxybutyrate dehydrogenase.

~~4. The test element of claims 1 or 2, wherein the second enzyme is a dehydrogenase selected from the group consisting of a glucose dehydrogenase, lactate dehydrogenase, malate dehydrogenase, glycerol dehydrogenase, alcohol dehydrogenase, sorbitol dehydrogenase, and an amino acid dehydrogenase comprising L-amino acid dehydrogenase.~~

~~5. The test element of claims 1 or 2, wherein the second analyte is glucose and the second enzyme is a glucose dehydrogenase or a glucose oxidase.~~

~~6~~3. The test element of ~~any of~~ claims 1 ~~to 5~~or 2, wherein the coenzyme is a compound according to formula (I)



(I)

in which

A = adenine,

T = in each case denotes O,

U = in each case denotes OH,

V = in each case denotes OH,

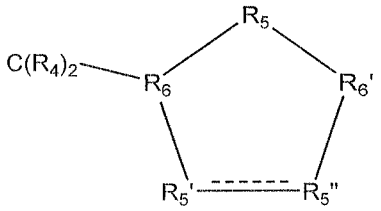
W = $CON(R)_2$ in which R denotes H,

X_1 = O,

X_2 = O,

Y = O, and

Z = a carbocyclic 5-membered ring of the general formula (II)



(II)

in which a single bond is present between R5' and R5", and in which

R4 = H,

R5' = CHOH,

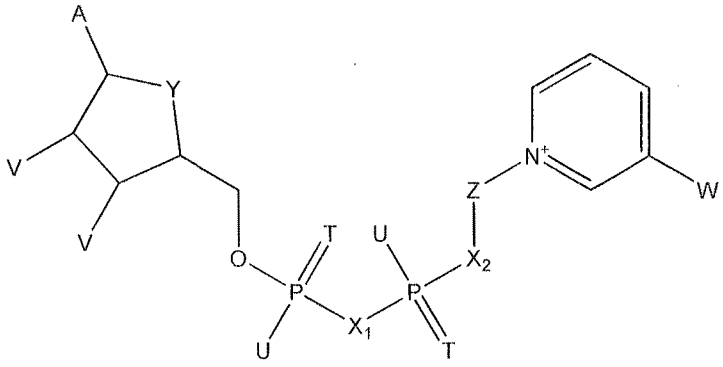
R5" = CHOH,

R5 = $CR4_2$,

R6 = CH, and

R6' = CH.

~~74~~74. The test element of any of claims 1 to ~~63~~63, wherein the coenzyme is a compound according to formula (I)



(I)

in which

A = adenine,

T = in each case denotes O,

U = in each case denotes OH,

V = in a first case denotes OH and in a second case denotes a phosphate group,

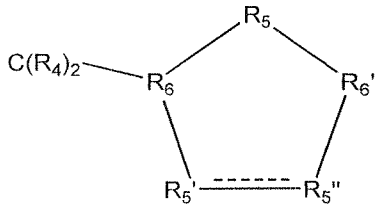
W = $CON(R)_2$ in which R denotes H,

X_1 = O,

X_2 = O,

Y = O, and

Z = a carbocyclic 5-membered ring of the general formula (II)



(II)

in which a single bond is present between R5' and R5", and in which

R4 = H,

R5' = CHOH,

R5" = CHOH,

$R5 = CR4_2$,

R6 = CH, and

R6' = CH.

85. The test element of claim 51, wherein the coenzyme is thio-NAD.

69. The test element of claim 15, wherein the coenzyme is thio-NADP.

107. The test element of any of claims 1 to 96, wherein the ~~further comprising a first reagent material, the first reagent material including the~~ first enzyme or the substrate for the first enzyme and the coenzyme selected from the group consisting of thio-NAD, thio-NADP and the compound according to formula (I) or a salt or optionally a reduced form thereof are included in a first reagent material.

118. The test element of any of claims 1 to 107, wherein ~~further comprising a second reagent material, the second reagent material including~~ the second enzyme or the substrate for the second enzyme and a coenzyme selected from the ~~group consisting of FAD, NAD,~~

~~NADP and the~~ compound according to formula (I) or a salt or optionally a reduced form thereof are included in a second reagent material.

~~12~~9. The test element of any of claims 1 to ~~11~~8, wherein the test element is ~~further comprising~~ a test strip configured to carry the first and second reagent materials.

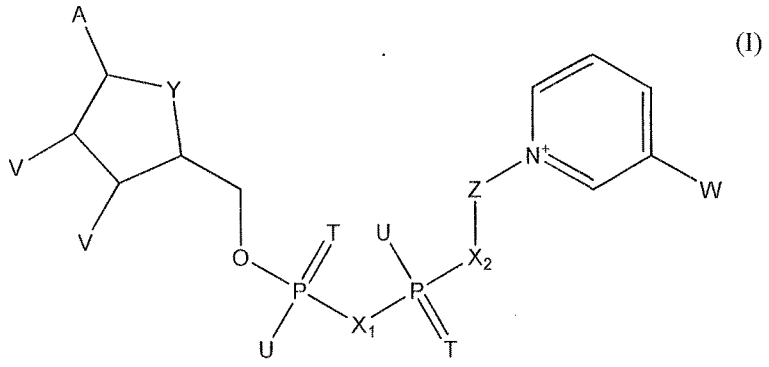
~~13~~10. The test element of claim ~~12~~9, wherein the test strip includes a first electrode system associated with the first reagent material and a second electrode system associated with the second reagent material.

~~14~~11. The test element of any of claims 1 to ~~13~~10, wherein the first reagent material further comprises one of nitrosoaniline, potassium ferricyanide, and a combination of a phenazine ~~derivative~~ compound and hexaammineruthenium chloride.

~~15~~12. A reagent material, comprising:

3-hydroxybutyrate dehydrogenase; and

a coenzyme compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

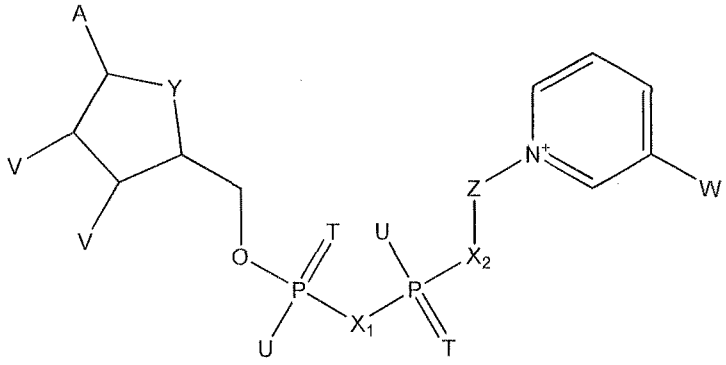
Y = NH, S, O, or CH_2,

Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X_2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

or a salt or optionally a reduced form thereof.

~~16~~13. The reagent material of claim ~~15~~12, wherein the coenzyme compound is according to formula (I)



(I)

in which

A = adenine,

T = in each case denotes O,

U = in each case denotes OH,

V = in each case denotes OH,

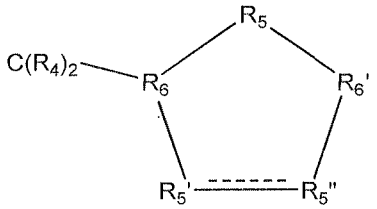
W = $CON(R)_2$ in which R denotes H,

X_1 = O,

X_2 = O,

Y = O, and

Z = a saturated carbocyclic 5-membered ring of the general formula (II)



(II)

in which a single bond is present between R5' and R5", and in which

R4 = H,

R5' = CHOH,

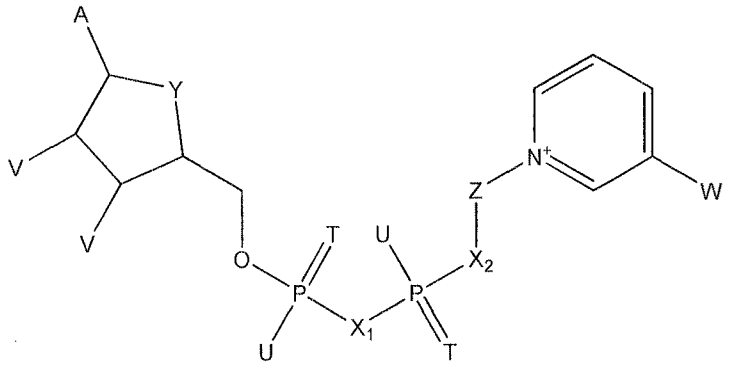
R5" = CHOH,

R5 = $CR4_2$,

R6 = CH, and

R6' = CH.

~~17~~14. The reagent material of claim ~~15~~12, wherein the coenzyme compound is according to formula (I)



(I)

in which

A = adenine,

T = in each case denotes O,

U = in each case denotes OH,

V = in a first case denotes OH and in a second case denotes a phosphate group,

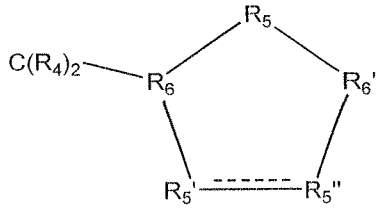
W = $CON(R)_2$ in which R denotes H,

X_1 = O,

X_2 = O,

Y = O, and

Z = a saturated carbocyclic 5-membered ring of the general formula (II)



(II)

in which a single bond is present between R5' and R5", and in which

R4 = H,

R5' = CHOH,

R5" = CHOH,

R5 = $CR4_2$,

R6 = CH, and

R6' = CH.

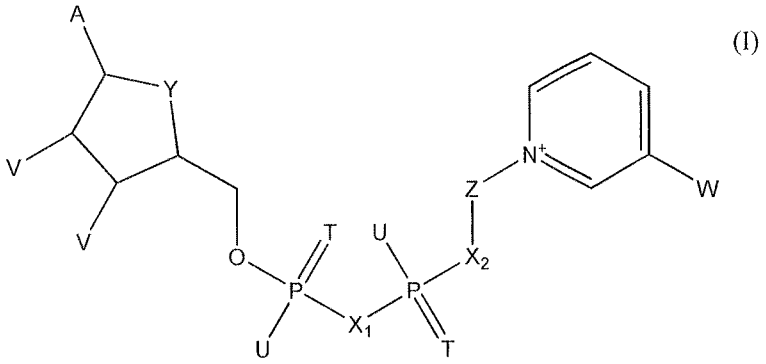
~~18~~15. The reagent material of any of claims ~~15~~ 12 to ~~17~~14, further comprising one of nitrosoaniline, potassium ferricyanide, and a combination of a phenazine ~~derivative~~ compound and hexaammineruthenium chloride.

~~19~~16. A test element, comprising a test strip carrying a first reagent material according to any of claims ~~15~~ 12 to ~~18~~ 15 for determining a first analyte, wherein the first analyte is hydroxybutyrate.

~~20~~17. The test element of claim ~~19~~16, wherein the test strip further carries a second reagent material for determining a second analyte, wherein the second analyte is glucose.

~~21~~18. The test element of claim ~~20~~17, wherein the second reagent material includes a ~~dehydrogenase enzyme selected from the group consisting of a~~ glucose dehydrogenase or a glucose oxidase~~, lactate dehydrogenase, malate dehydrogenase, glycerol dehydrogenase, alcohol dehydrogenase, sorbitol dehydrogenase, and an amino acid dehydrogenase comprising L-amino acid dehydrogenase~~.

~~22~~19. The test element of claim ~~20~~17 or ~~21~~18, wherein the second reagent material further includes a coenzyme selected from the group consisting of FAD, NAD, NADP and a compound according to formula (I):



(I)

in which

A = adenine or an analog thereof,

T = in each case independently denotes O or S,

U = in each case independently denotes OH, SH, BH_3^-, or $BCNH_2^-$,

V = in each case independently denotes OH or a phosphate group,

W = COOR, $CON(R)_2$, COR, or $CSN(R)_2$ in which R in each case independently denotes H or C_1-C_2-alkyl,

X_1, X_2 = in each case independently denote O, CH_2, $CHCH_3$, $C(CH_3)_2$, NH, or NCH_3,

Y = NH, S, O, or CH_2,

Z = a residue comprising a cyclic group with 5 C atoms which optionally contains a heteroatom selected from O, S and N and optionally one or more substituents, and a residue $CR4_2$ wherein $CR4_2$ is bound to the cyclic group and to X2, and

where R4 = in each case independently denotes H, F, Cl, or CH_3, provided that Z and the pyridine residue are not linked by a glycosidic bond,

or a salt or optionally a reduced form thereof.

~~23~~20. The test element of any of claims ~~20~~16 to ~~23~~19, wherein the test strip is configured for electrochemical determination of the first and second analytes.

~~24~~21. A method for determining first and second analytes in a sample, comprising the steps of:

providing a test element according to any of claims claim 1 to ~~14~~11 or ~~19~~16 to ~~23~~20;

contacting the test element with the sample;

detecting the first analyte; and

detecting the second analyte.

~~25~~22. The method of claim ~~24~~21, wherein the first analyte is hydroxybutyrate and the second analyte is glucose.

~~26~~23. The method of claim ~~24~~21 or ~~25~~22, wherein the steps of detecting the first analyte and detecting the second analyte are performed simultaneously.

~~27~~24. The method of any of claims ~~24~~21 to ~~26~~23, wherein the steps of detecting the first analyte and detecting the second analyte are completed within five seconds after contacting the test element with the sample.

~~28~~25. A method, comprising:

providing a test element aacording to any of the claims 1 to ~~14~~11 or ~~19~~16 to ~~23~~20 configured for determining glucose and ketone values in a sample;

contacting the test element with the sample; and

determining the glucose and ketone values in the sample within 7.5 seconds after contacting the test element with the sample.

~~29~~26. The method of claim ~~28~~25, wherein the test element includes a first reagent material for determining the glucose value and a second reagent material for determining the ketone value.

~~30~~27. The method of claim ~~29~~26, wherein the second reagent material includes a hydroxybutyrate dehydrogenase.

~~31~~28. The method of any of claims ~~28~~-25 to ~~30~~27, wherein the step of determining glucose and ketone values in the sample is completed within 5 seconds after contacting the test element with the sample.

~~32~~29. The method of any of claims ~~28~~-25 to ~~31~~28, wherein the glucose and ketone values are determined within 2 seconds of one another during the determining step.

~~33~~30. The method of any of claims ~~28~~-25 to ~~32~~29, wherein the sample comprises blood.

31. The test element of claim 8, wherein the second reagent material further comprises FAD, NAD or NADP.