



BIOM9021

A UghYfg`Dfc`YWwifk U`ZH]a YŁ

HYfa`H\FY`##`&\$&\$

; fUXi UHY`GWXcc``cZ6]ca YX]WJ`9b[]bYYf]b[]`##`! BGK ``9b[]bYYf]b[]



7 ci fgY`Cj Yfj]Yk

GhJZZ'7 cbhJWw'8YhJ]`g

7 cbj Ybcfg

B Ua Y	9a U]	5j U]'UV]'m	@cWWhcb	D\cbY
A]WUY`GHj Ybg	h\Yg]g"V]ca YXYb[4 i bgk "YXi "Ui			
: UhYa Y\ ? Uf]a]	h\Yg]g"V]ca YXYb[4 i bgk "YXi "Ui			

GvXcc`7 cbhJWw'Zcfa Uhcb

Gh XYbhGYfj]Wg`Wwb`vY`WcbhJWwX'j]U`[i.bgk."rc.#.YVZcfa.g](#)

7ci fgY'8YHJ`g

7fYX]hDc]bmg`*`

Gi a a UfmcZ`h`Y'7ci fgY

6€A - \$&%]g`h`Y'gYw`bX`\\U'ZcZ`h`Y'%&! C 7`fYgYUfW`dfc`Yw`'6€A - \$&\$`]g`h`Y`Zfgh`\\U'Z`9bfc`a`Ybh]b`
h`YgY`w`i`fgYg`U`ck`g`U`gh`XYbh`i`bXYfU`_Y`h`Y`Yei`j`U`YbhcZ6€A -- %(`A`Ugh`fg`Dfc`Yw`icj`Yf`k`c`
gYgg]cbg`"F`Ygi`hg`UfY`[`fUXYX`"

H`Y`V]ca`YX]W`Yb[]bYYf]b[`A`Ugh`fg`Dfc`Yw`U`ck`g`w`i`fgYk`cf`_`A`Ugh`fg`gh`XYbh`i`c`Yl`dYf]YbW`fYgYUfW`
fU]b]b[`Y]h`Yf`k`]h`b`h`Y`GVX`cc`cf`k`]h`w`U`V`c`f`U`h`b[]bgh]i`h`cbg`gi`VX`Ug`\\c`gd]U`g`UbX`7`G`F`C`"Dfc`Yw`g`
UfY`g`Y`V`W`X`V`m`h`Y`gh`XYbh]b`w`bgi`h`U`h`cb`k`]h`U`gi`dYfj`j`gcf`w`b`Xi`W]b[`fYgYUfW`]b`Ub`UfYU`c`Z]b`h`Y`gh`i`c`
h`Y`gh`XYbh`i`Z`h`Y`fYgYUfW`h`c`d]W`g`Y`V`W`X`]g`Yl`h`fb`U`h`h`Y`GVX`cc`#`b]j`Yfg]m`z`h`Y`gh`XYbh`i`gh`Uff`Ub[`Y`
Z`f`Ub]b`h`fb`U`";`G6a`9`w`!`gi`dYfj`j`gcf`#`j`g`g`Y`g`g`c`f`"H`Y`Dfc`Yw`h]g`w`b`Xi`W`X`c`j`Yf`k`c`h`f`a`g`"Dfc`Yw`g`UfY`
UggYggYX`cb`h`Y`V`U`g]g`c`Z`U`d`f`c`Y`W`h`f`Y`d`c`f`h]b`h`Y`Z`c`f`a`U`h`c`Z`Y]h`Yf`U`h`Y`g]g`c`f`U`fYgYUfW`d`U`d`Yf`fY`U`X`m`Z`c`f`
gi`Va`]gg]cb`h`c`U`fY`Z`fY`Y`X`c`i`fb`U`"D`Y`f`Z`c`f`a`Ub`W`]b`h`j`g`w`i`fgY`]g[`fUXYX`"

H`Y]g`w`i`fgY`w`b]b]i`Yg`h`Y`k`cf`_`d`f`c`d`c`g`Y`X`]b`6€A - \$&\$z`k`]h`h`Y`c`i`h`w`a`Y`V`Y]b[`U`)`\$\$\$`g`w`Y`b]h]Z`W`
fYgYUfW`d`U`d`Y`f`"

7ci fgY'5]a`g

H`Y`6]ca`YX]W`Y`9b[]bYYf]b[`A`Ugh`fg`Dfc`Yw`h]g`c`d`Y`b`h`c`X`i`U`f`Z`c`f`a`Y`f`m`w`b`W`f`Y`b`h`X`Y[`f`Y`Y`g`h`i`XYbh`k`\\c`
\\U`j`Y`gi`W`W`g`g`Z`"m`w`c`a`d`Y`h`X`H`Y`g]g`5`z`6`UbX`7`z`c`f`d`c`g`h[`f`U`X`i`U`h`g`h`i`XYbh`g`Y`b`f`c`"Y`X`]b`h`Y`A`Ugh`fg`c`Z`
6]ca`YX]W`Y`9b[]bYYf]b[`V`m`i`7`ci`fgYk`cf`_`D`f`c`[`f`U`a`w`c`X`Y`;`**`\$`E`"

7ci fgY`@YUfb]b[`C`i`h`w`c`a`Y`g

%`9`j`U`i`U`h`U`b`X`W`h]W`m`f`Y`j`Y`k`h`Y`g`w`Y`b]h]Z`W`]h`f`U`h`f`Y`
&`K`f]h`U`g`w`Y`b]h]Z`W`f`Y`d`c`f`h`U`b`X`w`c`a`a`i`b]W`U`h`g`w`Y`b]h]Z`W`Z`b`X`]b[`g`h`c`U`b`Y`X`i`W`U`h`X`U`i`X]Y`b`W`
" `8`Y`g][`b`z`W`U`f`f`m`i`c`i`h`z`U`b`U`m`g`Y`U`b`X`f`Y`d`c`f`h`c`b`f`Y`g`Y`U`f`W`h`U`g`_`g`"

H`Y`U`W`X`]b[`G`h`f`U`h`[]Y`g`

[@YUfb\]b\[`UbX`h`Y`U`W`X`\]b\[`U`W`h\]j`h\]Y`g`](#)

H`Y`g`h`i`XYbh`k`]`"f`Y`m`c`b`X`Y`j`Y`c`d]b[`U`b`]b`X`Y`d`Y`b`X`Y`b`h`U`b`X`w`c`U`V`c`f`U`h]j`Y`"Y`U`f`b]b[`U`d`d`f`c`U`W`"F`Y`g`Y`U`f`W`
e`i`Y`g`h]c`b`g`U`f`Y`c`Z`Y`b`c`d`Y`b`!`Y`b`X`Y`X`U`b`X`\\][`\\`m`g`d`Y`W`U`]g`Y`X`z`g`c`h`Y`g`h`i`XYbh`k`]`"Y`U`f`b`a`c`g`h`V`m`i`c`b`Y`!`h`c`b`Y`
a`Y`b`h`c`f]b[`d`f`c`j`]X`Y`X`V`m`h`Y`g`i`d`Y`f`j`j`g`c`f`U`b`X`h`Y`]f`f`Y`g`Y`U`f`W`h`Y`U`a`"

M`c`i`k`]`"Y`U`f`b`a`c`g`h`c`Z`m`c`i`f`g`_]`g`Z`c`a`D`\\8`g`U`b`X`D`c`g`h`8`c`W`g`]b`m`c`i`f`"U`V`"K`Y`Y`b`w`c`i`f`U[`Y`m`c`i`h`c`U`h`Y`b`X`"U`V`
a`Y`Y`h]b[`g`h`c`[`Y`h`U`b`X`_`b`c`k`"U`V`d`Y`f`g`c`b`b`Y`"

[9l`d`Y`W`U`h\]c`b`g`c`Z`g`h`i`XYbh`g`](#)

z`X`h`h`h`h`f`g`i`d`Y`U`g`g`Y`g`g`a`[`Y`b`h`U`f`Y`c`b`h`a`Y`

X]h]cbU`7ci fgY` bZcfa`U]c`g`

H\YfY`]g'bc`cZ]WU`WUgg'hja Y`Zcf'h]g'Wci fgY"McI`a i ghgh`Ybgi fY'mci f`Ybfc`a YbhUbX`fY[]ghfUh]cb`]g
i`d`fc`XUhr`]b`mci f`Ybfc`a Ybh`McI`f`ZJW!fc!ZJW`hja Y`bYXg`fc`VY`cf[Ub]gYX`k`]h`mci f`gi`dYfj`]gcFZ`Ug`mci
UfY`YI`dYWYX`fc`a`YYh`h`Ya`Uh`YUghicbW`dYf`k`YY`_"

5ggYgga Ybh

H\Y`ZbU`[fUXY`Zcf'6€A - \$&%#6€A - \$&\$'k]`VY`hY`k Y][\hX`Uj YfU[Y`cZmci f`UggYgga Ybhg`Zca
 6€A - \$&\$'f&\$i ƒ`UbX'6€A - \$&%f) \$i ƒ`Mci `k]`fYWj] Y`hY`gUa Y`[fUXY`Zcf`Vch`Wci fgYg'i dcb
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GWYbh]ZWA Ubi gW]dh	, \$i	A cbXUmK YY_`%%	%z`&z`

5ggYgga Ybh8YHJ]`g

5ggYgga Ybh%`GWYbh]ZWA Ubi gW]dh

GHUfhXUH. Bch5dd]WUVY

@Yb[h.) \$\$\$`k cfXg

8YHJ]`g.

H\Y`cVYWj] Y`cZh]g`UggYgga Ybh]g`hc`WYUH`U`fYgYUfW`a Ubi gW]dh]hUhWci `X`Zca`hY`VUg]g`cZU`ci fbU`
 Ufh]WY`"D`YUgY`fYj]Yk`hY`XcW`a Ybh]cb`A`ccX`Y`#HYUa`g`Zcf`Z`fh`Yf`]bg]fi`W]cbg`"B`ch`h`Uh`h`YfY`]g`U`gf]W`h
 k`cfX`"ja`]hcZ) \$\$\$`k cfXg"

%`@]h]fU]h`fY`fYj]Yk`#/UW_[fci bX`UbX`di`h]b[`hY`fYgi`hg`]b`Wcb]h] hf&\$i ƒ
 &`"9i`YW`h]cb`cZ`hY`fYgYUfW`dfc`YWz`ei`U`]hmcZUbU`mg]gž`X]gW`gg]cb`cZ`fYgi`hg`f) \$i ƒ
 ' `7`cbW]`g]cbg`UbX`j`Ui`Y`UXXYX`f&\$i ƒ
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Hi fb]h]b`gYH]b[.`H\]g`]g`bchU`Hi`fb]h]b`Ugg][`ba`Ybh

F Ygci fWg

DfYgWf]VYX`F Ygci fWg`

F Ygci fWg`k]`VY`a UXY`Uj U]UV`Y`tc` \Y`d`gh XYbtg] i]XY`h`Ya`]b`h`Y]f`ci fbYmZcf`H\Yg]g`5"

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Mci`Wb`Udd`mZcf`gdYWU`Wcbg]XYfU]cb`k` \Yb`]`bYgg`cf`ch`Yf`W]FW`a` g]UbWg`]b]fZYfY`k`]h`mci`f` UggYgga` YbhdYfZc`fa` UbW`"

C`h`Yf`Udd`]W]h]cbg`Zcf`YI`hYbg]cb`cZgi`Va`]gg]cb`cZ`h`Yg]g`fYdcf`fY`["`"Yei`]da` YbhVfYU`_Xck`bZ`YhW`L`

%` 8]gW` gg`h`Y`dcgg]V`]]micZUb`YI`hYbg]cb`k`]h`mci`f`gi`dYfj`]gcf`Z]fgh`
&`" F`Yei` Ygh`W]b`h`Yb`VY`cX[`YX`Vm`h`Y`gh` XYbh` \YfY` \`h`d`.#]bmi`f`"Wca`#m&`h`dnj`."`H\Y`gi`dYfj`]gcf`k`]`
h`Yb`fYW`j`Y`Ub`Ya`U`]`Ug_]b[`h`Ya`tc`Uddfc]`Yz`VY`ZcfY`]h]g`YgWU`U`h`X`tc`h`Y`XYW]g]cb`d`UbY`"
'`" F`Yei` Ygha`i`gh`VY`cX[`YX`Vm`K`YY`_`*`cZ`h`fa`"
(`" D`UbY`XYW]g]cb`k`]`VY`a` UXY`Vm`Yb`X`cZ`k`YY`_`+`"
)`" H\Y`XYW]g]cb`k`]`VY`a` UXY`Vm`U`d`UbY`-`Wcbg]gh]b[`cZ`h`Y`<`cG`f`b`f`h`Y]f`bca`]b`YY`L`Z`H\Yg]g`
7`ccfX]b]U`h`fz`UbX`%`c`h`Yf`d`Yf`gcb`"
*`" Gh`XYbtg`g` \`ci`X`VY`U`Y`f`h`X`tc`h`Y`Z]W`h`h`U`h`h`]g`]g`b`ch[`i`U`f`Ub`h`Y`X`Z`UbX`h`i`g`g` \`ci`X`b`ch`f`Y`m`cb`
[`Y`h]b[`Ub`YI`hYbg]cb`"
+`" H`m`d]WU`n`Z`YI`hYbg]cbg`U`fY`[`f`Ub`h`X`I`D`HC`" `k`YY`g`" H\Y`Yb[`h`cZ`h`Y`YI`hYbg]cb`b`Y`Y`X`g`tc`VY`
f`Yei`Y`gh`Y`X`UbX`^`g`h]Z]Y`X`Vm`h`Y`gi`dYfj`]gcf`"D`UbY`k`]`XYW]XY`h`Y`Yb[`h`cZ`h`a`Y`[`f`Ub`h`X`"
" `

DfcW`Xi`fY`]Z`mci`ZU]`

Gh`XYbtg` \Uj`Y`h`fY`cd]cbg`"

%` fY!Ybfc`Zcf`6`€`A` -`\$`&`\$`#`\$`&`%`z`b`Yk`d`fc`Y`W`h`UbX`gi`dYfj`]gcf`
&`" fY!Ybfc`Zcf`6`€`A` -`\$`&`%`U[`U]b`k`]h`h`Y`g`Ua`Y`d`fc`Y`W`h`!`b`Y`Y`X`g`Wcbg`Y`b`h`c`Z`U`b`U`d`d`f`c`d`f]U`h`Y`gi`dYfj`]gcf`
/`gh`XYbh`
'`" Gh`XYbh`Xc`Yg`Z`f`h`Yf`k`cf`z`fY!gi`Va`]hg`h`Yg]g`U`Z`h`f`U`a`U`i`c`Z`*`k`YY`g`"5`ag`d`Wa`Uf`_`W`U`d`d`Y`X`U`h`
)`\$`i`" `z`gh`" `b`ch`g`U`h`g`Z]W`c`f`m`z`h`Yb`b`Y`Y`X`g`tc`fY!Ybfc`"

H\]g`Ughcd]cb`]g`cb`m`Uj`U]UV`Y`]Z`h`Y`cf][`]bU`a`Uf`_`k`Ug` (`\$`Z`C`F`]Z`h`Y`gh`XYbh]g`]b`h`Y]f`UghgYa`YghYf`
VY`ZcfY`[`f`UXi`U]h]cb`fY[`UfX`Ygg`cZ`h`Y`cf][`]bU`a`Uf`_`L`"

[bXi`ghfm`VUgYX`dfc`YWg](#)

K`Y`Yb`Wci`fU[`Y`gh`XYbtg`tc`g`YY`_`d`U`f`b`Y`f`g`]dg`k`]h`]bXi`ghfm`z`gc`gh`XYbtg`W]b` \Uj`Y`U`W`!`gi`dYfj`]gcf`Z`ca`
]bXi`ghfm`<`ck`Yj`Yfz`]Z`W`b`Z]XYbh]U`]m]g`f`Yei`]fY`X`Z`U`W`b`Z]XYbh]U`X`]g`W`c`gi`fY`U[`f`Y`Ya`Y`bh`f`7`8`5`L`]g`c`V`][`U`h`c`f`m`
H\Y`U[`f`Y`Ya`Y`bh`k`]`d`f`ch`W`h`h`Y`]b]h`Y`W`h`U`d`f`c`d`Y`f`m`f`[` \`h`g`c`Z`h`Y`]bXi`ghfm`d`U`f`b`Y`f`z`I`B`G`K` `UbX`h`Y`gh`XYbh`
Gh`XYbtg`cf`U`W`U`X`Ya`]W`g`U`fY`b`ch`U`i`h`c`f`]g`Y`X`tc`g][`b`W`b`Z]XYbh]U`X`]g`W`c`gi`fY`U[`f`Y`Ya`Y`bh`g`cb`VY` \U`Z`c`Z`
I`B`G`K` `UbX`U`fY`U`X`]g`Y`X`tc`h`U`_`tc`h`Y`W`ci`fgY`W`c`f`X]b]U`h`c`f`UbX`I`B`G`K` `Y[`U`c`Z]W`h`c`U`f`f`Ub[`Y`Zcf`X`f`U`Z]b[`
UbX`g][`b]b[`cZ`h`Y`W`b`Z]XYbh]U`X`]g`W`c`gi`fY`cf`fY`g`Y`U`f`V`X`U[`f`Y`Ya`Y`bh`"

[@UHy'dfcWYXi fY](#)

Gi Va]gg]cb`cZ5ggYgga YbhHUg_g

@UVcfUhcfmfYdcfhg`UbX`a U`cf`Ugg][ba Ybhg`k]`fYei]fY`U`[Bcb`D`U\[\]Uf\]ga`8YWUfU\]cb`7cj`Yf`G`YYH`](#)

@UH`gi Va]gg]cbg`k]`VY`dYbU`]gYX`%\$i`cZ`h`Y`a Uf`_`Zcf`YUW`W]`YbXUf`XUm`UH`" `Z`mci`ZcfYgYY`U`dfcV`Ya]b`a`YYH]b[`h`Y`bca]bUH`X`gi Va]gg]cb`XUH`d`YUgY`W`b`h`U`W`h`h`Y`7`ci`fgY`7`cbj`Ybcf`h`a`U`_`Y`Ub`Uddc]b`h`a`Ybh`h`c`X]gW`gg`mci`f`g]h`U]cb`Ug`gccb`Ug`dcgg]V`Y"

5 WUXYa]W< cbYgmiUbX`D`U[]Uf]ga

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Gh XYbhZYXVUW_\Ug\YdYX'hc'g\UdY'UbX'XYj Y'cd'h\]g'Wci fgYž]bWi X]b['ZYXVUW_cVHU]bYX'Zca'cb!
]bY'Yj U'i Uh]cbg'Ug'dUfhcZI BGK 'g'Ug'dUfhcZI BGK 'g'a m9I dYf]YbW'dfcW'gg"Mc'i 'UfY'\][\`m
YbWci fU[YX'hc'Wca d'YH'gi W\ 'Ub'cb!]bY'Yj U'i Uh]cb'hck UfX'h'Y'YbX'cZHYfa "': YYXVUW_UbX'gi [[Ygh]cbg
dfcj]XYX'k]`VY']a dcfhUbh]b]a dfcj]b['h'Y'Wci fgY'Zf'Z hi fY'gh XYbthg"

85H9G'HC' BCH9

FYZf'hc'A m BGK 'Zcf'æ dcfhUbh8UH'gžUj U]UV'Y'Uh
[\hd.##a m'i bkg "YXi "Ui #gh XYbh#Ygci fW'g#? Ym8UH'g"\ha`](#)

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- "69GG

fYZf'hc'h'Y'GWcc`k YVg]h'Uj U]UV'Y'Uh
[\hd.##k k "Yb\[\]bYYf\]b\["i bkg "YXi "Ui #/\]ca YX\]W:\]Yb\[\]bYYf\]b\#

Gi dd`Ya YbHfM9I Ua]bUh]cbg.

Gi dd`Ya YbHfM9I Ua]bUh]cbg'Zcf'HYfa " '&\$&\$'k]`VY\Y'X'cb'A cbXUm%#h`>Ubi Ufm--: f]XUm%) h
>Ubi Ufmf]bWi gj YL'g\ci `X'mci `VY'fYei]fYX'hc'g]hcbY"

⇒a U[Y'7 fYX]h

GmbYf[]Yg]b'Gci bX'&\$%*

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5W_bck `YX[Ya YbhcZ7ci bhfm

K Y'UW_bck `YX[Y'h'Y'6YXY[U`dYcd'Y'k \c'UfY'h'Y'fUX]h]cbU`W ghcX]Ubg'cZ'h'Y'UbXg'cb'k \]W`I BGK
?Ybg]b[hc'b`W]a di g]g`cW]hYX"