

BIOM9020

A UghYfg'Dfc YWwfk U`ZH]a YŁ

HYfa &Z&\$&&



7ci fgY`Cj Yfj]Yk

GhJZZ'7cbhJWw'8YhU]`g

7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`]m	@cW]h]cb	D\cbY
A U]h\Yk `6fcX]Y	h\Yglg"V]ca YXYb] 4 i bgk "YXi " Ui			

GWXcc``7cbhJWw`bZcfa Uh]cb

Gh XYbhGYfj]W]g`W]b`VY`WcbhJWwX`j]U`i [i_bgk "rc# YVZcfa_g"](#)

7ci fgY'8YHJ]`g

I b]hg'cZ7fYX]h*`

Gi a a UfmicZh\Y'7ci fgY

D`YUgY'bcH\`WbX]XUH'g'a i ghVcbHJWh\Y'GVXcc`Zcf'WcbgYbhfc`Ybfc`"6€A - \$\$]g'cb`mUj U]UV'Y'hc
\[\`UW\]Yj]b[`ghi XYbHg`k]h`df]cf`k f]hYb`gW\cc`Uddfcj U"

6€A - \$\$]g'h\Y'Zfgh\U'ZcZh\Y`%&I C 7`fYgYUfW`dfc`YVh`6€A - \$&%]g'h\Y'gYVcbX`U'Z

5ggYgga Ybh

H\YFY'UFY'fk c'UggYgga YbhiUg_g'UWfcgg'6€A - &\$'UbX'6€A - &%"

⊖'6€A - &\$\$z'nci 'a i ghWca d'YH'Ub'jbHYfa 'fYdcfh'

⊖'6€A - &%z'nci 'a i ghWca d'YH'U'gWYbhjZ'Wa Ubi gW'dhff) \$\$\$'k cFXgl'

5ggYgga YbhiUg_	K Y][\h	8i Y'8UH	7ci fgY'@YUfb]b[Ci hWca Yg'5ggYggYX
%'Dfc'YWH!' ⊖HYfa 'F Ydcfh	\$\$i	Hi YgXUmK YY_'%%U�%%) - da	%ž&ž' ž(ž) ž*

5ggYgga Ybh%'Dfc'YWH!' ⊖HYfa 'F Ydcfh

5ggYgga Ybh'Yb[h. '&\$!' \$'dU[Yg
Gi Va]gg]cb'bcHYg. 'D'YUgY'gi Va]hj]U'hY'gi Va]gg]cb''b_'cb'A]WfcgcZiHYUa g"
8i Y'XUH. 'Hi YgXUmK YY_'%%U�%%) - 'da

H\Y' ⊖HYfa 'F YdcfhUggYgga Ybh]g'XYg][bYX'hc'Ybgi fY'hUhmc i '\Uj Y'UXYei UH'md'UbbYX'mci f'hYg]g
dfc'YWH'⊖]g'XYg][bYX'hc'Ybgi fY'hUhmc i '\Uj Y'd]W_YX'i d'Ybci [\ 'VUW_[fci bX'_bck 'YX[Y'hc'Ybgi fY'hUh
mci 'UFY'WcbXi W]b['U'bcj Y'UbX'g][b]Z]W]bhfYgYUfW'k' dfc'YWH'

5g'U'[i]XYžhY'hcU'bi a VYf'cZdU[Yg'ib'mci f'XcW a Ybhg\ci 'X'VY'VYhk YYb'&\$'UbX' "\$'Mci f'gi dYfj]gcf
a Um\Uj Y'UXX]hcbU'fYei]fYa Ybhgžgc'WXYW_k]h' hYa 'Zfgh'

Gi [[YghYX'Ghfi Wfi fY

D'YUgY'bcHY'hUh]g'g'U [YbYFU'ghfi Wfi fYžd'YUgY'WXYW_k]h' mci f'gi dYfj]gcf'Ug'hYmia Um\Uj Y'gdYW]Z]W
fYei]fYa Ybhg'VUgYX'cb'mci f'dfc'YWH'

- 5VghfUWh
- HUV'Y'cZ7cbHYbhg
- GHUHa Ybhcz7cbf]Vi h]cb
- 7CJ ⊖!% 'a dUWHGHUHa Ybh
- ⊖hfcXi W]cb'fa Ul '%dU[YL
- 5]a g
- 6UW_[fci bX
- @]HYfUhi fY'F Yj]Yk
- < mchYgYg'f]ZUdd'j]WV'YL
- F YgYUfW'k'D'Ub
 - A Yh'cXc'c[m
 - H]a Y'j]bY
- Dfc'YWH'8YdYbXYbhDfYdUfU]h]cbg

GHUHa YbhczWcbf]Vi h]cb

H\Y'ghUHa YbhczWcbf]Vi h]cb'g\ci 'X'gdYW]Z]W'm]XYbh]ZiH'Y'Wca dcbYbhg'cZfYgYUfW'k' bXYfU_Yb'VmH'Y

gh XYbh`Hc`Xc`h]gž]bX]WUHY`k` \]W`UgdYWg`cZhY`fYgYUfW`fYgi`hg`cf`Yb[]bYYf]b[`XYg][bg`]bW`XYX`]b`hY`
dfc`YW`a`Ubi`gW]dhk`YfY`XcbY`]b`Wc`UVcfU]cb`k`]h`ž`cf`i`bXYfU_Yb`Vmž`ch`Yf`a`Ya`VYfg`cZ`h`Y`fYgYUfW`
[fci`d`cf`VmYI`hYfbU`Wc`UVcfU]cf`"B`ch`h`U`h`k`cf`_`XcbY`Vmch`Yfg`a`i`ghVY`"a`]hX`h`c`ghYdg`h`U`h`k`ci`X`
YbUV`Y`h`Y`gh`XYbh`c`i`bXYfU_Y`h`Y]f`dfc`YW`ž`b`ch`h`Y`dfc`YW`h`h`Ya`gY`j`Yg`"9I`Ua`d`Yg`cZ`h`]g`a`Um`]bW`XY`
fVi`hbch`"a`]hX`h`c`

- gca`Y`gi`f[`Yf]Yg`VY]b[`i`bXYfU_Yb`Vma`cfY`YI`dYf]YbW`X`UV`Wc`YU[`i`Yg`"
- hgg`i`Y`W`h`fYg`VY]b[`a`U]bU]bYX`cf`dfc`W`ggYX`Vm`UV`Ugg]g]U`b`h`g`"
-

5 hYbXUbW`F Yei]fYa Ybhg

Gh XYbhg`UFY`gfc b[`mYbWci fU[YX`fc`UhhYbX`U`WUggYg`UbX`fYj`]Yk`YWh`fY`fYWcfX]b[g"

7 ci fgY`GW`YXi`Y`

[J\]Yk`WUgg`ha`YhUV`Y`](#)

H]a`YhUV`Y`

8UH`	HmdY`	7cbhYbh`
Gh XmiK`YY`_`_`,`5i`[i`gh!` %%5i`[i`gh`	5ggYgga`Ybh`	hYf]a`F`YdcfhXi`Y`A`cbXUmK`YY`_`%%`Uh` %%)`-`da`"``

F Ygci fWg

DfYgWf]VYX F Ygci fWg

F Ygci fWg'k]`VY'a UXY'Uj U]UV'Y'rc` \Y'd'ghi XYbng [i]XY'hYa`]b'hY]f'ci fbYmZcf'H\Yg]g'5"

9I hYbg]cbg

Mci`Wb`Udd'mZcf`[gdYWU`Wcbg\]XYfU\]cb`k` \Yb` \]`bYgg'cf'chYf'W\]FW`a`gHUbWg` \]bHfZYf'k` \]h`mci`f` UggYgga`YbhdYfZcfa`UbW`"](#)

C hYf'Udd`]W]h]cbg`Zcf'YI`hYbg]cb`cZgi`Va`]gg]cb`cZhYg]g`fYdcfng`fY`["`"Yei`]da`YbhVfYU`_Xck`bZ`YHwL`

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%`8` ]gW`gg`hY`dcgg]V`] ]micZUb`YI`hYbg]cb`k` ]h`mci`f`gi`dYfj` ]gcf`Z]fgh`
&`F`Yei`Ygh`WUb`h`Yb`VY`cX[`YX`Vmih`Y`ghi`XYbh` \YfY` \`hrl`#h\]bmi`f`Wca`#m&hndj`"H\Y`gi`dYfj` ]gcf`k` ]`
  h`Yb`fYW` ]`Y`Ub`Ya`U` ]`Ug`_ ]b[`h`Ya`rc`Uddfc]`Yz`VY`Zcf`Y` ]h` ]g`YgWU`UH`X`rc`h`Y`XYW]g]cb`d`Ub`Y`"
'`" `F`Yei`Ygha`i`ghVY`cX[`YX`VmK`YY`_`*`cZ`h`fa`"
(`D`Ub`Y`XYW]g]cb`k` ]`VY`a` UXY`VmYbX`cZk`YY`_`+"
)`H\Y`XYW]g]cb`k` ]`VY`a` UXY`VmU`d`Ub`Y`-`Wcbg]gh]b[`cZ`h`Y`<cG`f`b`f`h`Y`f`bca` ]b`Y`Y`Z`H\Y`g]g`
  7`ccfX]b]Urc`fz`UbX`%`ch`Yf`dYfgcb`"
*`G`h`XYbng`g` \`ci`X`VY`U`Y`f`f`X`rc`h`Y`Z]W`h`h`U`h`h` ]g` ]g`b`ch[`i`U`f`Ub`h`Y`X`z`Ub`X`h`i`g`g` \`ci`X`b`ch`f`Y`m`cb`
  ]`Y`h` ]b[`Ub`YI`hYbg]cb`"
+`H`m` ]W`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`rc`VY`
  f`Yei`Ygh`X`Ub`X`^`g`h`Z]Y`X`Vmih`Y`gi`dYfj` ]gcf`"D`Ub`Y`k` ]`XYW]XY`h`Y`Yb[`h`cZ`h`a`Y`[`f`Ub`h`X`"
" `

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

K`Y`Yb`Wci`fU[`Y`ghi`XYbng`rc`gYY`_`d`U`f`b`Y`f`g` \`]dg`k`]h`]bXi`ghm`z`gc`gh`XYbng`WUb` \Uj`Y`U`W`!`gi`dYfj`]gcf`Z`ca`]bXi`ghm`<`ck`Yj`Yfz`Z`W`b`Z`XY`b`h`U`]m`]g`f`Yei`]f`Y`X`z`U`W`b`Z`XY`b`h`U`X`]g`W`c`gi`fY`U[`f`Y`Ya`Y`b`h`f`7`8`5`L`]g`c`V`] [`U`rc`f`m` H\Y`U[`f`Y`Ya`Y`b`h`k`]`d`f`c`h`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`ghm`d`U`f`b`Y`f`z`I`B`G`K` `Ub`X`h`Y`gh`XYbng` G`h`XYbng`cf`U`W`X`Y`a`]m`g`U`f`Y`b`ch`Ui`h`c`f`]g`Y`X`rc`g`] [`b`W`b`Z`XY`b`h`U`X`]g`W`c`gi`fY`U[`f`Y`Ya`Y`b`ng`cb`VY` \U`Z`c`Z` I`B`G`K` `Ub`X`U`f`Y`U`X`]g`Y`X`rc`h`U`_`rc`h`Y`W`ci`fg`Y`W`c`f`X`]b]Urc`f`Ub`X`I`B`G`K` `Y[`U`c`Z`W`rc`U`f`f`Ub[`Y`Z`c`f`X`f`U`Z`]b[`Ub`X`g`] [`b] [`c`Z`h`Y`W`b`Z`XY`b`h`U`X`]g`W`c`gi`fY`cf`f`Y`g`Y`U`f`W`U[`f`Y`Ya`Y`b`h`

[@Uh`dfc`W`Xi`fY](#)

h`U`W`U`g`g`z`Udd`]W]h]cbg`Zcf`Uh`gi`Va`]gg]cb`WUb`VY`Udd`]YX`Zcf`69: `C`F`9`h`Y`Xi`Y`X`U`h`" `H` \`]g`]g`U`h`h`Y` X`]g`W`Y`h]cb`c`Z`h`Y`h`Y`g]g`W`c`f`X`]b]Urc`f`Vi`h`g` \`ci`X`c`b`m`VY`[`f`Ub`h`X`]b`YI`W`d`h]cb`U`W]f`W`a`g`H`U`b`W`g`" `5`g`d`Y`f`bcfa`U`z`gh`XYbng`WUb`U`gc`Udd`m`h`f`ci`[` \`a`m`I`B`G`K` `Zcf`gd`Y`W`U`W`cbg]XYfU]cb`"

:`c`f`6`€`A`-`\$`&\$`Ub`X`6`€`A`-`\$`&%`k`]`VY`XYXi`W`Y`X`c`Z`h`Y`f`Z`W`e[`Zcf`Yj`Yfm`X`U`m`U`h`" `D`Y`b`U`h`m`Udd`]Y`g`i`b`h`h`Y` a`U`f`_`g`Zcf`h`Y`U`ag`d`W`X`Y`W`Y`U`g`Y`rc`)`\$`z`Ub`X`Z`f`h`Y`f`U`h`b`Y`g`g`X`c`Y`g`b`ch`f`Y`gi`h`]b`Z]i`fY`c`Z`h`Y`U`ag`d`W`Z`Vi`h` a`] [`h`VY`U`Z]i`fY`c`Z`h`Y`h`Y`g]g`f`k`YY`_Y`b`X`g`W`ci`b`h`U`g`X`U`m`g`L`"

[5XX\]h\]cbU`gi`ddc`fh`Zcf`ghi`XYbng`](#)

- H\Y`7i`fY`b`h`G`h`XYbng`;`Uh`k`Um`[\`hrl`g`#`gh`XYb`h`i`bgk`"Y`Xi`"U`i`#`](#)

Gi Va]gg]cb'cZ5ggYgga YbhiHUg_g

@UVcfUhcfmfYdcfng'UbX'a U'cf'Ugg][ba Ybht'k]''fYei]fY'U' [Bcb'D'U\[\]Uflga'8YWUfUhc'7cj Yf'G\YYH'](#)

5gg][ba Ybht'g\ci 'X'VY'gi Va]H'X'cb'h'a Y''5'XU]'mdYbU'micZ) i 'cZ'hY'a Uf_g'Uj U]'UV'Y'Zcf'hUh
Ugg][ba Ybhk]''Udd'mZcf'k cf_'fYW'j YX'UZ'Yf'h'Y'Xi Y'XUH''5bmiUgg][ba Ybhia cfY'h'Ub') 'XUmg''UH'k]''bch
VY'UW'W'dh'X''H\Y'cb'mYI Ya dh]cb'k]''VY'k \Yb'df]cf'dYfa]gg]cb'Zcf''UH'gi Va]gg]cb'\Ug'VYYb'[fUb'h'X'Vm
h'Y'7ci fgY'W'cfX]bU'cf''9I h'bg]cbg'k]''VY'[fUb'h'X'cb'mcb'a YX]W'cf'W'a dUgg]cbUH'[fci bXg'i bXYf
YI hfYa Y'W'fW'a g'U'bv'W'g''

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

D@5; ≠F ≠GA

6Yk UfY`5b`Ugg][ba YbhUUh]bWl XYg`d`U[]Uf]gYX`a UHf]U`k]`fYW]j Y`U`\$i : U]žUbX`gh XYbhtg`k \c d`U[]Uf]gY`a UmZ]`hY`Wci fgY`Gh XYbhtg`k \c`d`U[]Uf]gY`k]`Uj Y`hY]f`bUa Yg`YbHfYX`cb`U`d`U[]Uf]ga fY[]ghf`UbX`k]`VY`]UV`Y`hc`X]gW]d`]bUfmiUW]cbž]bWl X]b[`Yl Wl g]cb`Zca `Ybfc`a`Ybh`
#]g`Yl dYWYX`hUUhU`gh XYbhtg`a i ghUUhU`h]a Yg`gi Va]hY]f`ck`b`k`cf`_`Zcf`UggYgga Ybh`Gi Va]h]b[`hY`k`cf`_`cf`]XYUg`cZgca YcbY`Y`gY`k]h]ci hWYUfmiUW_bck`YX[]b[`hY`gci fW`cZVcffck`YX`a UHf]U`cf`]XYUg`]g d`U[]Uf]ga "

5`UggYgga Ybhtg`k \]Wl`mci `UbX`]b`a i gh`Uj Y`U`[Bcb`D`U\[\]Uf\]ga`8YWUfU\]cb`7cj`Yf`G`YYH`H\\]g`\]g`Zcf`Vch`\]bX\]j`\]Xi`U`UbX`\[fci`d`k`cf`_`5HUVW`\]h\]c`mci`f`Ugg\]\[ba YbhVYZcfY`gi Va \]h\]b\[`\]h\]c`hY`7`ci`fgY`7`ccfX\]bUhc`f`cf`UhhY`GVXcc`C`Z\]W"](#)

D`U[]Uf]ga `]g`hY`i`gY`cZUbchYf`dYfgcb`g`k`cf`_`cf`]XYUg`Ug`]ZhYmik`YfY`mci`f`ck`b`"K` \Yb`]h]g`bYW]ggUfmicf`XYg]fUV`Y`hc`i`gY`chYf`dYcd`Y`g`a`UHf]U`mci`g`ci`X`UXYeI`UH`mUW_bck`YX[Y`k`cgY`k`cfXg`cf`]XYUg`hYm`UfY`UbX`k` \YfY`mci`Zci`bX`hY`a`f`]j`]b[`hY`Wca`d`YH`fYZYfYbW`XYH]`gž]bWl X]b[`dU[Y`bi`a`VYffg]H`Y`@YUfb]b[`7`YbHfY`dfcj`]XYg`Z`fH`Yf`]bZcfa`U]cb`cb`k` \UhWcbgh]h`H`g`D`U[]Uf]ga `Uh` \Hdg`#]gh XYbhi`bgk`"YXi`"Ui`#]U[]Uf]ga

5WUXYa]WbZcfa Uh]cb

7CI FG9'9J5@! 5H€B'5B8'89J9@CDA 9BH

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'hc'k UfX'h'Y'YbX'cZHYfa "': YYXVUW_UbX'gi [[Ygh]cbg
dfcj]XYX'k]"VY'ja dcfh]bh]b]ja dfcj]b['h'Y'Wci fgY'Zf'Z hi fY'gh XYbthg"

85H9G'HC'BC H9

FYZf'hc'A m BGK 'Zcf'æ dcfh]bh8UH'gžUj U]UV'Y'Uh
[\hfdg.##a m'i bgk "YXi "Ui #gh XYbh#fYgci fW'g#? Ym8UH'g"\ha`](#)

57589A ⇒ '58J ⇒9

: cf]bZcfa Uh]cb'UVci h

- ""B cH'g'icb'UggYgga Ybthg'UbX'd'U[]Uf]ga ž
- ""GdYWU'7 cbg]XYfU]cbgž
- ""GW'cc'Gh XYbh9h]Vg'C Z]W'fz'UbX
- ""69GG

fYZf'hc'h'Y'GW'cc'k YVg]h'Uj U]UV'Y'Uh
[\hfd.##k k k "Yb\[\]bYYf\]b\["i bgk "YXi "Ui #/\]ca YX\]WU'!Yb\[\]bYYf\]b\#

Gi dd`Ya YbhUfm9I Ua]bUh]cbg.

Gi dd`Ya YbhUfm9I Ua]bUh]cbg'Zcf'HYfa '&\$\$&&'k]"VY'\Y'X'cb'fH67 E'g\ci 'X'mci 'VY'fYei]fYX'hc'g]hcbY"

H\]g'Wci fgY'ci h]bY'gYthg'ci hXYgW]dh]cb'cZUggYg'Uh'h'Y'XUH'h'Y'7 ci fgY'Ci h]bY']g'di V']g\YX" H\Y
bUh fY'cZUggYg'a UmVXUb[Y Xi f]b['h'Y'HYfa 'UZf'f'h'Y'7 ci fgY'Ci h]bY']g'di V']g\YX" A ccX'Y'g\ci 'X'VY
W'cbgi 'h'X'Zcf'h'Y'i d'hc'XUH' WUgg'XYgW]dh]cbg" 'Z'h'YfY']g'Ubm]bW'cbg]gh'bWni]b'h'Y'XYgW]dh]cb'cZ
UW]j]h]Yg'VYtk YYb'h'Y'I b]j Yfg]m]h]a YHUV'Y'UbX'h'Y'7 ci fgY'Ci h]bY'fUg'i dXUH'X']b'A ccX'Y'Udd']Yg"
XYgW]dh]cb]b'h'Y'7 ci fgY'Ci h]bY'# ccX'Y'Udd']Yg"

⇒ U[Y'7 fYX]h

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

7F ⇒CG

7F ⇒CG'Dfcj]XYf'7 cXY. '\$\$\$- , ;

5W_bck `YX[Ya YbhcZ'7 ci bhfm

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